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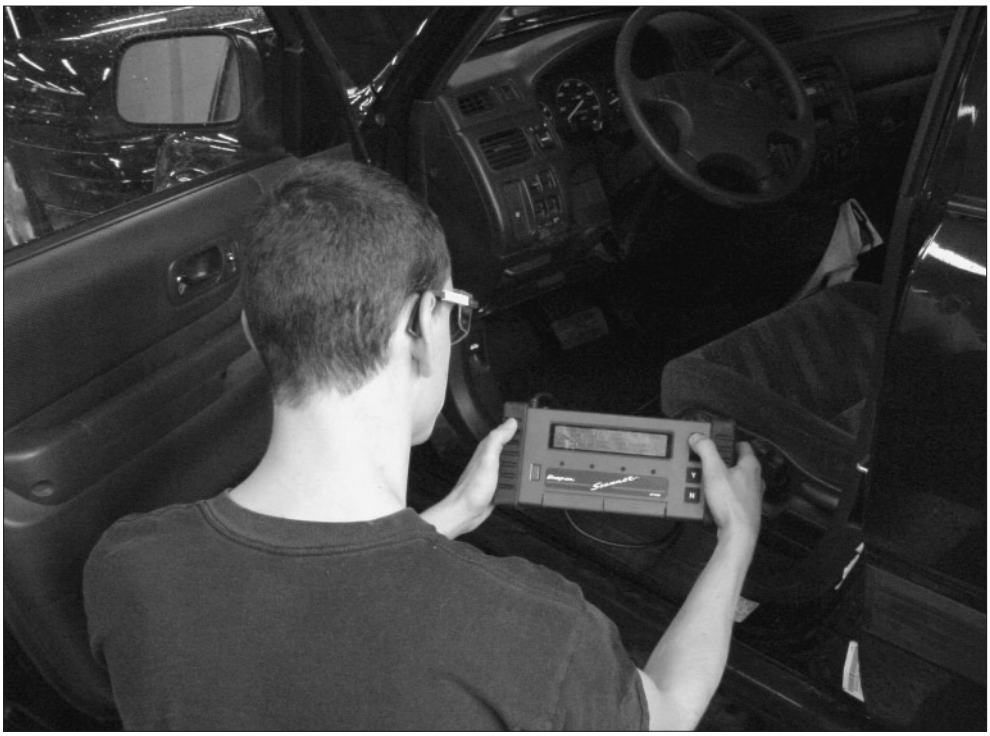
Technical Information For The Collision Industry

Using Scan Tools For Collision Repair
–Is It Time To Consider One For Your Facility?



A scan tool enables the technician to communicate with on-board computers.

Automotive technicians have been using hand-held scan tools to diagnose problems related to computer controlled electronic circuits since the early 1980s (*see above Figure*). Is it now time that collision repair technicians take advantage of what these tools have to offer? This article looks at what scan tools do, how they could be used in the collision repair process, and the considerations technicians should think about if deciding to purchase one.

SPECIFIC AND GENERIC

Scan tools are available for use on specific makes of vehicles, or generically, from several equipment makers. Which type to purchase depends on the required and desired capabilities.

Scan tools need to be physically linked to the vehicle by some type of cable connecting the scan tool to a diagnostic connector. The diagnostic connector allows data in the form of electrical signals to be transmitted between the vehicle computers and the scan tool. This allows fault codes to be sent from the computer to the scan tool for viewing, and allows the computer to erase the codes to reset the computer. The transmission of the data may also allow some parts to be tested or activated using the scan tool. With

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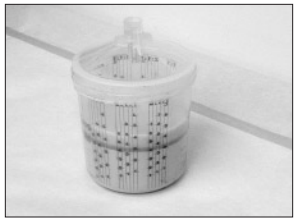

Accessible Systems

Scan tools can access a variety of vehicle systems that are controlled or monitored by electronic control modules. They do this by being supplied with electronic signals from the control module to a diagnostic connector that the scan tool is linked to. In some cases, the signals can be bi-directional allowing the scan tool to set items or activate parts of the systems during testing. With anti-lock brake systems, the scan tool may be required to bleed the anti-lock portion of the system by actuating pump motors and solenoids. Systems that are commonly serviced with the assistance of scan tools include but are not limited to:

ABS: anti-lock brake system
ARC: automatic ride control
ASARC: air suspension automatic ride control
EAT: electronic automatic transmission
ECA: electronic control assembly (engine, body, chassis)
ECU: electronic control unit (engine, body, chassis)
ECM: electronic control module (engine, body, chassis)
IVSC: integrated vehicle speed control
OBDII: on-board diagnosis II
SRS: supplemental restraint system
TCS: traction control system
VATS: vehicle anti-theft system

Many of these systems share sensors for input information. In order to do this, electronic control modules communicate between each other. For example, a faulty speed sensor might affect the ECM, EAT, TCS, ABS, and cruise control system. This may result in several instrument panel lamps being lit, making troubleshooting difficult. By using a scan tool, a technician can easily find the common relationship and cure all the malfunctions at once.

some systems and scan tools, electrical readings may actually be displayed for particular parts of the system. What can be read and performed is dependent on many variables, not the least of which is whether the scan tool is vehicle maker specific or a generic brand.

