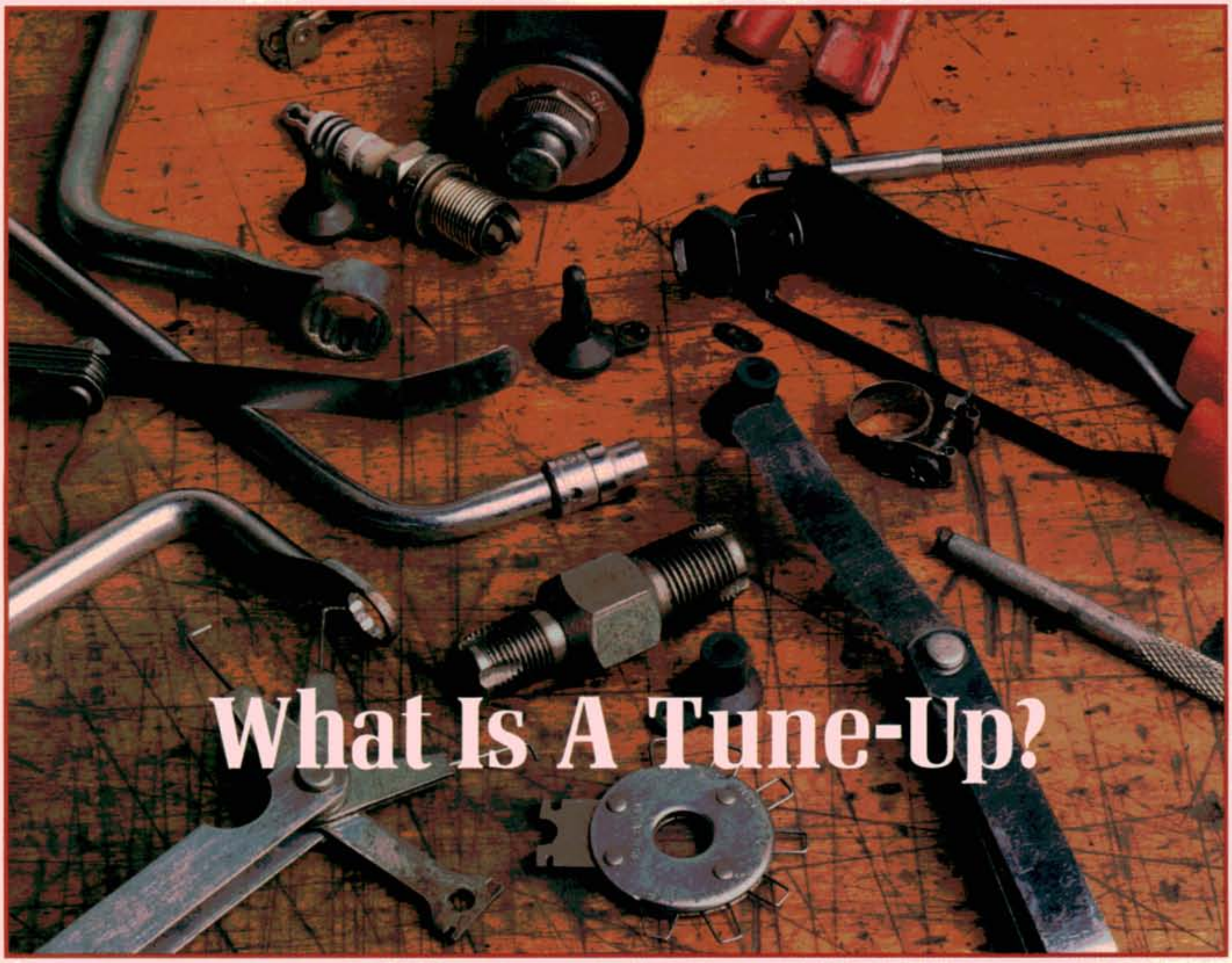


What Is A Tune-Up?

