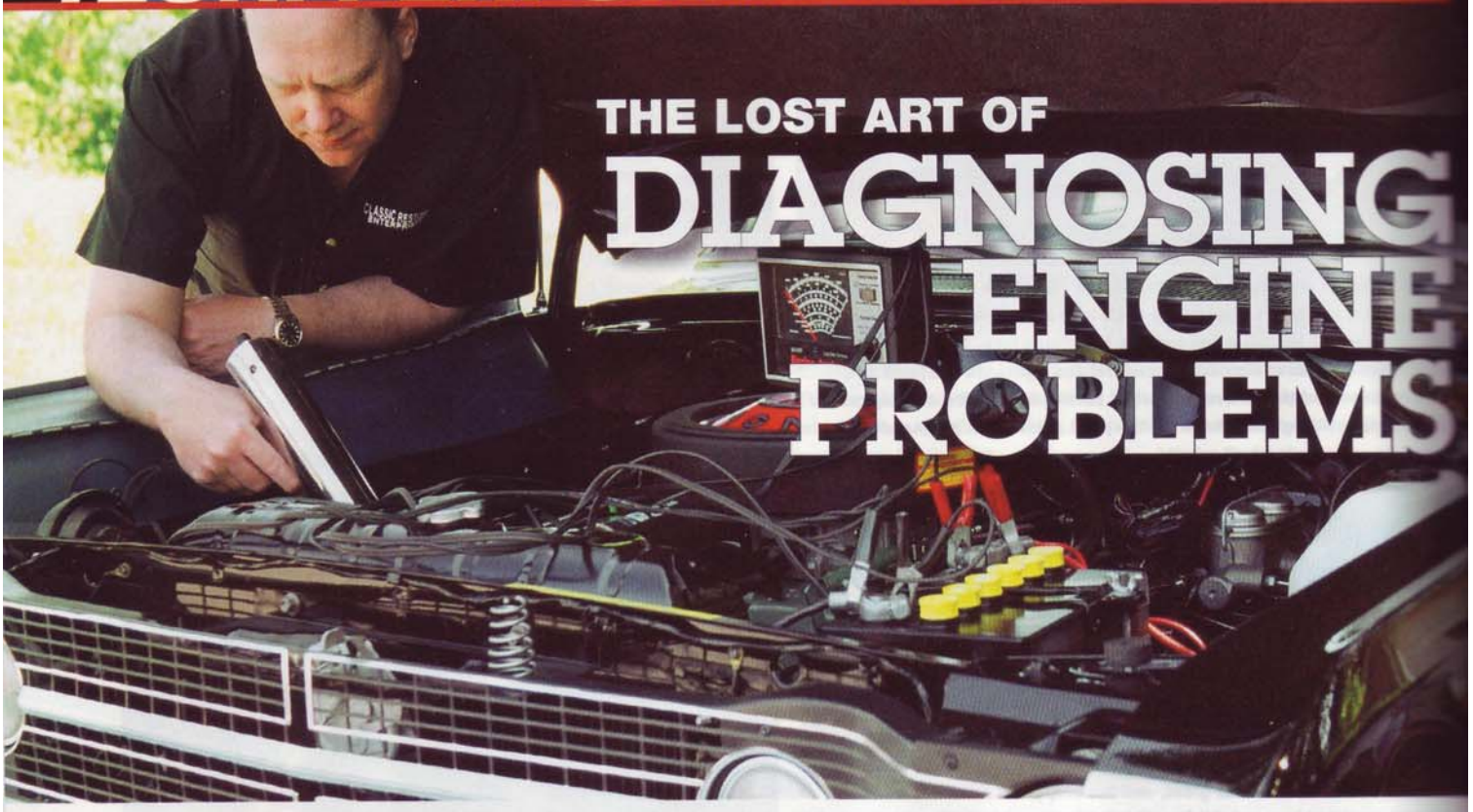


THE LOST ART OF DIAGNOSING ENGINE PROBLEMS

Words and photography by Ray Bohacz

Determining why an engine does not run properly is a skill that eludes many, and can stymie both professional mechanics and home enthusiasts. That's how the term "parts changer" came about, after all. Within the business, it describes someone who keeps throwing new parts or components at a problem until it is eventually solved. Doing that is not only an inefficient and costly approach to getting your car to run properly, but speaks volumes about someone's lack of knowledge of internal combustion mechanics.

