



Alabama Audis

German Rocket Science lives in the South

by Mat Hayashibara PHOTOS BY LES BIDRAWN



When thinking of performance for high-tech European machinery, the state of Alabama is probably far from the mind of the Audi enthusiast.

Alabama...isn't that Nascar and country music territory? Truth be told, parts of Alabama are magnets for high-tech industries, anchored by NASA's George C. Marshall Space Flight Center in Huntsville. With the NASA presence comes peripheral aerospace activity and the engineering schools required to feed it. Coupled with a very reasonable climate for business, the formula serves to create a crucible in which some really good rocket science can be blended with automotive engineering and put to simmer



APR is: Stephen Hooks, Chris George, Erin Cochran, Brett Augsbarger, Nick Kasberger, Tom Patton and Matt Middleton (not pictured, Eddie Burwell, Frank Dudel and Kenelm Winslow) Go see them if you want a faster Audi.

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The principles of Audi Performance and Racing (APR) were brought together in this environment. Steve, one of the three original cast members of APR, remembers the events: "Originally, myself and Brett, who is the head engineer here, got together in school at Auburn. We went from there, found the right people willing to work—young, enthusiastic and talented. One of the engineers has two Master's degrees from Georgia Tech, electrical engineering and physics. Another has a mechanical engineering degree from Auburn University, and one more has an ME from the University of Alabama at Huntsville". Serious credentials indeed.

Though inexperienced, the desire to succeed was evident from the get-go. Steve remembered, "We went right into this right out of school. We previously had another shop which was really a launching pad for this effort. It was also a performance shop, something to get us up and running, set up a business plan and

get everything going behind the scenes." From there the little shop grew quickly. Steve recalled "There are 10 full-time guys and two part-timers at APR now. We started out as a bunch of guys in engineering school!

Why Audis? Steve took a moment to elaborate: "The three owners are all Audi enthusiasts. We've been around and driven Audis for a long time and feel they are the greatest cars on the road! They offer the greatest value for the dollar of all the cars out there. That includes the performance, longevity and features of the cars. That's before you even start modifying them. You're getting an incredible car for a really good price. You might spend \$10,000 to \$12,000 more for a BMW that's sometimes less of a car."

Steve was quick to point out that Audi's efforts in motorsports during the '80s and '90s really awakened them to the performance potential of Audi cars: "We watched the IMSA and Trans-Am cars in the late '80s and early '90s, when they were beating everything out there. There were invincible in World Rallying at that time. We saw the incredible potential

of these cars in the mid '90s and realized things could really take off. But there was nothing out there in terms of serious tuning parts. We were very dissatisfied with what was available in the market, so our motivation was to develop some new parts. Most of the people out there were selling or re-selling parts that they had put no development work into; they came from somewhere else."

Why remain in the South? "Well, where we are here, we've got our costs pretty low. You can UPS or Fedex stuff anywhere it needs to be. We have really no local market; we've had maybe four or five people from Alabama come here. But you don't need to come here. This is really just a design, research and development facility. You can sell our parts worldwide. We're in the process of going full green with our dealer network over the next two months in the U.S. It's not a big deal being here in Alabama."

The arrival of the 1.8 Turbo A4 was a turning point and would prove the catalyst for APR's top-drawer product, the A4 turbo upgrade.

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Clockwise from above: Garrett impeller vs. K04 impeller: note difference. APR's optimized exhaust manifold as compared to stocker. K04 vs. Garrett: note housing difference. A4 vs. S4: bet on the lighter 1.8t. APR's S4 exhaust features resonance-chamber technology.



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"The genesis of the idea that the 1.8 Turbo Volkswagen and Audi cars are the tuner cars of the '90s. Our opinion was that there was not a whole lot out there besides the chips and exhaust; and then, that KKK K04 Turbo. In our opinion, not much of an upgrade was available. So, there really wasn't a lot available that could take advantage of what this motor is capable of."

Before designing any parts, the APR group took a serious look at the 1.8 engine and its shortcomings. "We started looking at the weak links in the motor and realized that the exhaust manifold and stock turbo had to go," Steve remembered. "So we used a Pro-E 2000 and Pro-E Modeler and designed a completely new exhaust manifold



Above: APR uses high-flow, balanced and blue printed injectors. **Below:** Increased boost puts significant strain on the S4's pipes; APR's high-strength clamps and tubes ensure things stay together.



from scratch. We also used computational fluid dynamics (CFD) analysis to verify the flow results on a computer" Pro-E is a computer-aided design (CAD) package that is optimized for designing complex three-dimensional shapes.

One of its more interesting capabilities is the ability to generate surface models of the parts in the computer, which permits post processing operations like CFD. Computational fluid dynamics is yet another computational

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technique used to model airflow and is in fact how the aerospace industry simulates the aerodynamic properties of various parts without having to go to the wind tunnel or build models. The proximity of APR to the local engineering schools definitely helped here, as the expertise to perform these kinds of design and analysis were readily available.