In today's world of electronic ignition and computer controlled fuel delivery systems, the idea of a tune-up may seem outdated. In the past, a tune-up included changing spark plugs and filters, as well as making basic engine adjustments such as timing, idle mixture, and idle speed. However, spark plugs last longer than ever before and recent advancements in engine management systems have made most of these basic adjustments unnecessary. So are tune-ups a thing of the past?

The tune-up may not be a thing of the past, but its definition has certainly changed. With the introduction of computer controls, there is a greater need for optimum performance by all the components in the system, including associated sensors, actuators, and other engine components. If even one sensor is out of calibration, it can upset the entire balance of emissions and fuel economy. An engine component failure such as a burned valve can cause major changes in engine operation. The excessive hydrocarbons can overheat the catalytic converter and the extra oxygen will drive the feedback system rich. That is why all parts must work together to achieve peak performance.

Performance is the operative word when discussing a modern tune-up. When a customer brings his or her car in and asks for a tune-up, they are really saying "I want my car to perform better." They do not understand things like closed loop fuel control, electronic spark timing, or idle air control systems, but they do know when their car is not behaving the same as it used to. Symptoms such as cold start problems, surging, poor fuel mileage, and dying at stops are just a few of the items that will cause a customer to come in and ask for a tune-up.

The term "tune-up" is familiar to most people. However, its meaning varies from one person to the next. Technicians generally think of a tune-up as replacing spark plugs and checking timing, idle speed and idle mixture. A customer may not think of a tune-up in the same way. After all, if a customer takes his bicycle in for a tune-up, he knows the bicycle mechanic won't install new spark plugs, but he does expect the bike to perform better when the work is completed. The brakes will be adjusted, the tires aired up, the chain oiled, and so on, all under the guise of a "tune-up."

As long as these services are performed, the customer will be satisfied that he has gotten what he paid for. The bicycle mechanic understands what his customer wants (improved performance), and delivers a service that satisfies that expectation. By the same token, when a customer brings his vehicle in for a tune-up, he will expect it to perform better when you are finished. Consequently, today's tune-up is an important service that has evolved from a set of parts replacements and basic adjustments into a procedure that involves careful inspections, followed by in-depth diagnosis when necessary. A successful tune-up is dependent on following proper procedures and using quality parts, but the most important elements are expertise, equipment and communication. Let's look at each of these elements in greater detail:

- **Expertise**—The technician's expertise is the most important component in effectively completing the tune-up. Due to the complexity of today's cars, set procedures are less important. Instead, the technician must decide what services are needed as he proceeds through the tune-up. As information is gathered, the technician will decide where he needs to focus his attention. This is what makes each tune-up unique. The technician must use his expertise to determine the correct course of action for these changing circumstances.
- **Equipment**—Proper equipment is needed to assure a quick and accurate diagnosis. For instance, an infrared temperature sensor will tell you in just a few seconds whether the thermostat is too cold. With just one test, a four-gas analyzer can uncover problems with the air/fuel ratio, air injection system operation, and catalytic converter efficiency. A DSO (digital storage oscilloscope) can display charging system voltage, injector pulse width, ground quality, and alternator diode condition with a single connection. Having the proper equipment assures an accurate diagnosis and holds diagnostic times to a manageable level.
- **Communication**—Even when the best equipment and technicians are available, a failure to communicate with the customer can undermine the best of intentions. It is important to gather as much information as you can while the customer is present. Make sure you understand and are able to meet their expectations. Ask questions such as: "Is your car starting okay?", "Does it miss or hesitate?", "Have you noticed any noises or leaks?". Some questions may seem unrelated to a tune-up. However, if we stop to examine a customer's expectations, it is easy to see how fixing an annoying rattle or stopping a puddle from forming on the garage floor might be considered an improvement in the vehicle's overall performance.

