

Readers' choice: Top technology stories of 2009

The editors look back at the past year's most significant articles according to readers of *Automotive Engineering International*, *AEI Online*, and *Truck & Bus Engineering Online*.

1. Uneven firing plays winning tune for Yamaha

"Uneven- or irregular-interval firing has been employed in racing engines—the so-called 'Big Bang,' with more than one cylinder firing simultaneously," said Masao Furusawa, Executive Officer of Yamaha Motor Co. and Senior General Manager of Engineering Operations, Motorcycle Headquarters, when telling the secret of Yamaha's winning formula in the **MotoGP** racing series. "Then there is the 'Long Bang,' with crank phases out of sync. Uneven-interval firing race engines have been known to improve lap times versus even-interval firing ones. How and why they work has not been clearly defined," he said. Furusawa observed that, by simultaneous two-cylinder combustions, peak torque would double, producing a momentary burst of power, but conversely the total number of combustions decreases, thus obtaining the same total. "What the rider wants is combustion torque proportionate to the throttle work, not inertia torque," said Furusawa, who drew an analogy to signal-to-noise ratio (SNR), an electrical engineering term. "Combustion torque is a signal, and inertia torque is noise. Unfortunately, noise increases proportionately to the square of revolutions, greatly deteriorating the SNR." Verification of the Yamaha SNR theory was performed by directly measuring fluctuations in rear tire revolutions during cornering using frequency analysis. Furusawa concluded that the 90° crank engine transmitted the signal/combustion torque singularly and effectively to the driving wheel; this was proven when Racer Valentino Rossi won the MotoGP World Championship astride the Yamaha YZR-M1 in 2004 and 2005. The 2008 season was still young when Furusawa revealed his unique SNR theory and the smallest hint of the YZR-M1 technology.

Full story at sae.org/mags/aei/5586



3. Braking news from Mercedes-Benz

Mercedes-Benz's S-Class hybrid-based ESF (Experimental Safety Vehicle) 2009 brings a new dimension to airbag applications. A "braking bag" between the front axle carrier and underbody paneling deploys in milliseconds when the car's Pre-Safe system decides that a front-on impact is inevitable, effectively doubling the retardation rate compared to wheel brakes on a dry surface.

The car incorporates several other safety technology R&D projects, one of the most extraordinary being inflatable metal structures in the doors to resist side-impact intrusion. A gas generator, supplied by Autoliv, produces an internal pressure of up to 20 bar (290 psi) in the structure, which then morphs to present a shape that has greater stability under high loads. A pulse system nudges the driver and front passenger inboard by up to 50 mm (2 in) immediately before a side impact. Pre-Safe 360° also monitors the rear of the vehicle at ranges up to 60 m (197 ft), applying the brakes 600 ms before a rear impact. An airbag positioned between driver and front passenger prevents their heads clashing in an accident. In the rear, a protective pad positioned above the center armrest keeps heads apart. The ESF's lighting systems include an LED-based adaptive main beam.

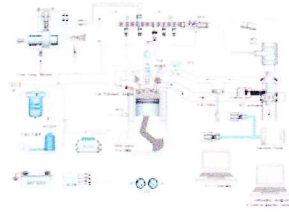
Full story at sae.org/mags/aei/6503



4. Optimizing diesel engine operating conditions

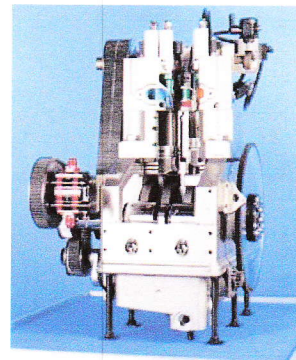
Premixed charge compression ignition (PCCI) diesel engines have the potential to achieve homogeneous mixture in the cylinder, resulting in lower NOx and PM as well as performance improvements. However, it is necessary to optimize operating conditions such as injection timing, multiple injection strategy, cooled exhaust gas recirculation (EGR), intake charging, and swirl control valve (SCV) to achieve the uniform mixture formation. PCCI combustion is typically no simple task due to a trade-off relation between NOx and PM. At the 2009 SAE World Congress, researchers from **Imagineering** and **Hanyang University** presented the results of a U.S. DOE analysis and optimization tool they used to simplify the calibration process of a four-cylinder PCCI engine system. First, an increase in the EGR rate decreases the combustion temperature and the air-to-fuel ratio. As a result, BSNOx emissions decrease rapidly, but BSPPM emissions and BSFC increase. Second, an increase in injection pressure up to 1150 bar results in a slight decrease in PM and BSFC, but a slight increase in NOx emissions. This is attributed to the promotion of the atomization of fuel and combustion efficiency due to the increased injection pressure. However, the high injection pressure of 1300 bar along with the early injection timing of ATDC -60° results in wall wetting that causes high BSFC.

