

Black Ops

PUTTING MODOTEK'S NEW ECU TO THE TEST ON THE STREET, DYNO, AND DRAGSTRIP Text and Photos by KJ Jones

In our last report on Project Cheaper Sleeper ("Spoiler Alert," May '13), we detailed all of the undercover changes that Rocco Acerrio (A.R.E. Performance & Machine) and Stevie Morrow (Stevie's Garage) made on the virgin-stock '91 Mustang LX (5.0/AOD). This time around we are highlighting several cool concepts that were implemented in the 'Stang's makeover. However, one component that was added—Modotek's BlackBox v2.0 ECU—stands out among the project's headlining upgrades.

Call it perfect timing, as we received word of the BlackBox v2.0 just a few days after your scribe assumed ownership of the project Fox for \$1,000. Shortly thereafter the idea of installing a low-dollar EFI 331/nitrous combination under its hood spawned. When weighing the options of how to control the engine package, we knew the Modotek ECU would be perfect for bringing our Pony's 331 stroker to life and dialing-in its performance on the street, strip, and chassis dyno.

In the old days, once performance mods went beyond adjusting timing and fuel pressure, it was time to tune EEC-IV engine management with a chip. These chips are small data modules that contain programmed timing and fuel commands

► Modotek's all-new BlackBox v2.0 engine-management system is controlling Project Cheaper Sleeper's A.R.E. Performance & Machine-built beast. This full-featured PCM system was selected for our effort because it plays right into our under-cover theme, plugging directly into the LX's stock wiring harness. Mark Chollet, the man we've come to know as Modotek Mark, is one of the technical wizards behind BlackBox v2.0's development. "We designed the Modotek BlackBox system specifically for stock 5.0 Mustang owners who plan on modifying to a point where stand-alone engine controls are necessary for achieving performance that goes beyond the ability of the stock ECU. It also supports 'Stangs that are already outfitted for making serious power via nitrous, turbos, and superchargers," Mark explained. "While there certainly are other systems on the market that operate similarly, the BlackBox is the only PCM that plugs directly into the factory's EEC-IV wiring and sensors in '86-'93 'Stangs, and is ready to control just about any pushrod-engine combination an enthusiast can create."



HORSE SENSE: We hope after reading this, you'll head down to your local newsstand and pick up a copy of our annual special issue, *1979-2013 Mustang Performance*. This year, instead of focusing on one particular platform or year range of Mustang, we're bringing you a magazine filled with features and killer tech ideas that follow a budget-build theme. Look for copies on your favorite mag rack starting August 18, and drop us a note on Facebook or send a Tweet to let us know what type of Mustang projects you're working on.



▲ This is basically all the BlackBox v2.0 consists of. Modotek also offers free calibrations that handle most of the basic bolt-on 5.0 upgrades, as well as additional wiring harness options that can solve some of the potential challenges caused by the OEM wiring's old age.



▲ First, second, third, and fourth glances at Sleeper's stock-block bullet certainly will keep you guessing about the engine's overall makeup. While some Fox aficionados may cite the Explorer intake manifold, Anderson Ford Motorsport Power Pipe (despite its black powdercoat), 75mm BBK throttle body/spacer combo, and short-tube headers as being the engine's only mods, there's a lot more happening inside. For more info on this sneaky powerplant, check your magazine archive for "Spoiler Alert," on page 58 of our May '13 issue. Just don't tell the Brand X guys. When they ask, we just say it's a "stock 302 with a cam and exhaust."

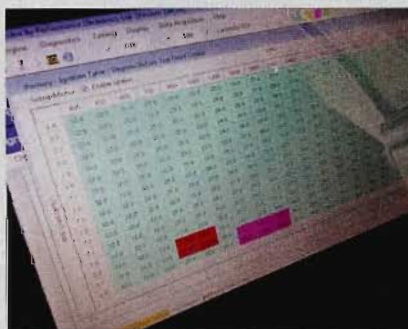


▲ The BlackBox v2.0 works with stock mass-air sensors or such mass-air upgrades as the Abaco DBX (an 85mm DBX measures airflow for Sleeper's engine). With BlackBox, the mass-air sensor can be controlled and monitored as a "load input," turning its curve into a 3D tuning map instead of the basic 2D mass-air scaling that is common in other tuning software.