Another practice that should send up a red flag is when a mechanic attempts to explain a condition away, accepting the problem as normal and justifying it with the statement, "they all run like that," or, "that is how they ran back then." Detroit never produced an engine that intentionally ran rough, burned oil, stalled, overheated, pinged or hesitated its way down the road. If the engine in your car is acting up, it is not an inherent design flaw, but rather an issue that needs to be corrected.

In comparison to wrenching, diagnosing requires a more in-depth knowledge of the workings of an engine. A mechanically inclined person can easily change a part and do a good job of it, but it takes a higher level of study to be able to accurately determine which part needs to be changed.

Another common mistake in diagnostics is falsely condemning a part that is really just out of adjustment. The carburetor and distributor are the primary recipients of this treatment, with some mechanics providing advice like, "If it doesn't run right, change the carburetor. If that fails, drop in a distributor."

This installment of the Lost Art series will provide a common-sense approach to determining the cause of engine problems.

The condition

There are seven main categories of performance issues. They are rough idle, stalling, lack of power, pinging/detonation, excessive oil consumption, exhaust smoke and hesitation.

It is common to have a problem in one area that impacts three or four others. Take, for example, a GM HEI system with a faulty ignition module that has a fixed dwell instead of the proper expanding dwell period. Depending on where the dwell is locked, the engine may experience any or all of the following: rough idle, stalling, lack of power, detonation and hesitation. This can very easily be thought of as the result of numerous issues, or one condition much more severe than a failed ignition module. Thus, when diagnosing an engine problem, it is important to take a logical and methodical approach, and to fix what is known to be wrong first, instead of assuming that it could not be the main culprit.

Another pitfall is avoiding the effort required to actually perform proper tests, or taking shortcuts there. For instance, a lazy diagnostician might use a test light instead of a voltmeter or assume the fuel pressure is sufficient because he can see gasoline instead of attaching a gauge and taking a reading. In contrast, if you actually checked and tested something as designed, you'd have a quantifiable number, not the typical, "I know that it's good."

A visual inspection of the engine is the first step in proper diagnostics. Is a wire loose? Did a vacuum line fall off? Do not look for a complicated solution to a simple problem.

Just as a doctor establishes a medical history for his patients, you should create a mechanical history for your engine. When it is running properly, you should spend a few hours performing a series of tests and recording the results as a baseline. This way, you will quickly be able to determine what has gone awry if a performance problem occurs. After all, you cannot know what is bad if you do not know what is good. This data should include base ignition timing and the amount of vacuum and centrifugal

advance, cranking compression, cylinder leak-down, alternator output, engine vacuum and so on.

Years ago, when I was teaching a class on the trade, I developed the acronym SAT: Stop And Think. To diagnose an engine malfunction, your thought process must become one with it. How would a lean mixture impact performance? Is the engine suddenly very octane-sensitive? Does it not like its normal idle speed? This is the process of "bonding" with the engine and knowing how it will respond to certain conditions, in much the same way you would get to know another person.

When a problem occurs, try to get a handle on whether it is ignition- or fuel-related. Make the mixture richer and leaner. Add and delete ignition advance. If you find the engine responds to a richer mixture, then you will probably be looking for a vacuum leak or weak ignition.

Do not make the mistake of believing this step will cure the condition and make the engine run like new. Instead, you should be looking for a positive response. An engine that has a severe manifold vacuum leak will idle better if you choke the carburetor with your hand, but will not run the same as if the manifold were not leaking. The engine's response to the change is what you need to acknowledge, not the change itself.

Listening and feeling the exhaust will tell you a lot about what is going on. True dual exhaust can help determine which side of the engine the concern rests. A problem that is affecting all cylinders, such as misadjusted breaker points, will impact every firing event. In contrast, a broken ignition wire or valve spring will produce a rhythmic misfire at the exhaust with smooth pulses in between.

Driving the car is also a diagnostic necessity. Being able to "drive through" a problem can help in locating the root cause. For example, does the engine only ping at light load or throughout the rpm range? Is the hesitation more pronounced just off idle, or can it be felt when the throttle is moved even at a low road speed?

