COMPLIMENTARY

Motorsport West MAGAZINE

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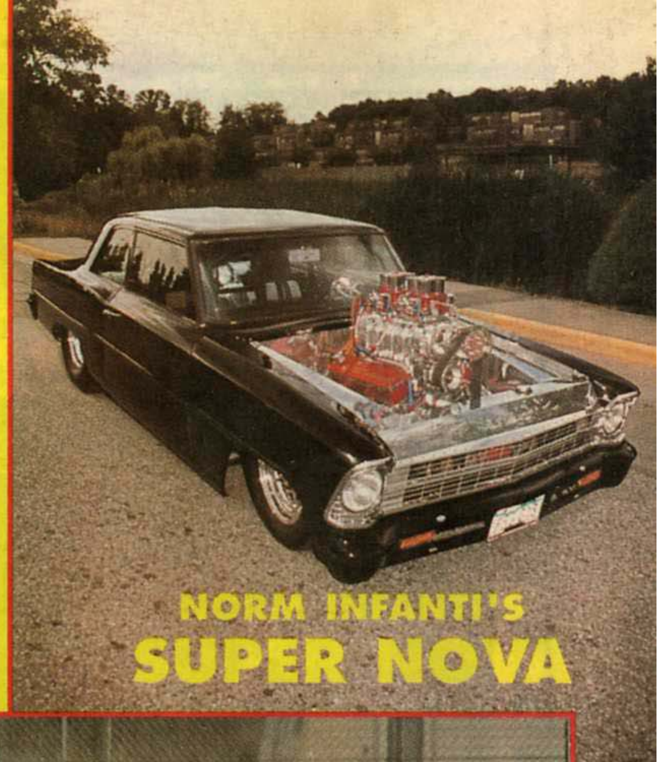

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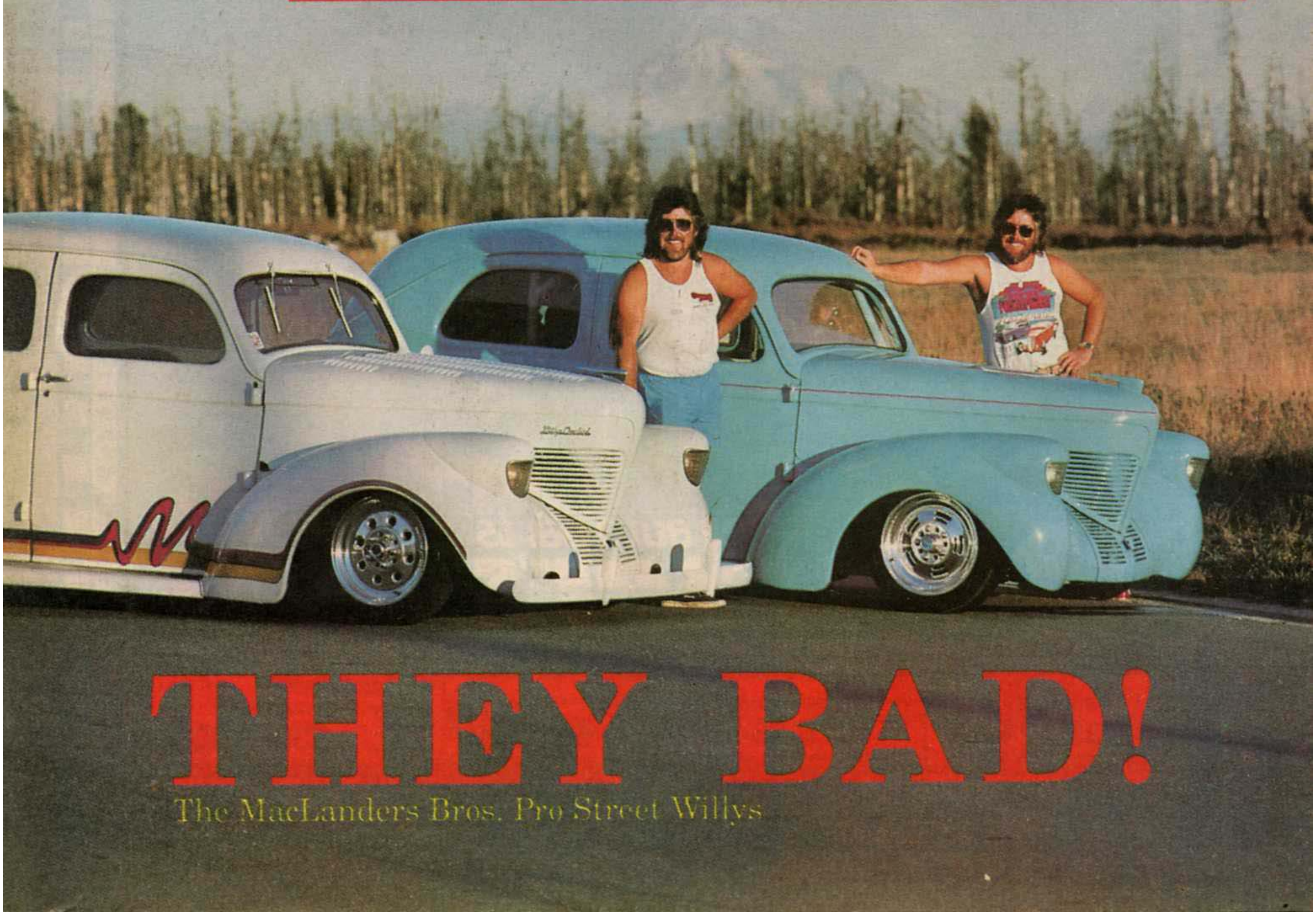