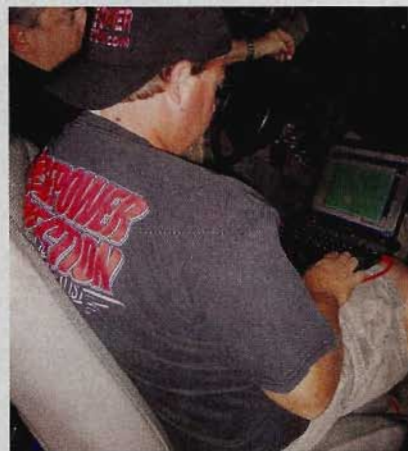
that override the stock programming for a modified 5.0. They plug directly into a PCM's circuit board. While effective, chips are old news because they are fixed calibrations that cannot be manipulated on the fly.

Through the years, piggyback processors were a saving grace, of sorts, for street Ponies making big steam. Of course, the next level on all of the aforementioned tuning variants are the various stand-alone systems. While any of these systems can be used for moderate-performance applications, like our project car, they're a lot more elaborate than we really need. Typically such systems are used for high-powered Mustangs loaded with race parts.

There's one thing that we said about BlackBox v2.0 in our last report that



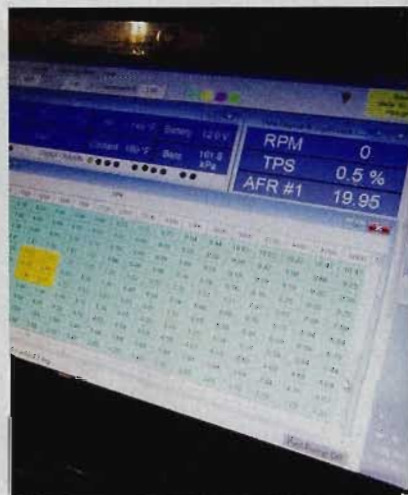
▲ Just like many high-end, race-car-oriented, standalone ECU systems, the Modotek allows users to fully control all aspects of fuel and ignition timing. This is the timing table for our '91's engine. With mass-air load primarily in the 0.5-to-1.6 range, optimal timing for Sleeper's 331 landed at 30 degrees. As you see, this relatively low mass air-load spectrum leaves a lot of extra cells. While we didn't get into those areas to set timing for our combination, each engine will use a different part of the table depending on the amount of airflow the engine consumes.



▲ You might remember our friend Brian Macy of Horsepower Connection in Lake Havasu, Arizona, from our power-making exploits on the dyno with Project T-top Coupe. A valued consultant to several aftermarket EFI manufacturers, Brian was invited to join us as we experimented with the newest player in the aftermarket EFI game to provide feedback and insights on the system's merits and nuances.

definitely deserves repeating here: Many of the standalone systems, while excellent, are often a bit too advanced for some setups. Modotek addressed cost (the basic BlackBox v2.0 system is only \$1,349) and user-friendliness head on by designing the first plug-and-play management system for EFI Foxes that connects directly (one-to-one) into a stock wiring harness. Furthermore, it allows users to precision-tune engines and power-adder systems (using a laptop) for maximum performance, the same way it's done with a stand-alone system that requires all-new wiring.

Enough about its potential. Let's get down to how it installs, and more importantly, how well it works on Cheaper Sleeper.



▲ BlackBox v2.0's Primary Fuel Table is the area where a majority of the tuning work occurs, especially for dialing-in idle and low-speed/street driveability. The table emulates the VE-style tuning map that most speed-density tuning systems use. However, it also manages fuel in sequential, semi-sequential (bank-to-bank), or throttle-body injection. We're also using Modotek's dual-wideband option, which allows us to datalog both banks of the engine to ensure they're operating at a safe air/fuel ratio.



▲ Cheaper Sleeper's 331 stroker was built by Rocco Acerrio of A.R.E. Performance & Machine of Simi Valley, California, and designed for use on the street or strip with standard pump fuel. We loaded the 'Stang's tank with 91-octane for all facets of our testing on the streets and freeway, and on the rollers of the Dynojet chassis dyno at GTR High Performance.