Vehicle Maker Specific

Many vehicle makers have scan tools that are designed specifically for use on their vehicle models (*see Figure 1*). These tools will usually allow the widest range of functions to be performed on the specific maker's vehicles. There are even some systems that can only be accessed by the vehicle maker specific tool. This is because the vehicle maker has chosen to keep the information proprietary. An example is some parts of the restraint system for specific vehicle makers. Without a vehicle maker specific tool, some restraint diagnostic information may be delayed for a couple years or not be available at all, depending on the vehicle maker's preference.

Even if the scan tool is vehicle maker specific, software cartridges that serve specific model years and systems are generally required. In some cases, the scan tools allow for hook-up through modems and are able to access on-line computers that can talk to the vehicle's computer. Some on-board computers can actually be reprogrammed or changed when some of these vehicle maker specific tools are being used. An example is where the engine timing can be changed or reset.

Generic Scan Tools

Generic scan tools are not specifically designed for use with only one vehicle make. These tools have, in the last 8 years, increased in capacity and scope compared to some of the first models. Generic scan tools also require updating of software, cable hook-up links, and access chips or keys for each new model year.

Figure 1–Vehicle maker specific scan tools allow access to the most information. Vehicle maker specific tools include the GM Tech 2 (left) and the Ford Star Tester (right).

Generic scan tools vary greatly in the features they provide and the systems that can be accessed. Specific diagnostic software may be needed for some systems, such as transmissions and anti-lock brake systems (*see Figure 2*). Other systems may also require some special hook-up link or an electronic chip in-line to access the specific data. In some cases, the tool

Figure 2–This cartridge, plugged into a generic scan tool, enables access to information on the anti-lock brake system (ABS) on most vehicles.

may only be able to view data, but not perform some of the reprogramming that a vehicle maker-specific tool can.

Other features include the ability to download to a desktop computer or to send information to a printer, including wireless remote printers. The type of on-screen tutorial and help functions available also vary between scan tools.

SELECTING A SCAN TOOL

Before purchasing a scan tool, it's good to define what types of vehicles will most commonly be serviced with it and what types of vehicle systems it will be used for. This is because there are scan tools that are specific to some vehicle systems. Others may be specific to a group of vehicles.

Software Availability

Software needs to be considered to determine what is needed immediately and what future updates will be available and needed. Many scan tools use cartridges that are changed from one application to another, so updating is done by purchasing additional cartridges. Some of the newer scan tools allow you to download updates on-line through a subscription. The number of software cartridges and memory sizes are expanding greatly, increasing the number of options available. Some scan tools have a large memory storage capacity and can be reprogrammed very rapidly using a personal computer. Others are updated by using a flash card, similar to a computer disc, that's installed into an access slot in the tool for rapid downloading. Other tools can be upgraded over a conventional phone line linked to the tool.

Features

The types of displays, help functions, service data information, diagrams, graphics, and other special features

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Types of Fault Codes

There are different types of fault codes that occur and that must be accessed for proper diagnosis. The codes might be accessible through flash codes, or just with use of a scan tool. Different vehicle makers use different terminology for the types of codes that can read through these methods. Service procedures will usually define the fault code terminology for the system being serviced. The following is a list of some of the terms and types of codes and definitions for faults.

Active Code
A code that is presently occurring and requires diagnosis and repair before it can be cleared. Also called a Current Code.

Continuous Code
Ford Motor Company term for a memory code that has been kept in the memory but is not current.

Current Code
A code that exists at the present time when checking faults and will not clear until the problem has been repaired.

Fault Code
A numerical or alphanumerical indicator for a specific system or area of a system that is sending an incorrect value to the computer. These can be read by a scan tool or on some vehicles and systems using flash codes.

Flash Code
A fault code that is displayed by the malfunction indicator light (MIL) for a system through a series of timed flashes and pauses. This may require using a jumper wire to connect two terminals of a diagnostic connector or pushing particular buttons or switches in sequence. Not all vehicles and systems use flash codes.

Hard Code
Code that is occurring at the present time and remains through a complete ignition cycle test.

History Code
A code that is presently not occurring and may actually have been repaired. In some cases history codes cannot be erased and are permanently stored in the electronic control module. An example of this might be a restraint deployment or the correct criteria for an airbag deployment being met.

Intermittent Code
A code that occurs only at particular points in time and does not stay active all the time. Also called a soft code. Not all systems have this capacity.

Memory Code
A code that is stored in memory but not active at the time, most often because of intermittent faults. Memory codes can also result from active codes being repaired without clearing the memory. Not all systems have this capacity.

On-Demand Code
Ford Motor Company term for a hard code, that occurs during a key-on, engine-off self-test.

Soft Code
Code that is stored by a vehicle system electronic control device and has appeared at an earlier point in time and is not presently occurring. This is considered to happen when a fault is intermittent.

Stored Code
A fault code that is not current or that is not caused by a fault at the present set of conditions.