Full story at sae.org/mags/aei/6279



2. Scuderi unveils Split-Cycle engine prototype

The first proof-of-concept prototype of the Scuderi Split-Cycle engine was unveiled by Scuderi Group at the 2009 SAE World Congress in Detroit. The prototype, shown in cutaway form with fully operating internals, is an exact duplicate of the actual bench-test engine

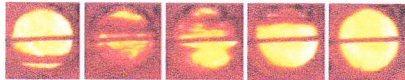


that began testing and analysis at **Southwest Research Institute's** San Antonio facility in May. The 1.0-L twin-cylinder, naturally aspirated, indirect-injection gasoline prototype is expected to produce up to 80% less toxic emissions than a typical gasoline internal-combustion engine, said company Chairman Sal Scuderi. The Scuderi engine was designed by company founder Carmelo Scuderi. His engineer sons Sal and Stephen have moved development forward steadily and methodically since their father's death in 2002. They believe the engine and its novel combustion process offer significant efficiency, emissions, and torque benefits compared with conventional Otto cycle engines.

Full story at sae.org/mags/aei/6317

5. Supercritical fuel injection could reduce diesel emissions

Future diesel engines that exploit a novel state of matter in which heated and compressed diesel fuel behaves both like a liquid and a gas could release as much as 80% fewer exhaust emissions while running 10% more efficiently, according to chemists at **Syracuse University**. The researchers have shown in lab tests that



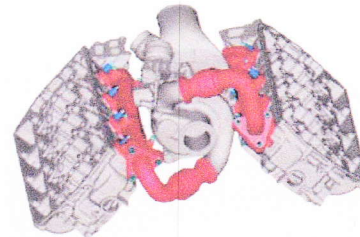
raising the temperature of diesel beyond its thermodynamic critical point—"hot enough that it does not become a liquid even at high pressures"—enables a supercritical (SC) fuel charge to mix with air much faster than standard diesel in conventional compression-ignition engines, said team leader George Anitescu. The patented concept could eventually yield a variety of benefits, including near-complete combustion of diesel fuel and recovery of up to 50% of the exhaust heat; potential elimination of around 80% of criteria pollutants and a significant reduction in released heat; possible engine downsizing by using smaller cylinder displacement to produce the same torque and power; minimizing the parasitic pumping of large volumes of excess air; and the elimination of exhaust aftertreatment systems. The new technology could also impact efforts to tame homogeneous charge compression ignition (HCCI).

Full story at sae.org/mags/aei/6816

6. Ford's V8 raises the diesel-engineering bar

Ford Motor Co. is completing validation of its 6.7-L V8, due to enter production late next year as an option for 2011 Super-Duty trucks. The all-new V8 is the first Ford diesel engine to be developed entirely in house, the first to be certified to operate on 20% biofuel (B20), and the first to comply with U.S. EPA 2010 emissions standards that require an 80% reduction in NOx. The engine is a showcase of clever packaging, combustion control, and robust design. Code-named Scorpion during development, the Six Seven as it is now known features compacted graphite-iron cylinder block, aluminum cylinder heads with dual coolant jackets, inboard-facing exhaust ports with outboard-facing intake ports, a single-sequential turbocharger mounted within the V of the block, piezoelectric fuel injectors operating at 30,000-psi (2070-bar) and capable of five injection events per combustion cycle, and Ford-patented software controls for mixing the urea fluid in the selective catalytic reduction (SCR) exhaust aftertreatment system. This will be the first North America-designed diesel to employ SCR. Output and fuel efficiency are expected to be significantly greater than those of the current 6.4-L PowerStroke diesel V8 and should give the SuperDuty range class-leading payload and towing credentials, according to Lead Engineer Adam Gryglak.

Full story at sae.org/mags/aei/6894



7. Stephens explains fate of GM's stillborn 4.5-L V8 diesel

General Motors' much anticipated 4.5-L Duramax diesel V8 program slated for MY2010 light-duty trucks broke new ground in design, packaging, performance, and program management. But the program fell victim to the prospects of even tighter future global emissions regulations, explained GM Vice Chairman for Global Product Development Tom Stephens. "As the regulations get more stringent, the cost of certifying diesels for passenger-vehicle applications at reasonable cost, compared with other alternatives, makes it difficult to justify moving forward," Stephens told *AEI* in a mid-July interview. The new light-duty DOHC V8 met the very stringent U.S. Tier 2 Bin 5 emissions standards. The engine's innovative cylinder heads featured inboard exhaust ports and internal intake ports. The new Duramax boasted piezo-type common-rail fuel injectors operating at 2000 bar (29 ksi) and a selective catalytic reduction (SCR) aftertreatment system for reducing NOx. Rated output was claimed to be more than 310 hp (231 kW) for 68 hp/L (51 kW/L) and 520 lb-ft (705 N·m).