It is also important to fully explain the details of your tune-up procedure to the customer. Make sure he understands what to expect when you are done. If he has concerns that will not be resolved by a tune-up, be sure to explain how much it will cost to diagnose the extra problems. This gives both you and the customer a solid starting point, and establishes a line of communication that will continue as the work progresses. With properly trained technicians, quality equipment, and good communication, a tune-up can be a very profitable job for the shop, while providing a service that many customers need.

Three Step Program

The tune-up begins with three important steps. The first step, which we have already discussed, is communicating with the customer. Next, the technician should take the car for a test drive. The test drive should be conducted using a variety of driving conditions, within a short distance and in a reasonable length of time. A few stops and accelerations, along with some light cruise conditions are the minimum elements of a complete test drive. The test drive should also address any specific complaints that have been expressed by the customer. Look at the gauges, check for noises, as well as stopping and handling characteristics. Make mental notes or write down anything you find.

Finally, bring the vehicle into your stall and do a quick visual check. What is the general underhood condition? Are there any missing components? Look at the battery connections. Remove a spark plug and check for wear and fouling. Check the filters, including air, breather, and fuel. If you have received permission for any extra procedures such as oil leaks, brakes, or suspension checks, perform these before revising the estimate as needed.

This is a good time to stop and evaluate the overall condition of the vehicle and determine whether you can achieve the customer's expectations for the dollar amount that was estimated. If in doubt, call and tell them what you recommend. If you have found anything new, tell them what it is and what the diagnostic fee to find the problem will be. It's not necessary to completely diagnose every problem before calling the customer. However, make sure you have determined all areas that need to be addressed. For example, if the ABS light came on during the test drive, call the customer to inform them of the problem and what it will cost to diagnose it.

Doing The Work

You are now ready to start the actual repairs. The repairs will be based on all of your previous findings. If the spark plugs are worn, replace them. If the test drive and visual inspection did not turn up any problems, then your tune-up should include a quick check of the charging system, tailpipe emissions, critical sensors and ignition system. If any problems are found, focus in on that particular area.

These quick checks will help you determine whether these systems are functioning properly. A simple battery voltage check is all that is needed to know if the alternator is charging. It doesn't mean there can't be any problems with the system, but it allows you to check several systems in a short amount of time.

The vehicle used for this article is a 1989 four-wheel-drive Isuzu Amigo with 139,000 miles on the odometer. The engine is a 2.6L Mitsubishi with multi-point fuel injection and a manual transmission. The customer left the vehicle after hours and placed a note in the drop box that said "tune-up." When contacted, the customer also requested an oil change, a general check over, and was concerned about a suspension squeak and a rough idle. She also mentioned a new battery cable had recently been installed and wanted to know if the work had been done correctly.

In the following photo captions, we'll demonstrate a tune-up procedure to show you how to meet your customers' expectations while increasing the performance of a fuel-injected vehicle with computer controlled idle and fuel mixture. This "tune-up" could have gone in several different directions, depending on what we found and the instructions received from the customer.

–By Randy Bernklau

1

After a road test, a visual inspection was next. There were no missing items or disconnected vacuum lines underhood. The battery was dirty and lacked a hold down. I removed the cover to inspect the timing belt, which looked old and cracked. Noisy valves indicated an adjustment was in order.

2

My road test had revealed a lower-than-normal reading on the engine temperature gauge. With the engine running and coolant flowing through the radiator, an infrared temperature sensor showed a low engine temperature reading. A stuck thermostat was causing the low temperature gauge reading.

3

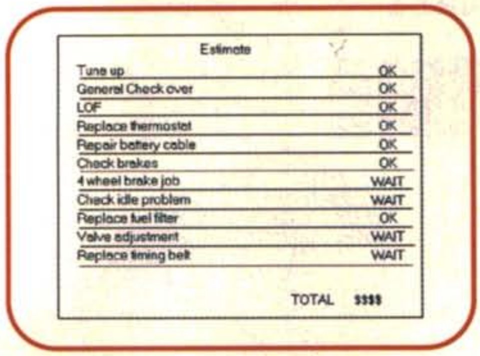
After unwrapping the tape, it was obvious that the battery cable repair had been done incorrectly. The cable's wire gauge was too small for the job. A light tap caused the wire to fall out of the butt connector. I decided to replace the entire cable, using the right wire size and permanent connections.