THEY BAD!

The MacLanders Bros. Pro Street Willys

SILICONE MUSCLE - Cheap Power Increases for EFI Vehicles

by Geoff Yue and Derek Spratt

We've bored you, our loyal readers, with the details of computerized engine management systems that may have only made sense if you were a computer nerd. It's time to give some inexpensive and simple tips on how to legally hotrod your late model grocery getter. Power improvements guaranteed or your subscription cheerfully refunded.

If you've got deep pockets, a computer chip could provide timing, boost and fuel delivery mods that may provide an improvement in power without detrimental side effects. Reduce the risk of disappointment and ask around for advice on a chip that works well for your vehicle.

If you don't have the money or a chip is not available for your car, don't despair. There's lots of simple backyard hop-ups that will generally keep your computerized vehicle safe, and legal at little or no cost while providing real "seat of the pants" power improvements.

Legalities

Removal of any emission control equipment is against the law and may not improve power. Depending on local laws, some of the mods listed here may be considered "illegal" even if exhaust emissions are unaffected.

Static Timing

More timing advance is the idea here. Find the position sensor that tells the computer when to fire the spark plugs. This may be a distributor or on some newer cars, a sensor on a cam or other rotating shaft. Rotate this unit to achieve greater initial advance. You may have to slot a few holes. Try 5 to 10 degrees additional advance. Check for engine ping.

Some knock sensor-equipped cars may lose power if too far advanced due to activation of the computer auto retard function. It is difficult to determine when this happens because the computer will be able to detect pinging before you can hear it.

Fuel Pressure

Change the fuel pressure regulator to an adjustable unit. This will allow you to adjust your full throttle fuel to air ratio. The computer will not try to compensate for these changes at wide open throttle. During part throttle operation, the O2 exhaust sensor will help the computer adjust fuel flow to stock levels.

Do not disconnect the intake manifold vacuum line from the back of the regulator. This provides a critical reference to enable the fuel injectors to operate at a constant pressure differential into the intake manifold.

Turbo Boost

If you own one of those forced induction wonder cars, you're in luck - fairly substantial power increases are close at hand by simply increasing the maximum boost level. No electronics involved here. Just place a restriction in the waste gate piping, between the turbine or intake manifold and the waste gate.