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should be considered when deciding on a scan tool. Displays can be very high quality graphics with live screens for some functions. Service information available through the scan tool can include quick-checks for a fault code or detailed steps to follow similar to a service manual. Part locations may also be displayed, for fuses, PCM, connectors, and other items. With scan tools that are dedicated to specific systems, there may be functions that allow two-way communications so the scan tool can actually activate parts of the system to test it.

Cost

Scan tool cost considerations must be based not only on the initial investment, but also the cost of upgrades each new model year. There are many less expensive tools available that provide very limited information. Some of these less expensive tools are designed to only serve do-it-yourselfers.

SCAN TOOLS AND COLLISION REPAIR

There are several ways that scan tools can be used to assist with collision repairs and damage analysis. Before any repairs are started, or during damage analysis, scan tools can be used to determine various pieces of information. If the vehicle can safely be keyed to ignition ON, the scan tool can be used to access information from the computers on-board. If instrument panel warning lights are going through self-check modes and staying on steadily or continuing to flash, the scan tool may be able to provide additional information. Scan tool readings won't necessarily tell you what part is defective, but rather what area of a system is setting the fault. Armed with that information, often times a visual inspection of that area will expose physical damage from the collision.

Knowing that a fault code exists before repairs are begun is helpful during and after the repair. With some systems, the scan tool may be able to read how many ignition cycles have occurred since the fault was set. Knowing this may help determine if the fault is collision-related or not. The scan tool may provide a history of several faults or how many times this fault has occurred. This information can be helpful to better understand why the instrument panel lamp is showing a problem. In some cases, the instrument panel may not show a fault but there are fault codes in storage. These can be read with a scan tool and recorded for future reference.

With some vehicle systems that operate through the body computer, particularly in vehicles that use multiplexing, the scan tool actually is able to bypass the switches that control the circuits. Examples of systems where a scan tool can be used for this purpose include climate control, instrument panel cluster, wiper motor, interior lighting, and others. This allows the technician to see that the circuit is capable of working and that the computer is also operational. If the test shows these parts of the system function without the switch, then the problem area of the circuit has likely been identified.

Retrieving Lost Codes

On many systems, fault code data is lost if battery power is disconnected for a specified period of time. Losing that information can cause a repair to become more involved. The fault code may not reappear until the vehicle can be driven and that condition occurs again. An example of this is anti-lock brakes that may require the vehicle to be moving for the system to perform a self-test and then set the fault if conditions dictate. Also, retrieving and recording all codes before beginning repairs, clearing codes, and then performing repairs can allow a technician to know that something during the repair might have been overlooked. If, after repairs, different fault codes appear and they're related to an area of repair, the technician may find that a connector has not been plugged in or a part has not been properly grounded.

Reprogramming The Engine

If battery power is disconnected from some vehicles, it's necessary to perform a drive cycle to reprogram the system. Scan tools can assist with this task if the tool contains the proper data and the correct software. This allows the vehicle to be running smoothly and the transmission shifting properly when the customer first drives the vehicle.

Sorting Out The Codes

If a fault exists following repairs, the scan tool can help to systematically diagnose it and then clear the stored faults from the computer's memory. It's important on systems that do have storage of previous faults that they be cleared to not complicate future repair processes. Many times these codes may automatically be cleared after 50–100 ignition cycles. However, if a week after the repair an instrument panel warning lamp comes ON, it's helpful to know that any code in storage is in fact a new one. Some faults such as those set by restraint system deployments may have to be cleared using a scan tool because they may not be cleared after a number of ignition cycles.

Securing a fault does not mean the part is defective. For example, an oxygen sensor fault might only mean that the sensor was disconnected at some time during the repair and the engine was started. Even if the sensor was plugged back in later and the fault was corrected, the instrument panel lamp may still show an oxygen sensor fault for three or four ignition

cycles. This is because the vehicle maker may require that many ignition cycles occur without a reoccurrence before the code is cleared. In this situation it is best to clear the code and then operate the system for proper operation.

USING A SCAN TOOL

The ease of using a scan tool depends on the approach that's taken toward the tool and the technology. If a technician is reluctant to use a personal computer, he or she may not find scan tools inviting at first. Younger technicians entering the profession today have grown up with computers and video games and find the use of scan tools to be second nature. The truth is, scan tools are quite user-friendly and can be easily operated the first time without much assistance from a manual.

Once the correct software cartridge, if required, has been selected and installed, the next step is to link the tool to the vehicle (*see Figure 3*). The diagnostic connector needs to be

Figure 3–The first step is to connect the scan tool to the vehicle, usually through a diagnostic connector.

located for the system being checked, and the proper cable selected. If it's the main 16-pin data link connector (DLC), most newer scan tools will be powered by the connector. After is the scan tool is turned ON, the technician is prompted to use the keypad or scroll up and down selecting answers to questions or for selecting information.

The scan tool then asks for vehicle information. Generally the model year must be identified, as well as the engine size, and possibly the transmission type. The vehicle identification number (VIN) may be needed to answer specific questions about certain character positions in the VIN. With the vehicle identified, the scan tool may ask to check engine fluid levels to see that they're correct. The tool may also ask whether other items have been checked, and to verify these using a YES or NO button. This will then allow the technician to select the vehicle system to be checked and the type of information desired.