Full story at sae.org/mags/aei/6672



Top 11-20

11. Fuel cells offer opportunity for stainless

Both proton exchange membrane (PEM) and solid-oxide fuel cell (SOFC) types present new opportunities for stainless steel—for example, in heat exchangers, humidifiers, combustors, and plates. "All of those different components could be made up of metallic materials, and very often stainless steel represents the best optimal point between costs and performance," said Scott Weil, a staff scientist at the **Pacific Northwest National Laboratory**.

Full story at sae.org/mags/aei/6486

12. Ford first with Li-ion on electric U.S. van

Ford's imported van/wagon, the Transit Connect, will be converted to all-electric at a U.S. plant by **Smith Electric Vehicles**. It will be offered with two different-capacity battery packs, one rated for 70 mi (113 km), one for 100 mi (160 km). Availability is scheduled for start of second quarter of 2010.

Full story at sae.org/mags/aei/6480

13. Schwarzenegger 'pumps up' SAE Congress

As the featured speaker to open the 2009 SAE World Congress, California Gov. Arnold Schwarzenegger praised the Detroit Three automakers for the changes they're making and came out strongly for consistent U.S. energy policy.

Full story at sae.org/mags/aei/6311

14. Lincoln to launch park assist in mid-2009

Parallel parking will get easier for owners of Lincoln's MKS flagship sedan and the new MKT crossover thanks to a new technology from **Ford Motor Co.** called Active Park Assist. The option, available in mid-2009, uses an ultrasonic-based sensing system developed with **Valeo** and Electric Power Assisted Steering developed with **TRW** to position the vehicle for parallel parking, calculate the optimal steering angle, and steer the vehicle into a parking spot.

Full story at sae.org/mags/aei/5582

15. Mini goes electric

The company plans to begin series production of an all-electric model in the medium term, and to mark the serious intent of its philosophy, it unveiled the lithium-ion battery

equipped **Mini E** (Electric) technology demonstrator at the 2008 Los Angeles Auto Show.

Full story at sae.org/mags/aei/4861

16. GMC debuts smaller model

General Motors expanded its family of compact crossover SUVs built on the corporate Theta platform with the announcement of the **GMC Terrain**, a derivative that is styled to look more like the traditional body-on-frame trucks that comprise most of GMC's portfolio.

Full story at sae.org/mags/aei/6274

17. Quaife control for Ford's Focus RS

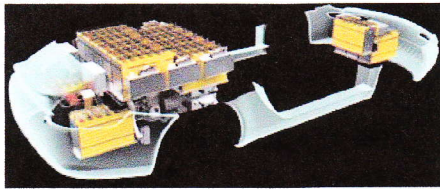
Front-wheel drive and high power and torque outputs are not always easy technology associates, despite advances in electronic traction control

8. Axeon aids RUF with electric 911

An electric Porsche 911 prototype has been announced by RUF Automobile in Germany. Step-off acceleration to 100 km/h (62 mph) in about 7 s is claimed, and its single charge range is described as being better than 300 km (186 mi). The eRUF 911 is equipped with a prototype Axeon lithium-ion phosphate base battery to be followed by a second prototype, which is expected to lead to a production model in 10-12 months.

Battery capacity is 48 kW-h, and charging time is 10 h. The car has a three-phase brushless ac electric motor with peak figures of 650 N·m (479 lb-ft) and 150 kW. Target performance of the production vehicle is a top speed of up to 225 km/h (140 mph) with a range of 250-320 km (155-199 mi) on a single charge. The overall 96-cell battery system has a mass of 550 kg (1210 lb), and RUF states that "preliminary data" puts vehicle mass at 1910 kg (4210 lb). The first eRUF prototype was built by U.S. specialist design and engineering company, CalMotors.