This restriction will limit the volume of air that can flow out thereby artificially forcing the maximum boost level up. Try machining a plastic plug with a small hole drilled through it to fit in the pipe. Buy a cheap manifold pressure gauge to monitor things. This could really add power. Water injection may help increase levels if pinging becomes a problem (cheaper than an intercooler).

Engine Temperature

A cooler engine is a more powerful engine. To keep your cool, try a low temperature radiator thermostat (a 160-175 degree unit will do the trick). You can expect a minimum of a 5% increase on the bottom end (less on top end due to the increased cooling effect of incoming air).

Running too cool may not allow the oil to warm up sufficiently and may result in a slight increase in engine wear. Try a good quality synthetic or lighter weight motor oil if oil temperature becomes a problem.

Air Temperature

The higher the incoming air density, the better. Cooler air is more dense and is therefore worth obtaining. Anything you can do to avoid heat buildup under the hood will help increase power (sometimes significantly). Try a plastic spacer between the intake manifold and the engine block. If there is any intake manifold warming device used, disable it. This may reduce cold weather drivability.

Exhaust System

Changing the muffler to reduce back pressure is not necessarily a big HP improver. The resulting noise may not be entirely pleasant either. However, there are some cars that really make power gains. V8 carb-equipped Camaros can get up to a 37% power increase with an end-to-end exhaust system replacement. Turbo cars exhibit the biggest improvements due to higher differential pressure across the turbine.

Have fun. There's nothing sweeter than free HP! Write us if you have any comments, questions, or suggestions. See you next issue.

1ST ANNIVERSARY ISSUE!

JULY / AUGUST 1989

FREE

Motorsport West

Oh Boy Alberta!

II SECOND STREET MOPAR

SILICON MUSCLE an Introduction to Engine Management Computers

by Derek Spratt & Geoff Yue

Automotive manufacturers have almost completely abandoned the use of traditional engine components such as carbs and distributors in favour of state of the art electronic control systems.

Unlike mechanical systems, computers can minimize exhaust emissions, and maximize fuel economy and performance without compromise, by providing a higher level of accuracy in the control of engine operation. Fewer components are required, most of which are highly reliable due to their electronic nature.

When components do fail or operate incorrectly, the problem is often automatically detected by the computer which will activate a warning lamp and switch to a limp mode program that helps keep the vehicle operating until it can be serviced. Repair time is reduced with the assistance of built in test modes which provide details on the fault type and location. This illustrates some of the benefits provided by this new technology.

A computerized engine management system consists of a control module that contains a CPU (Central Processing Unit) and PROM (Programmable Read Only Memory "Chip") and a number of input sensors and output control lines

The operation of the system is quite simple to understand. The instructions stored in the PROM tell the CPU to read the input sensors and then use the PROM look up tables to determine the operation of the output control lines.

The exhaust gas sensors are used to feedback information on the air/fuel ratio which is an important factor in determining emissions, fuel efficiency and performance. This mechanism eliminates the traditional requirement for periodic tune-ups.

It's a common misconception that computerized engines cannot be modified. As long as the changes do not significantly affect the signals which the input sensors detect, problems will not be encountered. Radical modifications may cause the CPU to think a sensor failure has occurred, thereby activating its limp mode. This may also happen if emissions control equipment is removed. If moderation is exercised, the changes should not cause problems.

A number of companies are marketing replacement PROMs for popular performance cars. Power increases are possible by reprogramming the PROM tables for maximum performance. These potential gains (10-15%) have been overlooked by manufacturers in favour of reliability and driveability.

A word of caution about replacement PROMs is in order. Some companies have taken short cuts in their R & D and have found ways to enrich the air/fuel ratio and advance ignition timing by forcing operation into the test or limp modes. This will potentially result in poor part throttle operation and long term engine damage. Other companies have done their homework and have fine products for sale.

Electronics technology brings answers to the demanding and opposing requirements for emissions, economy and performance. Added to this are an increasing variety of compatible electronics aftermarket products which are creating a new era in Hot Rodding.