The scan tool will communicate with the vehicle computers and display available data on the screen. It may supply current fault codes, history fault codes, or no codes present (*see "Types Of Fault Codes" sidebar*). The scan tool will also allow the codes to be cleared if desired. Codes should never be cleared without recording them for use later. The codes should be put with the service record for the vehicle repairs.

Armed with the fault codes, the technician can then use the service information to determine the correct diagnostic procedures to follow. The fault code, by itself, does not condemn the main part related to the code. This means accessing some type of service information to systematically check the system. These procedures can be built into the software of the scan tool, service manuals, on-line services, electronic database, or other source. These procedures will generally require the use of a DVOM for voltage and resistance readings, good visual skills, and good reading comprehension (*see Figure 4*). Diagrams for grounds, connectors, power distribution centers, individual parts, and system wiring may also be needed to locate correct readings. The scan tool will not do the work. It is a tool that helps obtain the information needed so that the correct diagnostic procedures can be followed.

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Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	—	*Go to Step 2*	Go to *A Diagnostic System Check - ABS*
2	Install a scan tool. Does DTC C1258 occur intermittently?	—	Go to Diagnostic Aids	*Go to Step 3*
3	1. Turn the ignition switch to the OFF position. 2. Disconnect the 6-way ABS brake motor pack connector. 3. Disconnect the 8-way EBTCM connector C2 4. Use the DVOM in order to measure the voltage between the 6-way ABS brake motor pack harness connector terminal F and ground. Is the voltage within the specified range?	0–1 V	*Go to Step 4*	*Go to Step 10*
4	Use the DVOM in order to measure the voltage between the 6-way ABS brake motor pack harness connector terminal E and ground. Is the voltage within the specified range?	0–1 V	*Go to Step 5*	*Go to Step 11*
5	1. Turn the ignition switch to the OFF position. 2. Use the DVOM in order to measure the resistance between the 6-way ABS motor pack harness connector terminal F and the 6-way ABS motor pack harness connector terminal E. Is the resistance within the specified range?	OL (Infinite)	*Go to Step 6*	*Go to Step 12*
6	Use the DVOM in order to measure the resistance between the 6-way ABS motor pack connector terminal F and the 6-way ABS motor pack terminal E. Is the resistance measured within the specified range?	0.2–1.5 Ω	*Go to Step 7*	*Go to Step 9*
7	1. Inspect the following components for damage: • The 6-way ABS motor pack connector • The 6-way ABS motor pack harness connector Damage may cause a short to voltage with the connector connected. 2. Inspect the following components for damage: • The 8-way EBTCM connector C2 • The 8-way EBTCM harness connector C2 Damage may cause a short to voltage with the connector connected. 3. Inspect CKT 1280 and CKT 1281 for signs of damage. Damage may cause a short to voltage. Is there damage which may result in a short to voltage?	—	*Go to Step 13*	*Go to Step 8*

Figure 4–A scan tool will not tell the technician everything. Use of a DVOM and visual skills are also required.

Using Scan Tools For Collision Repair–
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CONCLUSION

Scan tools offer many features and can help in the collision repair process before, during, and after the repair. The types, features, updating capabilities, technical support, vehicle and system coverage, and added features are widespread when comparing these tools. Each year these tools improve, gaining wider ranges of capabilities and becoming more user friendly. Researching the tool's capabilities and the most common applications in the repair facility is important before deciding to purchase a scan tool.

Scan tools by themselves will not point to the exact cause of every problem. Proper diagnosis still requires the use of service procedures, a DVOM, visual skills, and comprehension of the information. Many vehicles that have electronically controlled and monitored systems affected during the collision will benefit from the use of a scan tool. Vehicles that leave repair facilities with codes cleared will be potentially more easily serviced in the future without confusion from the previous codes.

Five-Character Code

Diagnostic codes up to about 1996 were generally displayed using one or two digit numbers depending on the vehicle maker and the system they related to. With the 1996 model year and OBDII requirements, the codes accessed through the 16 pin diagnostic link connector had to follow SAEJ2012 guidelines using a 5 character alphanumeric code.

1st character: P, B, or C
- P for power train
- B for body
- C for chassis

2nd character: 1 or 0
- 1 for Society of Automotive Engineers (SAE) designation
- 0 for manufacturer-specific

3rd character: Subsystem

4th and 5th character: Fault Code

Refinishing Plastic Parts
–Staying Flexible When It's Required

Although technicians have been refinishing plastic exterior parts for a couple of decades, questions continually come up. There are questions about how to identify plastics, and how important it is to identify the plastic? What different types of materials are available for plastics? When do you add flex agent? Some of these questions can be answered by addressing plastic categories, materials designed for refinishing plastic, and the plastic refinishing process.

IDENTIFYING PLASTIC

Plastics are identified with an International Standards Organization (ISO) code. Some manufacturers of plastic parts stamp the back side of the part with the ISO code. The chart in *Figure 1* is a list of plastics found on vehicles and their ISO codes.