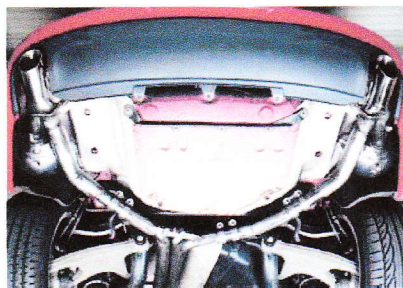
Full story at sae.org/mags/aeil/4679



9. Making tailpipe music

Engineering the tailpipe sound of an automobile has a long tradition. Mechanical devices such as flaps and/or alternate pathways in the exhaust system have served to give a car its brand-specific sound. Eberspächer has now demonstrated an electronic way of actively engineering tailpipe sound. The active sound system can muffle the tailpipe noise by up to 20 dB, make a diesel sound like a sporty gasoline engine, and could give a downsized gasoline engine the beefy sound of a much bigger engine—or it can make sure that a nearly silent all-electric vehicle can be heard by pedestrians. Instead of flaps or other mechanic devices, the system uses a muffler-integrated speaker controlled by a dedicated electronic control unit (currently Bosch-sourced) that emits antiphase sound waves to damp, eliminate, or add individual frequencies and vibration orders in the exhaust gas flow. Equipped with active sound, the rear muffler, for instance, can be reduced by up to 60% in size and may have up to 40% less weight, and exhaust system components could be standardized to a much higher degree.

Full story at sae.org/mags/aeil/6377



systems. The new Ford Focus RS returns exceptional figures for a front-wheel driver, including 224 kW (300 hp) and 440 N·m (325 lb-ft), a combination that calls for special control solutions.

Full story at sae.org/mags/aeil/6360

18. U.S. joins greenhouse-gas game and ups CAFE ante

President Barack Obama announces complementary program to implement greenhouse-gas limits and to increase CAFE targets.

Full story at sae.org/mags/aeil/6545

19. Lithium-ion may be spark needed for sluggish hybrid market

As automakers race to develop electrified vehicles, consumers are balking at

the cost of battery-powered powertrains. Continuing advances in battery technologies and electronic controls are going to play a major role in reducing the pricing premium associated with lithium-ion batteries.

Full story at sae.org/mags/aeil/6333

20. Designing a better steel

Gearing is an area where advanced steels are flourishing. One company that develops such gear steels is QuesTek Innovations LLC. The Evanston, IL-based materials solutions company applies its proprietary Materials by Design R&D process to the design and development of not only new iron-based alloys but also those based on nickel, aluminum, titanium, and copper.

Full story at sae.org/mags/aeil/5891

10. Bentley to reveal alt-fuel car at Geneva

A lighter weight biofuel Bentley was presented at the 2009 Geneva Motor Show that Engineering Director Dr. Ulrich Eichhorn described as being not only the greenest Bentley ever to enter production but also the most powerful, fastest, and most extreme: "It is the first biofuel supercar." The combination of very high output—463 kW (621 hp) and 800 N·m (590 lb-ft)—provides the two-seat Bentley Continental Supersports with performance figures that



include a 0-100 km/h (0-62 mph) time of 3.9 s and a 329-km/h (204-mph) top speed. The car represents a step toward Bentley's stated aims of achieving a reduction of overall tailpipe CO₂ of at least 15% by 2012 through improved technologies for current powertrains, new transmission systems and drivelines, weight reduction, and attention to detail development. But more is expected. Particularly significant is Bentley's plan to introduce a new powertrain, within about three years, capable of providing a 40% improvement in fuel economy. Bentley is placing future emphasis on well-to-wheel measurement of emissions rather than tailpipe figures. "With CO₂, it is the global concentration that matters," said Eichhorn. "It doesn't matter if it comes out of the power station or the car."

Full story at sae.org/mags/aeil/5964

Truck & Bus Readers' Choice

Articles of the year according to readers of AEI's Truck & Bus Engineering Online and Technology eNewsletter.

1. The future is bright for LEDs *Full story at sae.org/mags/tbe/6481*
2. First 'triple-hybrid' fuel-cell bus goes into service *Full story at sae.org/mags/tbe/6474*
3. Heavy-duty hybrids *Full story at sae.org/mags/tbe/5958*
4. Tighter emissions limits drive new heavy-duty diesel control strategies *Full story at sae.org/mags/tbe/5682*
5. New Euro-V engines, revised transmission, and new chassis from Volvo Trucks *Full story at sae.org/mags/tbe/6241*
6. Hybrids advance, but payback still an issue *Full story at sae.org/mags/tbe/6151*
7. Lithium-ion power for commercial trucks *Full story at sae.org/mags/tbe/5716*
8. Iveco launches EEV engines for Europe *Full story at sae.org/mags/tbe/5763*
9. Prototype PHEV fleet van gets 100 mpg *Full story at sae.org/mags/tbe/6430*
10. Lightweighting heavy trucks *Full story at sae.org/mags/tbe/6748*