About the authors: Derek Spratt and Geoff Yue are associates with Performance Solutions, a Vancouver business that is developing electronic performance products for computerized vehicles.

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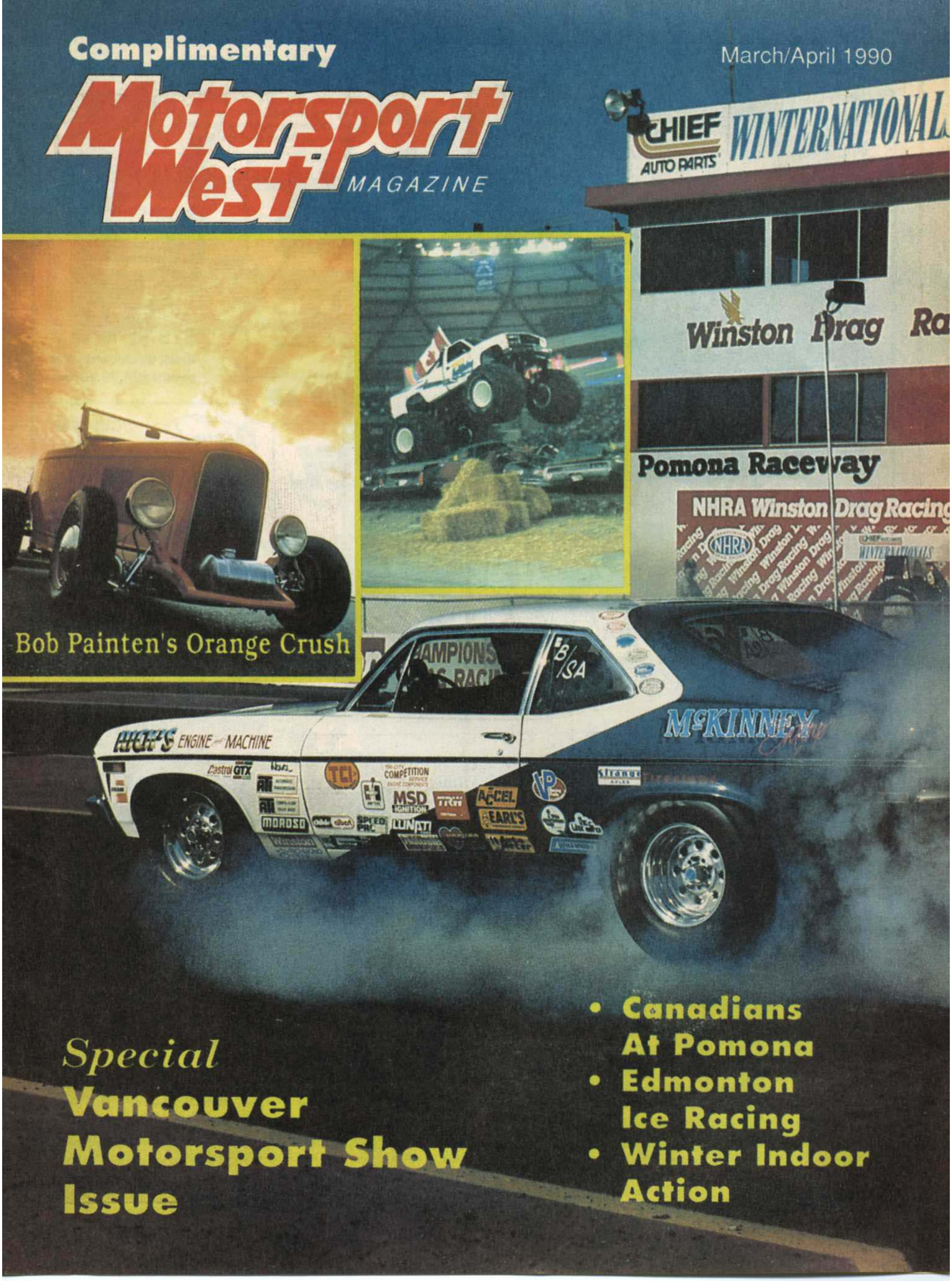


Bob Painten's Orange Crush

Special

Vancouver Motorsport Show Issue

- **Canadians At Pomona**
- **Edmonton Ice Racing**
- **Winter Indoor Action**

Silicone Muscle

By Derek Spratt & Geoff Yue

Clean Air, No Fun, Eh?