▲ We logged more than 300 street/freeway miles on Sleeper's engine and drivetrain before putting the project 'Stang to the power test on the dyno. The BlackBox v2.0 ECU has all of the typical tables that are used for driveability calibration: air-temperature compensation; fuel and ignition compensation (per cylinder, if desired); water-temperature compensation; fuel and ignition; MAP compensation; and battery, barometer, accel/decel, and starting compensation tables. While experimenting with the system, we discovered one cool feature that actually isn't a tuning feature at all—a diagnostic scan tool that's built into the system for troubleshooting. Yes, BlackBox v2.0 has the ability to fire the injectors, and through its onboard oscilloscope, detail their open-and-close rates. This is great for solving injector-related issues. There also is a similar diagnostic function for cam-sync and crank-sync inputs, which let you see exactly what the incoming signal to the PCM looks like. It also includes a data-acquisition function that facilitates monitoring all details of the engine's operation at 20-to-100 samples per second.

▶ As we noted in the projects introductory article ("Beg, Borrow, and Deal," Jan. '13), your author's daily pilgrimage to and from the 5.0 West Coast home base (El Segundo, California) is a 60-mile round trip that many times can take as long as three hours to complete, especially when traffic on SoCal's infamous 405 Freeway is at a standstill. With that traffic and warm ambient temperature in mind, we were anxious to see how the new setup would fare during a long ride at crawling speed. Cheaper Sleeper proved it is up to the task, as engine temp remained steady at 160 to 170 degrees, voltage solid at 14.4 volts, and oil pressure at a constant 65 psi, with the engine never really going past idle for at least 20 miles.



▲ Project Cheaper Sleeper, our stealthy, low-dollar '91 Mustang LX, makes moves through its natural habitat, the streets of Southern California. We have to send a shout of thanks to Big Stevie Morrow of Stevie's Garage in Simi Valley, California, for imparting his creativity and infinite mechanical talent on Project Cheaper Sleeper. If you have a cool upgrade idea for a late-model 'Stang, Stevie definitely has the know-how and skill to make almost any concept a reality.

ON THE DYNO

ON THE DYNO

The break-in period (approximately 300 miles of road testing) for Project Cheaper Sleeper's new bullet allowed your tech editor and tuning wizard Brian Macy of Horsepower Connection to work with the new Modotek BlackBox v2.0 engine-management system. This affordable (\$1,349) plug-in ECU can use short-term and long-term fuel trims to determine the amount of fuel correction necessary for achieving a targeted air-fuel ratio (13.97 for cruising).

In the tuning world, the short-term fuel trim is the amount of fuel that the O₂ sensor is allowed to change instantly, while the long-term trim is fuel values that are stored in another table and applied to a calibration by the tuner when and where desired or necessary in the map.

We actually started calibrating with the basic 5.0 startup tune programmed in the BlackBox v2.0 by the factory, and used the unit's Closed-Loop, Long-Term Factor Table (or in basic terms, the "learning option") to help get our fuel map in check rather quickly while driving down the highway. One of the neat things about this system is that (with a laptop, of course) you can watch this table real time to see how far off you are in your tune and apply changes to the whole table or just small sections.

While everything went well with achieving great driveability, we were anxious to strap our Mustang on the rollers of GTR High Performance's



▲ While determining Sleeper's power and torque gains were at the top of our must-do list, Brian and Ricardo Topete of GTR High Performance (driver's seat) spent a good amount of time making low-speed/part-throttle runs on the Dynojet, fine-tuning that aspect of the PCM's calibration.

Dynojet chassis dyno to see how the ECU would measure up when it was time to calibrate the engine for power, naturally aspirated and with a hit of spray from the Nitrous Oxide Systems plate that is secretly swedged between the 331's upper and lower intake plenums.

We made several runs, steadily changing values in the PCM's Base Fuel Table



▲ BlackBox v2.0 can present real-time, 3D graphic versions of all tuning tables. Brian feels that this presentation is extremely helpful for novice tuners, as it clearly identifies all of the holes in a fuel or timing map, and helps users build smooth, efficient curves.

until air/fuel ratio matched the target we set in the Closed-Loop Table. Once that was achieved, we experimented with the timing to see where the engine made the most power. At WOT, 32 degrees of total timing and 12.7:1 air fuel netted us 278 horses at the feet. That's a solid 100hp gain (through an AOD) over Cheaper

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DRAG DAY

As you can imagine, we were really excited about taking Project Cheaper Sleeper to the dragstrip and evaluating how the additional power (hopefully) improves the Pony's previous-best e.t. and speed. In the spirit of your tech editor's experience participating in *Hot Rod* magazine's Drag Week 2012, the decision was made to conduct a "Drag Day," loading all of the racing essentials into the 'Stang's hatch and driving to the dragstrip in Bakersfield, California...140 miles away (one way) from KJ's home...and back.