Plastics can also be categorized as rigid, flexible, semi-rigid, extra rigid, soft, etc. Since there's no consistency from one manufacturer to the next, it's best to just consider what the part is being used for, as well as the paint maker recommendations. A TPO, for example, when used for an interior trim piece, may be classified as rigid. A TPO used for a bumper cover may be classified as flexible. For refinishing purposes, the question is when the paint maker requires a flex additive or a product containing flex additive to be used. Flex additive allows the refinish material to tolerate some deformation of the part without cracking or chipping.

Plastic materials can be further classified as either olefins or non-olefins. The major characteristics of these groups will assist in identifying the needed preparation steps and refinish requirements.

ABS	Acrylonitrile Butadiene Styrene
BMC	Bulk Molding Compound
GFK	Fiberglass
GTX	Alloy blend of nylon
HPA	Honda Polymer Alloy
PA	Polyamide
PBT	Polybutene Terephtallate or Pocan
PC	Polycarbonate or Xenoy
PP-EDPM	Ethelene Propylene Diene Modified
PP-EPM	Ethelene Propylene Modified
PPO/PA	Rigid Polymer Alloy
PPO	Polyfenylene Oxide Polymer
PUR	Polyurethane
SMC	Sheet Molded Compound
TPO or TEO	Thermoplastic Polyolefin
TPU	Thermo Polyurethane

Figure 1–These are some common plastics used on vehicles.

Olefins

Olefins usually are materials that contain a high amount of butyl (rubber), feel soft yet slippery, and have an oily or waxy appearance. These products don't sand well, require extra effort to clean, and may require baking to help expel internally trapped solvents. Olefins are the more difficult type of plastic to refinish, usually requiring a flexible primer. Using the float test, or dropping a small sliver of the material in water, will easily identify an olefin. Olefins will float when placed in water (*see Figure 2*).

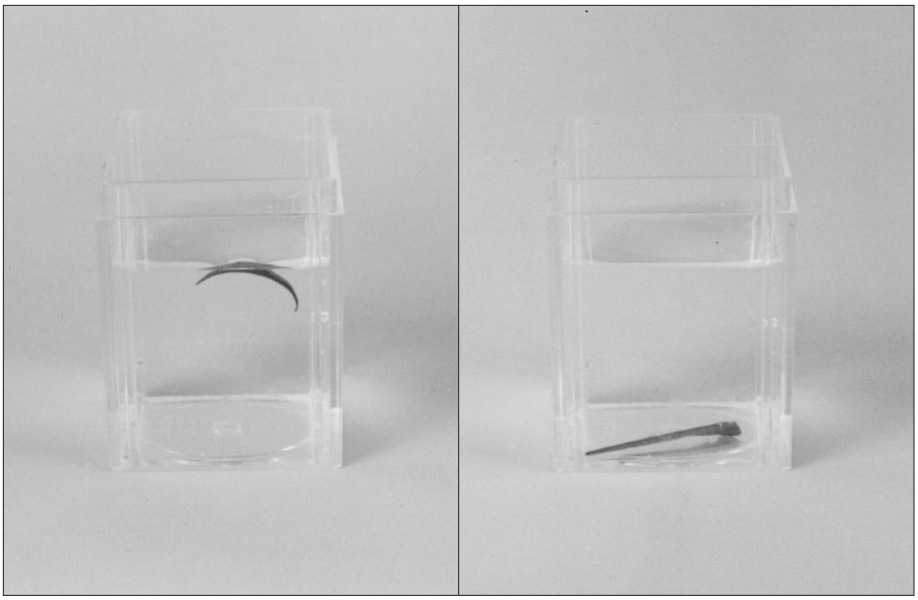

Figure 2–The float test will identify an olefin. Drop a small sample of the plastic in water. Olefins (left) will float, non-olefins (right) will sink.

Non-Olefins

Non-olefins generally are easier to refinish, will usually sand quite easily, may not require a surface modifier or adhesion promoter, and can be identified using a float test. Non-olefins will sink when placed in water.

PRODUCT SPECIFICS

It's highly recommended by all paint and specialty product makers that technicians choose and use one product line. Paint makers either have the products for refinishing plastics or will refer to a specialty product maker's specific products. Don't cross brands when choosing these special materials.

The following materials are used in the process of refinishing plastics. Understand that the paint line used by your facility may or may not have all of these.

Plastic cleaner removes inorganic contaminants such as wax, grease, silicone, road tar, and other contaminants.

Adhesion promoter provides an improved adhesion bond to the flexible substrate. Some paint makers recommend applying this material or flexible primer when refinishing all types of plastics.

Flexible primer-surfacer allows for filling and leveling, similar to the process done on non-flexible metals or plastics.

Sealer, either flexible or not, provides good adhesion to the substrate. It also provides topcoat hold-out, which prevents topcoat solvent from penetrating sensitive substrates that results in wrinkling or lifting. All sealers provide a uniform background color. Flexible sealer adds to overall flexibility of a finish.