Fun or not, your vehicle license will depend on it by 1992 with the proposed introduction of new stringent vehicle Emissions Inspection and Maintenace (I/M) Program in B.C. This Silicone muscle article is devoted to keeping your ride in motion in the years ahead.

If you're one of the 35% of drivers in B.C. who own a 1975 or newer vehicle that has had it's emission control system tampered with, you may be in for a rough ride.

The proposed I/M Program will enforce provincial or GVRD emission standards that are based on federal government regulations for new vehicles. The levels will be set at a realistic level for each model year which reflect normal wear and tear. The intent of this program is to reduce air pollution, of which automobiles account for an amazing 80% of the total in the Vancouver area. An effective I/M Program will be able to reduce emissions up to 30% by identifying vehicles which are not operating properly and directing the owners to bring them up to emissions compliance. This is normally a minor expense.

The proposed vehicle testing centers will perform a general visual inspection (i.e. for catalytic converters) and some form of exhaust gas analysis. The exact testing methods have not been finalized, but they will be thorough. The main point here is that your vehicle will have to look and smell like a similar factory piece.

Although hot rodders are not being singled out, pollution control equipment tampering and removal can increase emissions by up to 500% and will therefore be a natural target of the inspectors. The federal government is getting serious about new vehicle standards and is considering the adoption of California's 1994 standards which are the toughest in the world. These standards are based on grams per mile measurements which means new vehicles will have higher gas milage and smaller engine sizes.

It should be pointed out that, in most cases, tampering with a late model vehicle's emission control equipment provides little if any performance improvement. Some turbos are the only possible exception, as the additional backpressure created by catalytic converters can kill turbo boost and increase lag time. Catalytic converters are an integral component in the design of exhaust systems and need to be present to maintain the accoustic balance which directly affects the engine's torque curve. No other components cause a loss of performance. Removal of the air pump, or Oxygen sensors can seriously affect drivability, gas mileage and reliability with little or no performance improvement.

This looks like a bleak picture for hot rodders with 1975 and newer vehicles. Some people will certainly be negatively affected by the proposed I/M Program, but performance modifications are still possible. Late models cars have definite advantages with their modern engine management computers. The goals of low emissions, good gas mileage and high performance can all be achieved through accurate control of all functions by the computer. Improving the breathing ability of these engines and cranking up the turbo boost still work - just don't go so wild that the computer freaks out.

A new generation of emissions-compatible performance parts are becoming available, the most significant being electronic performance equipment. Some of the power chips which have gained wide acceptance may cause problems passing the I/M test. Check out manufacturer's claims before purchasing. Products that only alter the stock setting at wide open throttle are guaranteed to pass the I/M test.

We should look at the proposed I/M Program in a positive light. Clean air is everyone's business - we just have to get a little more sophisticated in out approach to the 11 second 1/4 mile street machine.

COMPLIMENTARY

Motorsport West

NOV. 1989

MICKEY CALDWELL BUILDS A BEAUTY

- SEAFAIR NATS.
- ROD FEATURE
- ALL THE BIG CRUISES

SHOCKWAVE WOWS AIR SHOW

This Silicon Muscle column provides a basic introduction to the components found in modern fuel injection systems. We'll cover each component in enough detail to provide the required background for the next issue - Successful Factory EFI Modifications. Let's get started with the intake system.