In a nutshell, the effort was a total success! The project 'Stang was flawless in both driving segments of the road trip. And on the track, the gain of nearly 1.5 seconds and close to 10 mph over the best factory-stock performance (naturally aspirated) is awesome when you consider the car's 3,500-pound weight and that passes were made without manually shifting the AOD. The Performance Automatic tranny was run in D for the duration of our test day to replicate the manner in which the 'Stang was driven (with the stock engine and AOD) in our baseline runs.

Unfortunately, time ran short on our test day and we were not able to fire the nitrous system. However, we're happy with the results and what we learned by running the car in naturally aspirated trim first. Now, of course, we know there are plenty of similarly configured Foxes out there that post better numbers than this and may be just as capable of performing as efficiently on the street. The important thing to keep in mind for our 'Stang is that from the project's outset we noted there's no desire to set the world on fire with this Pony. Doing that typically carries a hefty price tag, even when you're smart shopping and finding good deals.

The horsepower and torque gains that we saw on the dyno and in the mile-per-hour increase in the quarter-mile are



▲ The racing side of our 5.0 West Coast operation actually does have the benefit of having both enclosed and open trailers that can be used for track outings. However, as a way of testing and confirming Sleeper's true street/strip credibility, we elected to load essential race gear in the LX's hatch and drive it to-and-from the dragstrip.

strong indicators that by simply adjusting the TV cable (to extend the transmission's shift points when racing in D) or by manually shifting the AOD, Sleeper definitely is a 13-second/100-plus mph ride. We also know that by installing a looser torque converter, swapping heads and intake for better airflow, putting the heavy Pony on a diet, and focusing on a few more racier mods, Sleeper probably would be in the 12s—without the nitrous.

Other than possibly knocking off a few pounds, don't count on seeing such changes any time soon. We're proud of the solid accomplishments that were made thus far, and remember, we still have a 150hp shot of nitrous to play with the next time Project Cheaper Sleeper is at the track.



▲ The dragstrip test was conducted at Famoso Auto Club Dragway in Bakersfield, California, roughly 140 miles north of your tech editor's home base. The run is a straight freeway shot into 5,000-foot elevation and ends with a brakes-better-be-good descent down the infamous Grapevine hill into Bakersfield. BlackBox v2.0 handled the atmospheric highs and lows with no issues.



▲ We had to mark our arrival in Bakersfield with a photo. The journey was our 'Stang's longest and farthest non-stop effort since we got it running; it made the run without experiencing any problems.

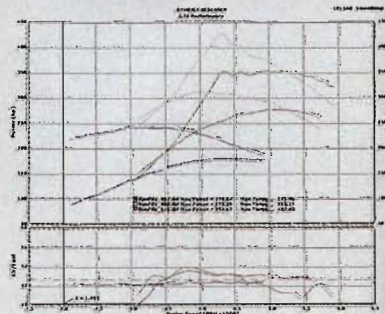
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ON THE DYNO CONT.

Sleeper's original bullet, thanks to a few more cubic inches, a slightly better (but still OEM 5.0 Ford) cylinder-head/intake-manifold package, and a lumpy camshaft, all of which can be scored for minimal cash outlay.