Flexible additives are added to basecoats, clearcoats, and single-stage refinish materials. In paint lines where flex additive is not already contained, a separate flex additive can be added to primers, surfacers, or sealers. When added to a material, these agents add plastic characteristics of flexibility and scuff and chip resistance.

REFINISHING PROCESS

Since there's such a wide variety of plastics and refinish materials, it's crucial that you understand the specifics of your refinish line. The following two steps are the most general of all the paint makers, however, and should always be followed.

Cleaning

Plastics require extra effort to remove stubborn contaminants like mold releases, wax, or silicone. Imbedded or trapped solvents also may be released after a thorough cleaning with both soap and water and plastic cleaner (*see Figure 3*). Some new

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Figure 3–Cleaning with soap and water and a plastic cleaner is an essential first step with bare plastic parts.

replacement parts may require baking in the spraybooth or by using heat lamps to release trapped solvents.

Solvent Test

Sensitive substrates can cause lifting or wrinkling in the finishing process. To check for a sensitive material, either on a panel being partially repaired or a new part, a solvent test can be performed.

Using the solvent from either the plastic primer or topcoat, wipe the suspect area for about two minutes, keeping it wet. Leave the panel sit for about 5 minutes. Then inspect the area for a reaction of lifting, softening, or wrinkling. If no reaction has occurred, continue with the repair process. If the substrate reacted, remove all loose material. Apply a sealer to the sensitive area with light, somewhat dry coats, allowing extra flash time between coats. This process will usually build an acceptable bridge over the sensitive material and prevent a reaction later in the refinishing process.

TIPS AND HINTS

Steps required for refinishing plastics are required for most refinishing operations, but become especially important with plastics.

Mix carefully. Not only must a balance of products be maintained, but also the sequence of reducing and adding hardeners must be followed. Adding hardeners to unreduced refinish material may cause seeding, or miniature hardening of particles of the material. Seeding will go unnoticed until the material is sprayed and small sand-like granules are seen in the refinish.

Spray gun selection is important. Although flexible refinish material is thicker, using a smaller size fluid tip provides better atomization. Better coverage with a minimum of texture will result. This is very important when spraying single-stage, since the flex additive has reduced the hide factor of the color.

Gloss control may become a concern since flex additives use clear resins as the carrier for the flexible chemistry. At least one paint maker recommends a small addition of a "matting" agent to reduce this concern. Most often however, sanding and polishing give control of the final gloss factor.

PROCESS QUESTIONS

There are still questions and concerns about plastic refinishing that remain unanswered.

How do I match texture?

Technicians must be familiar with the spray gun and the results that occur from minor changes in air pressure, distance, travel speed, and flash time. In easy terms, spraying farther away, moving faster, and allowing longer flash times will increase texture. An article in a previous issue discussed texture control (*see "Texture Techniques" in the July-August 2000 issue of the Advantage*).

What if the part is off the vehicle versus on the vehicle?

The refinish process should remain the same. It may be advisable, however, to install the part on the vehicle, or position it on a stand in the same position it will be installed on the vehicle, before applying color coats to allow better color control and blending, if this is needed.

Should I spray flexible parts and non-flexible parts separately?

Yes, for undercoats such as primer, filler, and sealer. Basecoat colors are applied to all parts the same. Single-stage and clearcoats could be applied with the "two-gun method," one with flex additive and the other without. Small, combined repairs could be completed all with flexible finish. Larger, combined repairs may see a saving in not adding flex additive to the basecoat or clearcoat, then following with the two-gun method. Having flex additive in the material on non-plastic parts will do no harm. As already mentioned, a coating with flex additive will have better chip and scuff resistance.

Follow the paint maker's recommendation regarding the use of flex additive. Paint makers vary in the requirement for flex additive in both undercoats and topcoats.

CONCLUSION

Refinishing plastic panels and parts will continue to be a complex process. More and various types of plastics are being used by the vehicle makers. New coating chemistry reaches the market regularly and processes change. Technicians need to stay abreast of all the latest technologies. Ask your suppliers to provide you with the latest information about products and processes. Read the industry trade publications, follow the paint maker recommendations, and watch for refinishing training programs in your area.

Four-Wheel Steering Comes To Trucks
–Turn Radius Of A Sedan

Four-wheel steering systems have been used in industrial settings for decades. One example is the towing truck used to move aircraft around airports, which uses manual controls to steer both sets of wheels. Most of these trucks don't have a front and back, but drive in whichever direction is needed. One steering wheel steers the front wheels and another wheel or control stick steers the opposite end. These vehicles can turn in remarkably small circles by turning front and rear wheels in the opposite direction, or move sideways by turning both wheels in the same direction. For this reason, they're sometimes called crabs. Farm equipment has also used four-wheel steering on large equipment to help turning.

This type of four-wheel steering is not needed on passenger vehicles. But there are some systems being used on vehicles that turn the rear wheels slightly to assist in turning. These are called rear-wheel steering systems. Some systems are passive, relying on other parts to allow for toe changes as a result of lateral loads placed on the suspension parts. Other systems are active, using actuators to change toe as controlled by a computer. Some rear-wheel steering systems are used primarily for low speed operation. Turning the rear wheels a few degrees in the opposite direction reduces the turning radius, making parking easier.