Intake Air Flow: This is measured by either of 2 different techniques: Mass Flow or TP/MAP sensors which are explained below:

Mass flow. A sensor is placed in line with the throttle body. It consists of a small heater wire and a temperature sensor. As more air flows into the engine, the current required to keep the heater wire at the same temperature increases. This current is proportional to the rate of air mass flow, thereby automatically compensating for changes in atmospheric air density.

Throttle Position (TP) and Manifold Absolute Pressure (MAP). The TP sensor measures the throttle plate position while the MAP sensor measures the absolute pressure in the manifold. With these 2 inputs, the computer can calculate the rate of air mass flowing into the engine. This method also compensates for changes in atmospheric air density.

Exhaust Oxygen: Oxygen sensors placed in the exhaust manifolds act like switches - they turn on and off at a specific oxygen level. Exhaust gas oxygen levels are directly related to the intake air/fuel ratio before combustion. Aside from providing the engine management computer with feedback information on the intake mixture, oxygen sensors also help provide mixture control for catalytic converters which require precise incoming chemical balances for proper operation.

Engine Temperature: The computer measures the coolant temperature to determine the engine startup enrichment period (usually 0.5 to 5 seconds), the idle speed, the ignition timing, and general air/fuel ratio.

The exhaust oxygen sensor does not provide accurate feedback information until the engine has warmed up. The computer will not rely on the oxygen sensor output until it senses that the coolant temperature has reached a certain point. Until this point is reached, the computer uses preprogrammed air/fuel values.

Detonation: Some engines have detonation (knock) sensors mounted in the cylinder heads. These uncontrolled explosions are caused by peak flame temperatures and pressures which exceed the dieseling point of the fuel. When the computer detects detonation it retards the ignition timing or reduces the turbocharger boost level, thereby lowering the flame temperature.

Engine Position: The computer needs to know the position of the pistons and valves to know when to fire the spark plugs and injectors. The engine speed must also be accurately measured. The position indicator provides a number of pulses for each engine rotation. Sometimes this signal comes from the distributor (if present), otherwise a position sensor is located on another rotating shaft (eg. cam or crank).

Fuel Flow: Fuel injectors control the flow of fuel. They are actually just electrically controlled valves. They can only be turned on or off. To generate a variable flow rate, they are cycled on and off at the same rate as the engine RPM with the ON time increasing in proportion to the measured air flow into the engine.

A gasoline engine requires approximately 0.5 lbs of fuel per horsepower per hour at peak operating efficiency. This value can be used to calculate the maximum theoretical engine horsepower based on the maximum injector flow rates. For a V8 Mustang, the injectors can flow 19 lbs of fuel per hour, resulting in a 304 hp limit. In practice, the computer limits the injector pulse width which reduces this value.

Ignition Timing: Although the electronic circuits that fire the spark plugs look complicated, all they do is amplify the small computer output signals. The actual timing is calculated from engine temperature, RPM, throttle position and knock sensor inputs.

Although the initial timing can usually be adjusted externally, the timing advance curves are fixed in the computer's memory. Even if a distributor is present, it no longer has mechanical centrifugal or vacuum advance mechanisms.

Air Pump and Exhaust Gas Recirculation (EGR): The air pump and EGR, if present, are usually operated via electronic or vacuum valves which are controlled by the computer. The EGR can be switched off by the computer during wide open throttle conditions thereby eliminating any reduction in maximum power.

Automatic Transmissions: Automatic transmissions are becoming computer controlled. Factors such as torque converter lockup, gear shift points and overdrive control are altered to suit driving conditions. This helps provide better fuel economy, performance and smoothness.