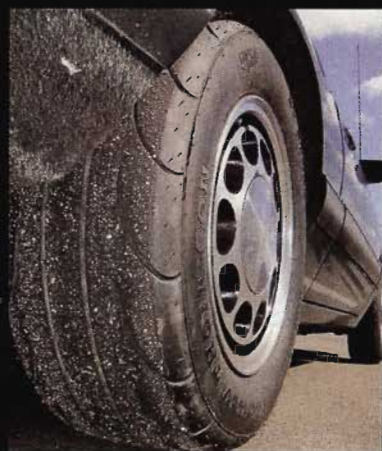
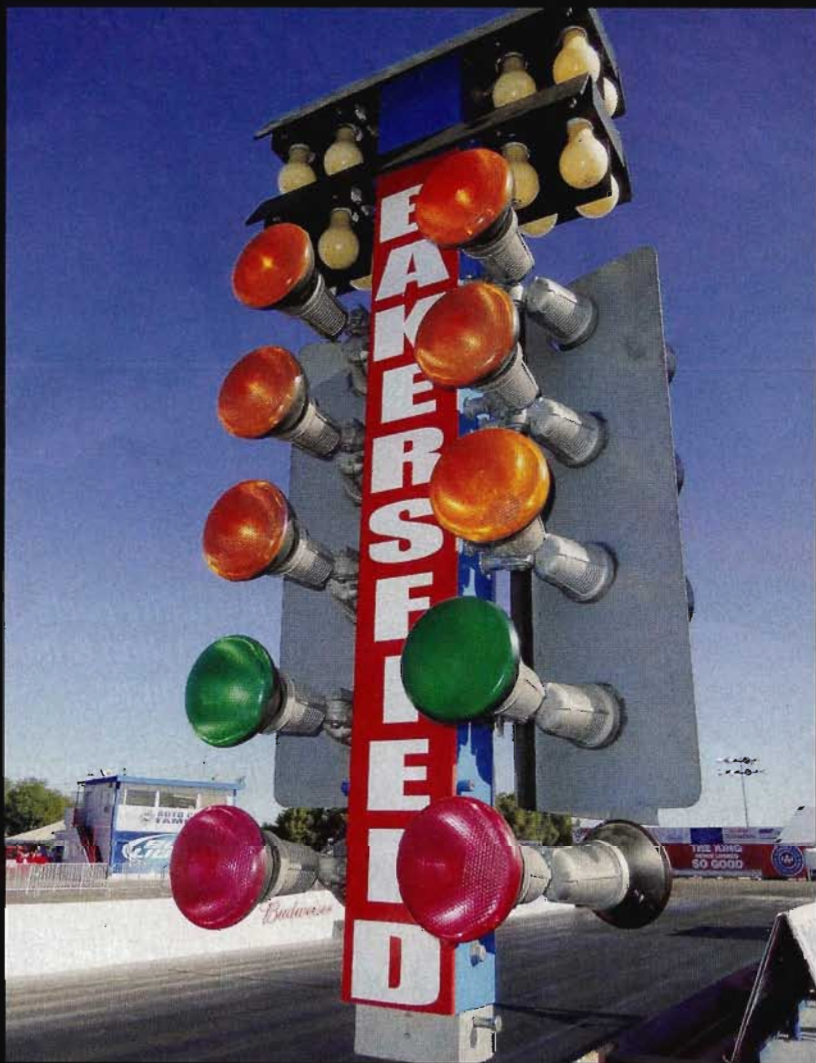
With the naturally aspirated calibration set, we then focused on building a nitrous tune. For nitrous, ignition timing typically is retarded when the unit is activated while fuel is enriched. With target air/fuel set at 12:1, Sleeper's stroker responded best to 6 degrees of timing retard, hitting the dyno hard with 354 horsepower and 427 lb-ft of killer torque at the feet.

As an expert who works with all types of high-end engine-management systems and consults with manufacturers on ways to improve them, Brian gave his thoughts about the Modotek BlackBox v2.0. "BlackBox is a great ECU for the price," Brian said. "The system is full of awesome features, and there is no shortage of modifiers in the software that will allow beginner and advanced tuners to get almost any engine combination running well, as long as all of the general specifics for the engine are in order. Honestly, had this system been around when KJ's T-top Coupe was built, that supercharged Mustang could actually have a mass-air sensor and be tuned to make the same 1,000 hp that it currently makes," Brian said.



▲ We're pleased with the gains we saw from the sleeper's new drivetrain, which includes the AOD transmission that highlights Performance Automatic's 5.0 Restoration Street-Smart Package (PN PASS53150). With a 15-percent power loss taken into account for the AOD, the project 'Stang's naturally aspirated 278 rwhp actually is 330 at the crankshaft (almost one horsepower per cubic inch). As you see in the graph that accompanies this data (red trace), a perfect 100hp gain over the Pony's original high-miles stock engine (blue trace). The green trace represents the result of a 150hp nitrous hit (354.67), which equates to 418 ponies at the crank with the AOD correction applied!