Do not be afraid to get your hands dirty. Since the spark plug resides in the combustion chamber, it is a window into the engine. Take all the plugs out and keep them in order to identify the cylinder. Look for a major difference in color or wear, and then check the cylinder in question more thoroughly. There are

You should always perform a visual inspection, but don't forget to physically make sure all wires and vacuum hoses are securely attached. Do not let dual carburetors, such as those on our subject AMX, intimidate you: The engine still follows the same laws of physics.

When diagnosing a rough idle, go around and snug the intake and carburetor bolts. This is especially true when an aluminum intake manifold is attached to cast-iron cylinder heads. A manifold that leaks just a little, though on many cylinders, can produce a very poor-running engine.

Listen to and feel the exhaust. Also, smell your hand to determine how the engine is running. What many believe is an odor of a rich mixture is actually excessive hydrocarbons from a misfire. Incomplete combustion can be caused by an excessively lean mixture, or by a mechanical or ignition problem.

If the engine was taken apart or work was performed on it, check to make sure the ignition coil polarity is correct. The wire that goes to the breaker points needs to be on the coil's negative terminal. Reverse polarity will cause a very poor-running engine with little power.

very few mechanical conditions inside the engine that would impact all of the spark plugs at the same time. If they are all fouled, the cause is most likely with an external part, such as the carburetor or ignition coil.

Think outside the box. Recognize that the working engine is composed of a series of mechanical events that are interrelated. What would you think if the car ran fine and then you changed the oil and it started to idle rough? If you did not disturb a vacuum line while doing the work, the most probable cause would be that the engine oil was severely diluted with gasoline and the fuel vapors were being picked up by the PCV and introduced into the intake manifold. In this case, whoever adjusted the mixture screws did it with fuel in the oil. Once you changed the oil, the carburetor idle mixture screws were set too lean, because they were compensating for the fuel in the crankcase.

Diagnostic leads

The following are basic guidelines for diagnosing each condition, with the most likely cause first:

Rough idle: Misadjusted carburetor, vacuum leak, worn/misadjusted breaker points, coil polarity wrong, fouled plugs

Lack of power: Insufficient ignition advance, secondary butterfly on carburetor not opening, metering rods/power valve not functioning, restricted exhaust, starving for fuel

Pinging: Excessive ignition lead, carbon-laden pistons and combustion chambers, lean mixture, high cylinder-head metal surface temperature/coolant, EGR (if equipped) not functioning, ignition timing scatter from worn distributor bushing

Hesitation: Weak accelerator pump stroke, vacuum advance not functioning, idle mixture screws set wrong, vacuum leak, insufficient amount of base timing

Stalling: Idle speed set too low, massive vacuum leak, idle circuit in carburetor blocked, EGR valve stuck open, choke tension (when cold)

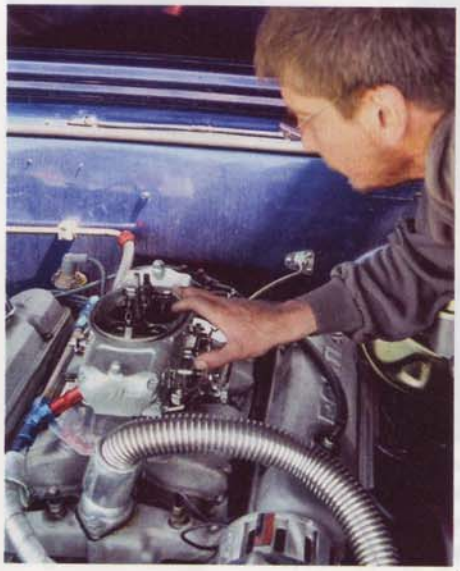
Oil smoke on startup only: Worn valve guides/seals

Excessive oil consumption: Wrong oil viscosity, oil diluted with gasoline, worn oil ring on piston, excessive cylinder bore wear/glaze, short trips/numerous cold starts

Diagnosing a problem often takes more thought than actual work with your hands. Time spent analyzing the situation is more effective than having wrenches fly; taking your time doing proper diagnostics will pay off in the end.

Here, we worked with Willie Bartholomew, ace technician at Melvin Benzaquen's Classic Restoration Enterprises in Pine Island, New York, to demonstrate some common diagnostic procedures. Use the following representations of diagnostic procedures as a guideline, modifying them for your needs.