Other design modes are used to enhance high speed maneuvering. High speed handling can be dramatically improved by turning the rear wheels in the same direction as the front wheels. With normal two-wheel steering vehicles driving at highway speeds, when the front wheels are turned, the rear wheels are subjected to lateral loads. The front of the vehicle is pointed in a new direction and the rear tires must resist the side loads imposed to track after the front tires. If both sets of wheels are turned at the same time, in the same direction, all four tires share the lateral loads equally. This results in greater stability and better handling.

Figure 1–The 2002 GMC Denali features the first four-wheel steering system for passenger trucks. (Courtesy of General Motors)

QUADRASTEER™

General Motors has introduced a four-wheel steering system for light duty trucks called Quadrasteer™. The first application is the 2002 GMC Denali full-size pickup (*see Figure 1*). As applied to the light truck chassis, this system has three phases of operation: neutral, positive, and negative. In the neutral phase, the rear wheels are pointed straight ahead. This phase is when the system is deactivated or when vehicle speed is about 70 km/h (45 mph). In the negative phase, the rear wheels are turned in the opposite direction of the front wheels. This happens at speeds below 70 km/h (45 mph). How far the wheels turn is determined by the angle of the front wheels and the vehicle speed. A maximum of 12° is programmed. The positive phase occurs at speeds above 72 km/h (45 mph). The rear wheels are turned a smaller amount in the same direction as the front wheels.

Figure 2–A button on the instrument panel allows switching from conventional two-wheel steering, four-wheel steering, and a towing mode. (Courtesy of General Motors)

A mode select switch on the instrument panel has three settings: two-wheel steering (2WS), four-wheel steering (4WS), and four-wheel steer tow (TOW) (*see Figure 2*). More positive turning is programmed for the TOW mode than the 4WS mode.

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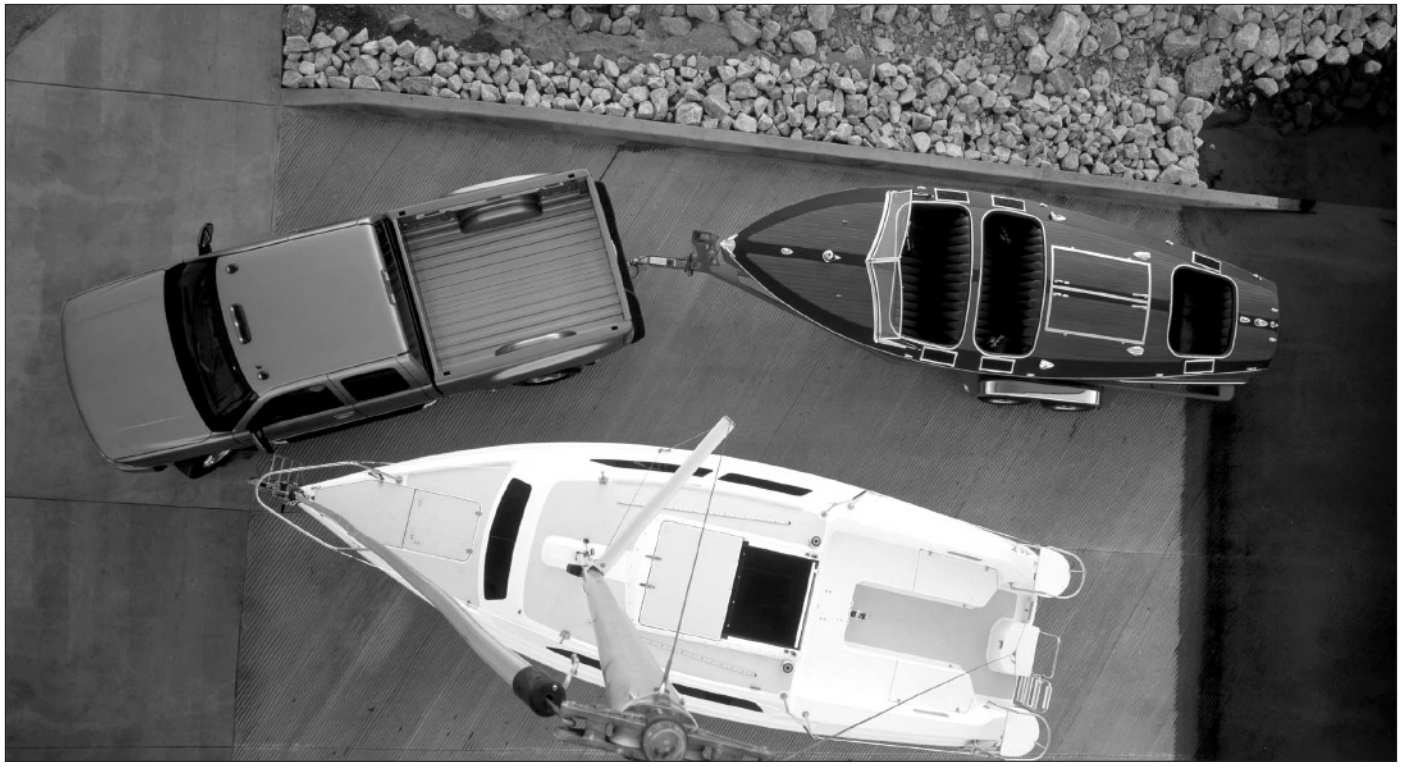