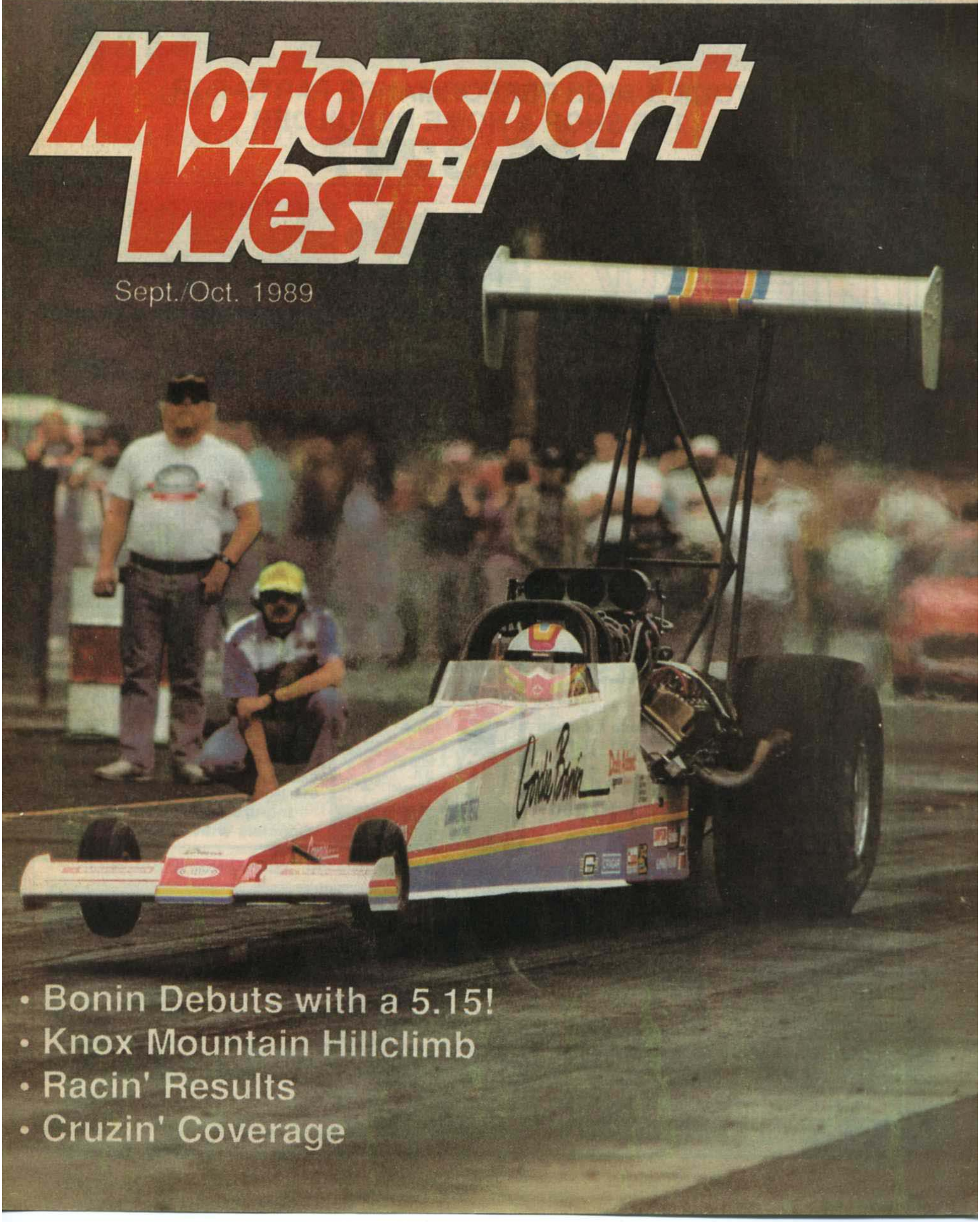
Now that we have covered the basic system components, the business of going faster can be discussed. See you next time.

- Derek Spratt & Geoff Yue/Performance Solutions.

FREE CANADIAN COVERAGE FREE

Motorsport West

Sept./Oct. 1989



- Bonin Debuts with a 5.15!
- Knox Mountain Hillclimb
- Racin' Results
- Cruzin' Coverage

The Silicon Muscle column has become a regular feature in Motorsport West Magazine. Last issue's column provided a brief introduction to the use of computers under the hoods of today's performance automobiles. Each each future issue, a different aspect of this new technology will be discussed:

- Fuel Injection
- Emission Controls
- The Combustion Process
- Intake Systems
- Exhaust Systems
- Applications
- Performance Measurements

This issue's subject deals with the controversy over 60's vs. 80's performance cars.