4

My spark plug inspection revealed worn center electrodes, but the plugs looked relatively clean. There was no indication of oil burning or abnormal combustion, just normal wear. The fuel filter also needed to be replaced, but the air filter was new. I noted these items on my estimate sheet.

5

Next I raised the vehicle on the hoist to drain the oil. The oil was dirty, but contained no abnormal contamination. The squeak was coming from the front brake pad wear indicators. The rear pads were also near their wear limits. The rest of my undercar inspection revealed no additional problems.



Estimate

Tune up	OK
General Check over	OK
LOF	OK
Replace thermostat	OK
Repair battery cable	OK
Check brakes	OK
4 wheel brake job	WAIT
Check idle problem	WAIT
Replace fuel filter	OK
Valve adjustment	WAIT
Replace timing belt	WAIT
TOTAL	$$$$

6

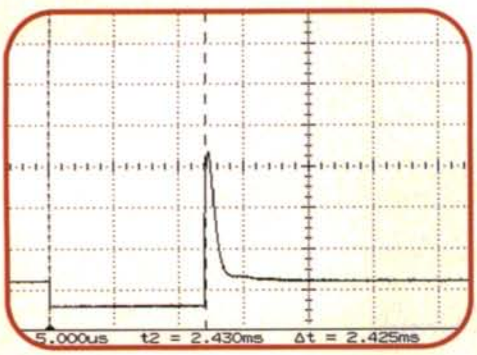
Several repairs were needed, but the major systems were sound and the vehicle was worth fixing. A revised estimate was given to the customer. The customer decided to wait on the valve adjustment, timing belt, rough idle, and brakes, but allowed us to go forward with the rest of the work.

7

The correct battery cable (list $100) was out of stock, so I ordered a similar cable from an aftermarket supplier and soldered a terminal to the pigtail. This provided the proper wire gauge and saved the customer about $70. I cleaned the battery case and terminals, then installed a new hold down bolt.

8

A new 180 degree thermostat brought the engine temperature and gauge up to par. You might not consider a thermostat replacement as part of a "tune-up," but a cold thermostat can cause a high idle, poor gas mileage, and excessive emissions. I had to replace it before continuing with the tune-up.



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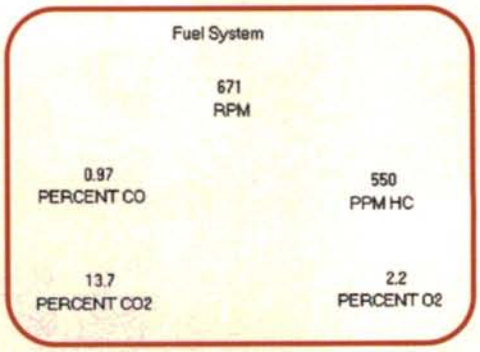
With new plugs installed, it was time for baseline measurements to determine the cause of the idle problem. The customer had declined any extra diagnostic time, but I still needed to focus on this area. The secondary ignition was fine and the injector pattern (shown here) was also normal.



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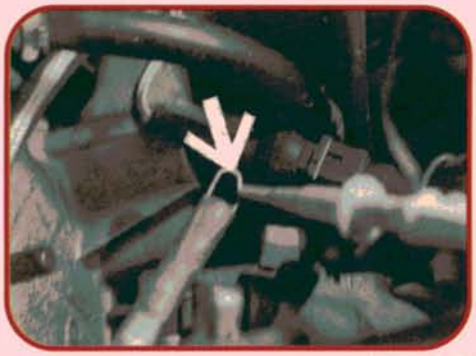
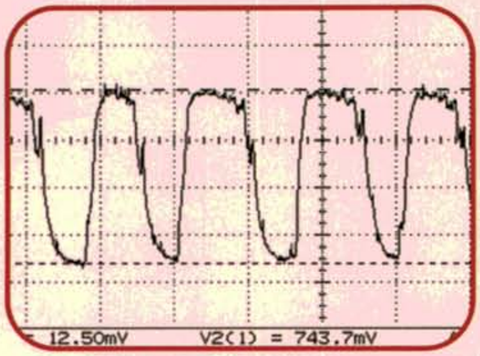
The four gas showed hydrocarbon, oxygen, and carbon monoxide levels were high, and the carbon dioxide level was low. Idle speed was also below normal. Removing the hose between the mass air flow sensor and the throttle body exposed some badly sludged throttle plates.