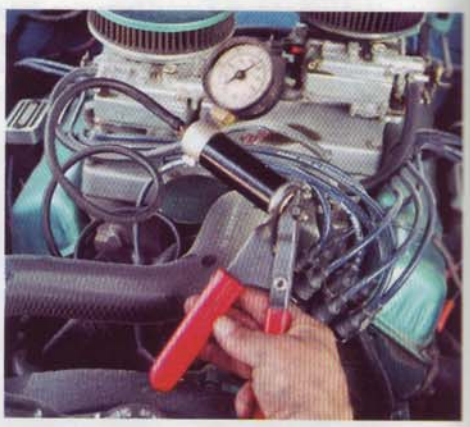
Carburetor cleanliness is very important for proper operation. This carburetor was very black in the venturis, usually a sign of backfiring/popping through the intake when cold.



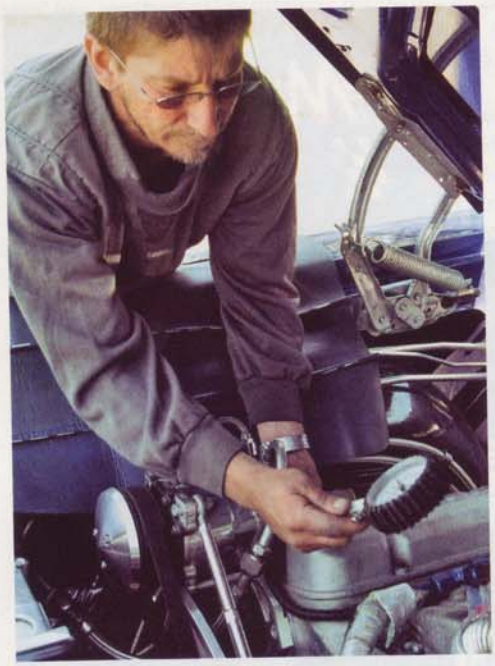
With the engine off, look down the carburetor and check for a strong accelerator pump stroke in both venturis. With the engine running, check that fuel is not dripping from the booster(s). If it is, a bleed may be clogged, the throttle plates may be misadjusted, or the float level could be set too high.

Always look at the spark plugs for wear and color. A clean center electrode with a blackened perimeter usually indicates excessive cold starts without enough driving time to clean the plug off.

A handheld pump is an essential tool to check vacuum-operated devices such as the distributor advance and choke pull-off.



Engine vacuum readings should be steady and increase as the rpm is raised from just off idle to approximately 2,500 rpm; if not, the exhaust is restricted. A needle that shakes violently is usually the result of a broken spring or burned valve.



A compression test is most accurate with all of the plugs out, the throttle to the floor and a battery charger connected and turned on. A cylinder leak-down test (not shown) will determine the condition of the engine seal (from the valves and compression rings), but requires a special tool and access to an air compressor.

Even if the timing seems to be correct, take a look inside the distributor to examine for wear, as well as dirt and oil.

A carburetor-equipped engine with a properly functioning choke that is also properly adjusted will provide EFI-like cold starts and drivability. If you need to warm up the engine before you can move the car, the choke circuit is not working correctly.

Whenever using a propane tool and tachometer to locate a vacuum leak or adjust the mixture, choose the rpm scale with the highest resolution (most graduations) for the most sensitive reading.

Some engines (like Buick V-8s) have had EGR systems since 1972, while most others have been so equipped since 1973. If the valve is not working and is stuck closed, the engine will have a tendency to ping. Even a working valve can suffer from being carbon-blocked. Using a rag or insulated glove, force the valve open with your finger while the engine is idling. The engine should run rough. If it does not, then the intake manifold passage is blocked with carbon and needs to be cleaned.

A timing light with a dial-back feature (advance) is the most accurate for checking the distributor. Bring the rpm up to 3,000 and check for stability of the timing marks. If the distributor bushing or timing chain is worn, the timing will bounce around at high speeds and may cause detonation and poor performance.

Source:

Classic Restoration Enterprises
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845-258-2050 • www.classicresto.com

In almost every instance, once a problem is corrected, it is a good idea to readjust the idle mixture screws using a tune-up tachometer. This will allow you to maximize the setting for the corrected condition.