Many automotive enthusiasts who have grown up wrenching power out of 60's muscle cars are now attempting to apply outdated principles to late model cars. Sometimes things work, and sometimes things don't. What is needed is a better understanding of the basic principles of performance and computerized engine management system operation.

1960's - The Good Old Days

The 60's were characterized by cheap, high octane gasoline, lenient government emissions and safety regulations, and strong factory involvement in motorsports events. Fierce competition between the North American automotive manufacturers, known as the "horsepower wars", resulted in an unprecedented number of performance cars available for sale.

The marketing of these cars was centred on their power ratings. The quoted manufacturers figures were "gross" ratings. This method of determining engine power was largely unregulated until 1971 when the SAE net power rating standard was introduced.

To determine gross power ratings, the engines were run on a dyno without the water pump, alternator, steering pump, air pump, emissions controls or other accessories attached. Racing exhaust manifolds with vacuum pumps were sometimes used. The result: widely differing and exaggerated power ratings.

The SAE net power rating standard requires all engine accessories, emission control devices, and intake and exhaust restrictions to be present when testing an engine.

Engine torque figures are not well understood by many car enthusiasts and so the marketing of factory performance cars has always centred on horsepower ratings. A broad torque curve is an asset for a street driven vehicle and also contributes to overall performance. The 60's high performance engines were designed to be high revving in order to produce the greatest possible horsepower figures at the expense of low and mid range torque.

1970's - Doom and Gloom

The 1970's saw all advances in automotive engine performance disappear. A combination of factors caused the extinction of the 1960's muscle cars: increasingly stringent emissions and fuel efficiency standards, new safety standards, dramatic increases in fuel costs and fuel shortages. The technology required to provide low emissions lagged behind the laws that were enacted. While the crude emissions control devices that were implemented reduced the emissions levels, they generally decreased the fuel economy as well. To combat this, engine sizes were reduced and smaller chassis were employed.

1980's - High Tech Rescue

A number of developments started to change things around - new technology and the relative abundance of fuel. After spending years trying to band-aid engines with mechanical emissions control devices, the digital computer and catalytic converter were introduced. The automotive enthusiasts looked on these devices and their associated wires and sensors as more of the same evil yet they were a blessing in disguise. They provided the potential for a revival of the muscle car era.

Most early attempts at improving the performance of these new technology engines involved stripping off these devices. What was actually happening was very significant - engines no longer had to have lean mixtures, low compression ratios, and poor drivability. The computer could finely adjust the fuel flow, timing and exhaust gas recirculation and the catalytic converter could chemically clean up what the computer missed. The engines could now have greater power, economy, low emissions and drivability without

without conflict.

1990's - Hot and Getting Hotter

Today's engines now produce roughly equivalent power to their 60's counterparts with vastly improved drivability and reliability. Late model V8 Mustangs which are rated at 225 net HP would have been given a gross rating of about 300 HP if produced in the 1960's. The new ZR1 Corvette produces 380 net hp from a 350 cid engine. This is equivalent to a gross rating of 480 hp, providing 12 second 1/4 mile passes - something never before achieved with a factory small block.

Late model Buick Grand Nationals and Mustangs commonly run in the 13's. With proper engine and computer modifications, these cars can run in the 12's while maintaining complete emissions legality. This is fast company - faster than almost any 60's muscle car ever produced.

There is no doubt that electronics will be embraced by the performance enthusiasts in the future - the market for these products will increase. The day will soon come when the hot setup for any performance machine will be a computer controlled fuel injection system. It will have to come, because these systems can out perform carburetors in all important areas: maximum power, torque characteristics, part throttle response and fuel economy.

High performance isn't dead, it just looks different.

About the authors: Geoff Yue & Derek Spratt are associates with Performance Solutions, developers of the Digitune Performance Computer. MW