Steve continued, "Once you design a part in Pro E and perform the analysis, you can do a rapid prototype in a laser stereolithography machine. That gives you a plastic part you can test and perform fit checks with. From there, you can make a manufacturing tool. That tool then goes to the foundry for making



Above: APR's EMCS (enhanced modular chipping system) is an ECU interface that allows the S4 unparalleled control of the car's performance. **Below:** CAD-rendered tubing ensures top performance.



the final castings."

Laser stereolithography is one more advanced computer technique. The computer representation of the part is used to directly create a three-dimensional part by scanning lasers over a liquid plastic that is cured by ultraviolet light. By building up a part layer by layer in a vat of this plastic, very complex shapes can be realized with no drawings are machining. This is really leading-edge engineering, as far as the method for parts development used;

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it is basically the method used by the aerospace industry to develop their mechanical parts. "Within the next three months, we'll have our own SLA machine," Steve noted. "This is technology that is used by every F1 team, and in North America is in the hands of Fortune 500 companies or aerospace companies. We base all of our processes on the most advanced leading-edge technology we can find, and applying it to the automotive scene."

After getting the shape on the manifold as perfect as could be, attention was turned to the material it would be made from. It was clear the stock cast iron also had to go. Steve explained, "The material used for casting the manifold is Inconel-625, which is probably one of the best materials for this application. It's heavily nickel based; there's no iron in it. It's very dense and its properties are such that it really holds the heat in, unlike cast iron. So all of the energy is focused on making the turbo work instead of being wasted and heating up the engine compartment."



APR's Stage II program for the 1.8t is good for approximately 250 bhp.

The stock KKK turbo wasn't up to the task APR had cut out for it. Steve expressed APR's opinion of the parts: "We don't use any of the KKK turbos, because you don't have many options, and the design is kind of antiquated. You can see Audi and other manufacturers use the Garret units in their racing programs. It's light years ahead of the other units out there." Fuel management is also enhanced, as Steve pointed out: "We don't cut corners, we do not fit a rising rate regulator as a Band-aid for the fuel management; we fit bigger injectors instead. These are higher quality Lucas units that we have specified. "NGK spark plugs and a high-flow catalyst are also included in the turbo upgrade kit. The manifold, turbocharger, injectors, a high-flow catalyst and all of the ancillary pieces like lines, fittings and hoses are included in the APR

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bolt-on A4 Stage III kit. When assembled, the system appears stock under the hood; it takes a very close look at the manifold and turbo to realize the car has been modified.

With respect to the ECU's chip tuning, the APR program includes some modifications to the stock engine management computer; this is done in-house at APR. The circuit board and programming of the EPROM are extensively changed; there is considerable added code in the APR EPROM chip. The A4 exhaust system is 2 1/4in. in diameter from the catalyst all the way to the rear, with two mufflers.

Manufacturing is carried out wherever APR deems it can be done best, as Steve explained: "Some things are done here, in-house, and we contract with people in Texas to perform foundry work, casting and the like. Our shock partners are in Ohio. We try to pick the best sources in North America for whatever we're trying to do."

All the cars pictured are APR's R&D



APR's technology works just fine on the new generation of Volkswagens. By-pass valve(left). APR's stout stainless-steel hosing(right).

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vehicles and see the road regularly. We'll do our best to explain the way they were set up when the photo shoot occurred, but be aware that APR is in constant process of developing, testing and introducing new parts. So, by the time you read this, the development mules are bound to be quite different.

The white A4 has larger Alcon brakes installed. Steve observed that Audi Motorsport uses Alcon components in its race cars like the R8R and all of the Touring cars. "Audi has worked closely with Alcon, and has done an excellent job with them," he says. "They are a little on the pricey side, but we feel the extra cost is worthwhile." In front, the white A4 has the 13x1.25-in. D-type rotors with four-piston monoblock calipers, and out back R-type rotors of stock size with twin opposed two-piston calipers are installed. Stainless-steel lines and AP Racing silicone brake fluid are used as a matter of course.

Koni adjustable shocks, specially re-valved for the application, have been fitted to the white A4. Hypercoil springs of a 600 lb/in. rate are used in front, while 650 lb/in. springs are used in the rear. The shock bodies are externally threaded with adjustable spring perches, so the ride height is fully adjustable. In the photo, the car is sitting about 2.5 in. lower than stock, having just completed some testing at Mid-Ohio. The stock sway bars remain on the car, as Steve didn't feel upgrades are necessary. "Our philosophy is that the shock tuning sets your roll resistance. If that and the springs are setup correctly, sway bars aren't necessary. We feel it's one of the very last things you do, if everything else fails. A lot of companies like to throw them in, on any car. If it's not right, or it doesn't work, we just don't sell it or do it."

The engine in the white A4 is what APR calls a "Stage III Plus" configuration. All of the parts from the Stage III turbo upgrade kit are fitted, along with a front-mounted intercooler, a different recirculation valve and a full exhaust. The intercooler fits into a



APR was one of the first to tap into the TT's potential. APR's overbuilt exhaust bits (right).