DRAG DAY CONTINUED



▲...And out back, MT's 235/60R 15 ET Street Radials fit perfectly in the Mustang's unmodified (save for fender rolling) wheel wells. One thing to note is the tires are slightly taller than a Fox-body's stock-style boots. As such, fitment might be a concern for aggressively lowered cars and could warrant installing taller rear springs, adjustable control arms, or coilovers.



▲ Burnouts at the dragstrip are typically a method of cleaning off the rear tires to ensure they're ready to stick to the racing surface and provide the best launch possible. As such, roasting the tires and sending plumes of smoke skyward isn't exactly "necessary," but it definitely looks cool. A caveat to this is when you're making the first pass on brand-new drag radials. Our friend Big Carl Robinson of Mickey Thompson recommends "hitting the DRs pretty hard on the first hit." With a line-lock (see Other Hidden Pleasures sidebar) ensuring the Pony would sit stone still, following that rule was easy.



▲ Setup and the transformation from street to strip is easy when you have the right equipment. We had the tires swapped, air-pressure set, and the Pony ready to run in less than an hour.



▲ From the side, it's just another stock 5.0 on 10-holes. Ha!



▲ Mickey Thompson Tires' 26x6-inch Sportsman S/R radials are narrow enough to give Cheaper Sleeper a skinnies look up front...

AUTO CLUB FANOSO RANCHO
ARRA SPRING NATIONALS
JUNE 15-17
JUNE 22-24 INCA WEST COASTER
SUMMIT SERIES PAGE 84
Time: 87.7 FN or 5:38 AM

5:25 PM
22/JUN/2012

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COMMENTS: AUTOMATED 104 11
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► This is the data from our project 'Stang's previous-best dragstrip run. This pass was made with the car in its original untouched trim, and with the transmission shifting itself (in D) through the quarter-mile.

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DRAG DAY CONTINUED

► BlackBox v2.0 has several user inputs and outputs that can enable maps or other features, or turn accessories on or off. While we didn't work with the nitrous system on this outing, a flip of a toggle switch is all that's necessary for arming the system, which lets the PCM know to retard timing and send a pulse-width-modulated signal that operates the solenoids per values entered in the unit's progressive nitrous controller. As it is with the bigger systems, everything with the BlackBox v2.0 is done through keystrokes of the laptop, including setting three separate rev limits.



► Sleeper stopped the clock in 14.37 seconds with a speed of 99.13 mph in naturally aspirated trim and the AOD left in D (not shifted). While the performance isn't ultra-quick or fast, we're impressed with the 1.4-second quicker e.t. and nearly 10 mile-per-hour gain over the stock-engine's best. We also realize that with manual shifting (the AOD's TV cable setting had caused the trans to short shift), both e.t. and speed will improve to be more in line with the 13-second/100-105-mph laps that are typical for similarly configured Mustangs.

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Car #	Test-L	Test-R
CHESS ...		
100/100 ...	0	14371
DIAL ...		
R/T791
160 ...		2.187
200 ...		4.151
1/8 ...		9.346
MPH ...		76.70
1000 ...		12.052
1/4 ...		14.377
MPH ...		99.13

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..... Convert: 0/1 Start: 2011

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MORE HIDDEN PLEASURES

There are all sorts of cool upgrades that are buried within Project Cheaper Sleeper. This is a sampling of a few more sneaky mods that we came up with—cool yet functional and efficient changes that play right into our stealth street/strip 'Stang concept.

While we've emphasized throughout this project that mods like these can come cheap through smart shopping, deal-making, and so on, we must add one caveat. Custom-made wheels like the big 'n' little-style 10-holes that Pico Wheel Service created are among the few pricier items. You probably won't come across a set of hoops like that on the used market, and by the time you have a set made, have the wheels powdercoated (notice the black accenting on our wheels), and then add Mickey Thompson rubber, you'll have spent a little more than a grand.

Yes, that's a pretty big ticket for cool. However, if you plan well and make good moves in other areas, scoring nice custom pieces certainly can happen despite a tight budget.

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MORE HIDDEN PLEASURES CONTINUED

► Spy photos of Sleeper's modified 15-inch, 10-hole wheels created quite a buzz on our Facebook page. For those who missed our report on this project in our May '13 issue, which detailed the origin of the pared-down (fronts were narrowed from 7 to 5½ inches) and widened hoops (1 full inch was added to both rear wheels to maximize the drag radials' contact patch on the track), Pico Wheel Service of Van Nuys, California [(818) 982-0375], is the company that performed the surgery.