Figure 3–Four-wheel steering in the positive positive-phase TOW mode prevents a trailer from swaying when changing lanes. (Courtesy of General Motors)

The negative phase is intended to assist in low speed situations such as parking, turning in tight spaces, and trailer backing. The normal turning circle of the *Denali* is a little over 14 meters (46 feet). With the Quadrasteer system ON, that's reduced to 11.4 meters (37.4 feet), or about the same as a mid-size sedan. The positive phase is intended to make higher speed situations more stable. By keeping the centerline of the vehicle more nearly aligned with the direction of travel, yaw forces are minimized. Particularly when towing, this reduces the tendency of the vehicle, and the trailer, to sway from side-to-side when changing lanes (*see Figure 3*).

PARTS AND SERVICE

The rear-wheel steering is made possible by use of an electric steering rack mounted to the rear axle housing. It's controlled by the Rear Wheel Steering Control Module, which is mounted on the rear undercarriage. This uses input from a number of sensors to determine the correct rear-wheel steering control.

Mode is controlled by both the Mode Select Switch and the vehicle speed. The amount of rear wheel steering applied is done automatically. Default is to tow-wheel-steer in case of any part or signal failure. Powerful springs inside the rear steer rack center the steering system, unless power is applied to the actuator motor. This motor may be serviced separately.

Servicing this system, particularly after collision damage, is mostly a matter of replacing parts. Sensors and the steering motor may be replaced if damaged. The rack and pinion steering rack is serviced as a unit. The wiring harness may not be repaired on this system, so cut wires will require a new harness. Inner and outer tie rods are serviced. The outer tie rod has an overlaying bracket as a redundant retainer, should the ball joint nut malfunction.

Mode lamps indicate which mode the system is in. If the vehicle is left in neutral for four seconds or longer, the system defaults to 2WS and flashes the previous mode lamp until the transmission is placed in gear. This is to accommodate automatic car wash requirements.

FOUR-WHEEL STEERING ALIGNMENT

Aligning the suspension on vehicles equipped with this system is a little more involved. A conventional four-wheel alignment will be done. Caster and camber are not adjustable on the rear. Also the steering wheel must be centered very accurately. Following the mechanical alignment, a "Learn Alignment Procedure" must be performed. This consists of using a Tech 2 (GM-specific scan tool) system to allow the controller to "learn" the sensor positions.

I-CAR Industry Briefs

GM Issues Material Specification For Repair Adhesive Bonding

General Motors has issued a materials specification for adhesives that are to be used for bonding external metal panels during collision repair. The specification GM6449G, titled "Automotive (Metallic) Panel Bonding Performance Guidelines For Aftermarket Service Use," outlines performance guidelines of structural adhesives that can be used to bond external body panels as an option to welding. The only external body panels mentioned in the specification are door, deck lid, hood, and roof skins. The test procedures and performance requirements contained in this specification are to serve as a template for material suppliers and adhesive manufacturers to test their products to.

Previously, General Motors developed and released a specification for bonding exterior sheet molding compound (SMC). This specification, GM6448G, is a materials specification developed to allow for the approval of service materials for repair and replacement of SMC bonded panels.

Regarding the metal bonding material specification, at this time there are no specific recommended procedures and guidelines for the use of the material that qualifies for this specification. In other words, General Motors has yet to release a service bulletin or any other information providing procedural or specific application guidelines, other than to define the scope for metallic outer replacement body skins. Some of these outer skins are currently bonded to inner reinforcements in production.

GM COLLISION REPAIR INFORMATION AVAILABLE ONLINE

Collision repair technicians can now access General Motors information on the Internet, and some of it's free of charge. The free information is limited to specific collision repair procedures that have been consolidated into book form and distributed at past NACE tradeshows. Access this information at www.techinfo.gmgoodwrench.com.

Also available online is SI2000, which is the service manual information used by GM technicians. This includes not only collision repair information and measurement specifications, but all the mechanical and electrical service manual information. Not all information is included on all year models. The access is available for one 24-hour day, 5 days, or one month. Register at www.acdelcotechconnect.com.

3M PAINT PREPARATION SYSTEM

A new spray gun paint cup system by 3M, called the Paint Preparation System (PPS), streamlines the process of spray gun cleaning and reduces the amount of paint and cleaning solvent waste. When using the system, a liner from a wall dispenser is placed in a mixing cup and fitted with a lid with a locking collar. The refinish material can be mixed in the

usual way. What's unusual about the system, is that by bleeding the excess air from the cup, the spray gun can be used at any angle. The liner further collapses as the material is sprayed (see above). Afterwards, the unused paint can be properly labeled and stored in the liner, or the empty liner can be disposed. Spray gun cleaning is reduced to rinsing out the small passages within the spray gun body between the cup and the air cap.

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