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stock bumper without modification. Steve estimated the car produces 325 to 330 bhp in this configuration, with 21 psig of boost. Remember, this is with a motor that is unmodified internally, with what Steve terms as "about 50,000 accumulated miles of abuse." "It's never hiccupped once!" Steve said.

The APR clutch and lightweight aluminum fly wheel (7.5 lb) has been fitted to the white A4. "It's really great if you like to spin it up," Steve commented. To eliminate driveline lash,



Light, nimble and hugely fast, APR's Stage III program for the A4 1.8t is more than a match for the S4.

the APR urethane engine mounts are used; these units are also designed with CAD. Topping off the engine room is a vented fiberglass hood.

This summer, a Stage IV kit will become available with some internal engine parts: a new crank, rods, pistons and special cams. Capped with some head work, APR is expecting even bigger power gains. As with the other kits, this will be OBD-II and CARB compliant.

The car presently wears 8x17-in. O.Z. wheels with Toyo Proxes RAI road-racing tires. These are to be replaced as this is being written. "We're the largest dealer of Fikse in the United States, and were going to put some of the SM10 wheels on it, 8.5x18 in.," Steve said.

Inside, racing harnesses have been installed, along with a MOMO race seat. APR plans to market a removable rear harnesse bar for competition shoulder belt attachment in the A4s soon. There's no cage in the A4...yet.

The red S4 is in what AR terms as a "full Stage 2" trim. This has Alcon-B type brakes, consisting of 13x1.25 rotors squeezed by four piston-calipers. Soon, this S4 will utilize six-piston calipers for even more stopping power. The suspension is the highest level upgrade offer by APR for street-driven S4s. This is comprised of Koni externally adjustable two-way shocks (compression and rebound damping are both tunable) with special valving developed by true choice motor sports in a Hilyard, Ohio, best known for working with Indy car teams.

The shocks begin life as stock Konis but are totally rebuilt by true choice. Eibach springs of 600 lb/in. front and 650 lb/in. rear are installed.

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Again, due to threaded spring perches and shock bodies, the ride height is fully adjustable on this car. SM5 8.5x18 wheels wear Yokohama AVS Sport 235/40-18 tires.

The APR exhaust system and Stage I chip, along with a K&N drop in air filter, are the extent of the S4s engine work. Still, the combination brings 320 bhp and 375 lb-ft of torque. Turbo upgrades are in the works, APR plans on producing two kits for the S4, one with 450 bhp and another with a whopping 550 bhp! Both will offer Garrett turbo upgrades, the big-bore king hell-killer kit will include a redesigned exhaust manifold, incorporating ideas developed in the A4 program.

The S4s hood is an 11-lb APR unpainted carbon fiber unit. (The stock unit weighs 38 lb). No further drivetrain modifications have been performed to this point, but more are in the planning stages.

The yellow A4 is in a mild (for APR anyway!) Stage II specification. This consists of a 1.0-bar (1 bar is one atmosphere of pressure, or about 14.7 psi at sea level) boost chip, a K&N filter and APR exhaust. In the suspension department, it has the same coilover shocks, and for brakes it uses the Alcon-B types, in the front only.

The black Golf currently has only the APR chip and T T wheels but will become the development platform for the APR 1.8 Turbo kits for the transversely mounted engines. Due to the orientation of the VW and TT motors, there are the expected mechanical changes made to fit the different engine bay, but Bosch 7.0 electronics will remain the same, as they do for the Audi A4. APR is glad that the platform engineering and shared components between the A4 and VW products allows them to have a bigger market for their 1.8T tuning kits. "It's a great cross over," Steve observed. "By the end of this summer, we will have 1.8T 280- and 310-bhp kits for the transverse cars. That covers the Jetta, Golf, Beetle and TT."

Steve noticed differences in the electronics, however, especially in the software area. "On the inside, the Beetle was the only car the VW

engineers worked on. The Jetta, Passat and Golf were all done by Audi."

The denim-blue TT is a Stage II car with the 1.0-bar boost chip and an APR exhaust. H&R lowering Springs and SM5 8.5x18 wheels with Yokohama AVS tires get the stance right. Steve noted the coilover kits for the transverse cars will be out in a short while.

In looking at all the cars together, Steve pondered a frequent customer question: "People ask all the time, should I build an A4 1.8T or buy an S4? The answer to me is if you want to cruise a thousand miles on the highway and go fast in a straight line get an S4. If you want a marvelously accelerating, handling and braking car, then the A4 1.8 is the way to go, without a doubt."

Steve and APR are enthusiastic about the future and the performance of their bolt-on turbo kits. "What you end up with is a daily dri-

ver that your wife or girlfriend can drive every day and enjoy. But, you can drive it on the track and then drive it home. You get driveability, great reliability, but awesome power. It's easy to get a 320 to 350 bhp on a stock motor with just these bolt-ons. That's without going inside the motor."

But soon, the rocket scientists know-how and advanced techniques will find their way inside the engines of the APR Audis, just like it has enhanced performance in the bolt-on turbo kits.

Audi Performance & Racing

1027-B Opelika Rd.

Auburn, AL 36830

(800) 680-7921

Fax: (334) 502-5180

www.goapr.com