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▲ Our friends at A and A Tires & Wheels in Reseda, California [(818) 343-8473], handled mounting and balancing the Mickey Thompson drag radials and front runners for our project Pony.



▲ Most NHRA-sanctioned dragstrips require cars with aftermarket racing wheels to use steel valvestems are secured to the wheels with jam nuts. We took that step with our modified 10-holes. A sheared valve stem is the last thing we want to happen when we're racing.

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MORE HIDDEN PLEASURES CONTINUED

► We've seen countless Mustangs doing burnouts at the dragstrip, where drivers are mashing the brake pedal and throttle simultaneously, hoping their Ponies will sit still long enough to clean off and create enough heat in the tires for good launch traction. While this has been standard practice for years, the procedure is actually inefficient, as it can super-heat the rear brakes and ultimately cause them to drag when you're launching. A Hurst line-lock system is a long-proven accessory for achieving picture-perfect burnouts. We de-badged the solenoid and mounted it in a lower area of the engine bay for stealth purposes. In an effort to keep cockpit switchery to a minimum, Stevie wired the line-lock to the OFF side of the 'Stang's cruise-control switch.



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▲ A two-step rev limiter is one of three individual rev controllers that are built into Modotek's BlackBox v2.0. Since Cheaper Sleeper is a footbrake 'Stang (dragstrip and stoplight launches done without a trans-brake), Stevie mounted a foot-activated momentary button for the two-step on Cheaper Sleeper's brake pedal.



▲ For all that we've got going on with Project Cheaper Sleeper, you might have noticed there has not been any mention of a hotter ignition being used for the 331. Like most other components, the MSD Digital 6A box is hidden, residing within the driver-side inner fender with a pass-through for wires to go straight to the coil. We definitely recommend adding some sort of ignition enhancer (as well as a hopped-up distributor and coil) for combinations like Sleeper's, especially if a power adder is on board. And all of this stuff can be had for low dollars—we found everything in two separate Craigslist ads.

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MORE HIDDEN PLEASURES CONTINUED

► As mentioned earlier, the engine's vital signs (oil pressure, water temp, and so on) are monitored by a powerful real-time datalogger that's built into the new BlackBox v2.0. While the ECU's data-recording feature is invaluable, having a few traditional gauges installed in your Pony as a backup to the OEM gauges is a good idea, as it allows you to quickly reference exact numeric values and confirm all systems are operating as they should. We're watching Sleeper's oil pressure, water temperature, and transmission temperature with Auto Meter's Pro-Comp Ultra Lite series electric gauges, secretly installed in the LX's glovebox. (Stevie's Garage offers this Fox-glovebox gauge mount with or without the gauges of your choice.) Electric gauges are used in the glovebox over standard mechanical gauges to avoid errant readings due to feed lines that might become pinched or broken.



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The Hurst Roll Control Kit is designed primarily for high performance race cars to momentarily (max. 60 seconds) keep the front brakes engaged while staging for a drag race, reducing the chance of "rolling the lights" and producing more effective launches by evenly preheating the tires.

- Fully enclosed epoxy molded electrical coil for reliability
- Solenoid serviceable for cleaning or rebuilding
- ABS / Traction Control compatible
- Stainless steel pre-bent lines
- Easy bolt-on installation



2010+ Ford Mustang
Part #5671519



Phone: 707-544-4761



www.hurst-shifters.com

▲ The passenger-side kick panel provides a stealth-yet-stock cover for our project-'Stang's stealthy, far-from-stock PCM. **5.0**

SOURCES

A.R.E. PERFORMANCE & MACHINE

(805) 583-0602

HORSEPOWER CONNECTION

(360) 280-6112

www.horsepowerconnection.com

MICKEY THOMPSON

(330) 928-9092

www.mickeythompsonstires.com

MODOTEK

(440) 352-0100

www.modotek.com

NITROUS OXIDE SYSTEMS

(270) 781-9741

www.holley.com

PERFORMANCE AUTOMATIC

(240) 439-4650

www.performanceautomatic.com

STEVIE'S GARAGE

(805) 578-6065