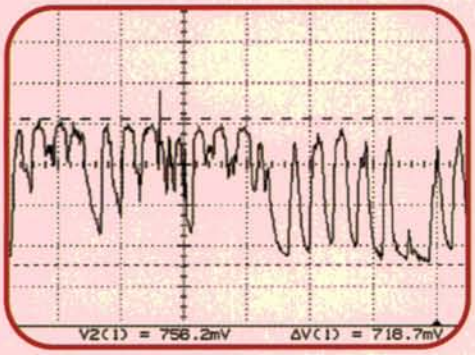
11

Cleaning the throttle plates corrected the idle problem, but the hydrocarbon and oxygen levels were still too high. I needed more tests to zero in on the problem. By inserting a paper clip alongside the wire in the oxygen sensor connector, I connected my DSO to monitor the O_2 sensor signal.



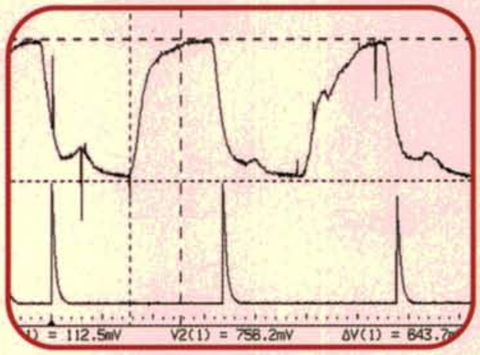
12

The O_2 sensor waveform looked okay at 2500 RPM. The low voltage on the high end of the O_2 sensor's oscillations (743.7 mV) concerned me, however. I like to see the sensor put out more than 800 mV at the top of its swing from lean to rich. I made a note of this abnormality and continued my diagnosis.



13

The O_2 sensor's waveform looked terrible when the engine returned to idle. There were cylinder misfires (the sharp downward spikes seen in this waveform). The O_2 signal should be independent of individual cylinder firings. This waveform isn't, indicating a misfire occurring in one cylinder.

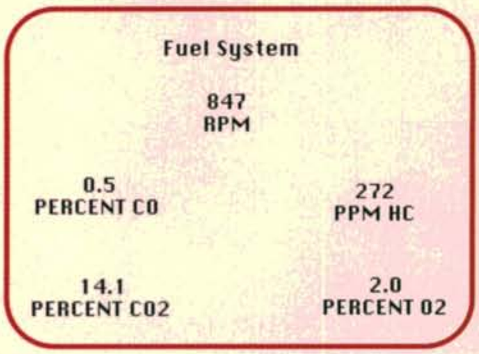


14

To figure out which cylinder was responsible for the misfires, I synced the O_2 waveform with the ignition. The O_2 sensor signal is definitely influenced by the cylinder firings. It is easy to measure the O_2 response time, too. The rich/lean/rich transition times were well below 100 ms.

15

The catalytic converter inlet temperature was 240 degrees and the outlet temperature was 200 degrees,. The converter was DEAD. There was no point in spending time pursuing the hydrocarbon problem. It was most likely a valve seating problem, since the O_2 sensor waveform was normal above idle.



16

The engine now idled smoothly. The battery cable was repaired, possibly preventing a failure in the future. The thermostat was functioning, improving gas mileage by allowing closed loop operation. The vehicle still had problems, but the customer's expectations had been met for the dollars spent.