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Popular[®] Mechanics

APRIL 1990
VOLUME 167
NO. 4



71 COVER STORY

Ocean engineers are building the world's first underwater aircraft.
—PM illustration by Jeff Mangiat



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EDITOR'S NOTES

RESearch TELLS us that remodeling your kitchen will give you the greatest return on investment at resale time of any remodeling project. So it's only fitting that we devote this year's Home Improvement Guide entirely to kitchen remodeling. Home and Shop Editor Steve Willson and his associates, Tom Klenck and Roy Berendsohn, designed the section so that you can approach each project either on its own or as part of a larger integrated effort. To accomplish this, we called on longtime contributor



Neal Barrett in his kitchen.

Neal Barrett to first construct a circa 1970 kitchen in a studio, then make the dramatic improvements you see taking place in this month's special section. This approach gave us much more control than we would have had doing the work in someone's actual home. In all, more than four months were spent developing the pages in this year's Guide. We hope you think it was worth it. . . . A one-man sub that incorporates aircraft technology to go



Vizard is in, Booth is out.

deeper and faster underwater—and therefore cover a larger area while exploring—than any previous submersible. Do I have your attention yet? If so, check our cover story on page 70. . . . We recently lost Electronics Editor Steve Booth to a lucrative offer to become editor-in-chief of *Video Review*. Taking Steve's place as Electronics Editor is former Contributing Editor Frank Vizard, who has been writing about consumer electronics for us for the past five years. As Vizard becomes full-time Electronics Editor, Steve Booth becomes a Contributing Editor, covering the video field for us. So in effect, Vizard and Booth have swapped spaces on the masthead. Our other new addition is Rick Titus as West Coast Editor. Titus has served on the staffs of *Hot Rod* and *Motor Trend* and last year won the Drivers Championship in the Sports Car Club of America's Escort Showroom Stock series in GT class. What's more, he's currently restoring his father's 24-Hours Of Daytona-winning 1969 Pontiac Firebird race car. A great driver and hands-on too. What more could you ask for? Till next time.



GT champ Rick Titus.


Joe Oldham

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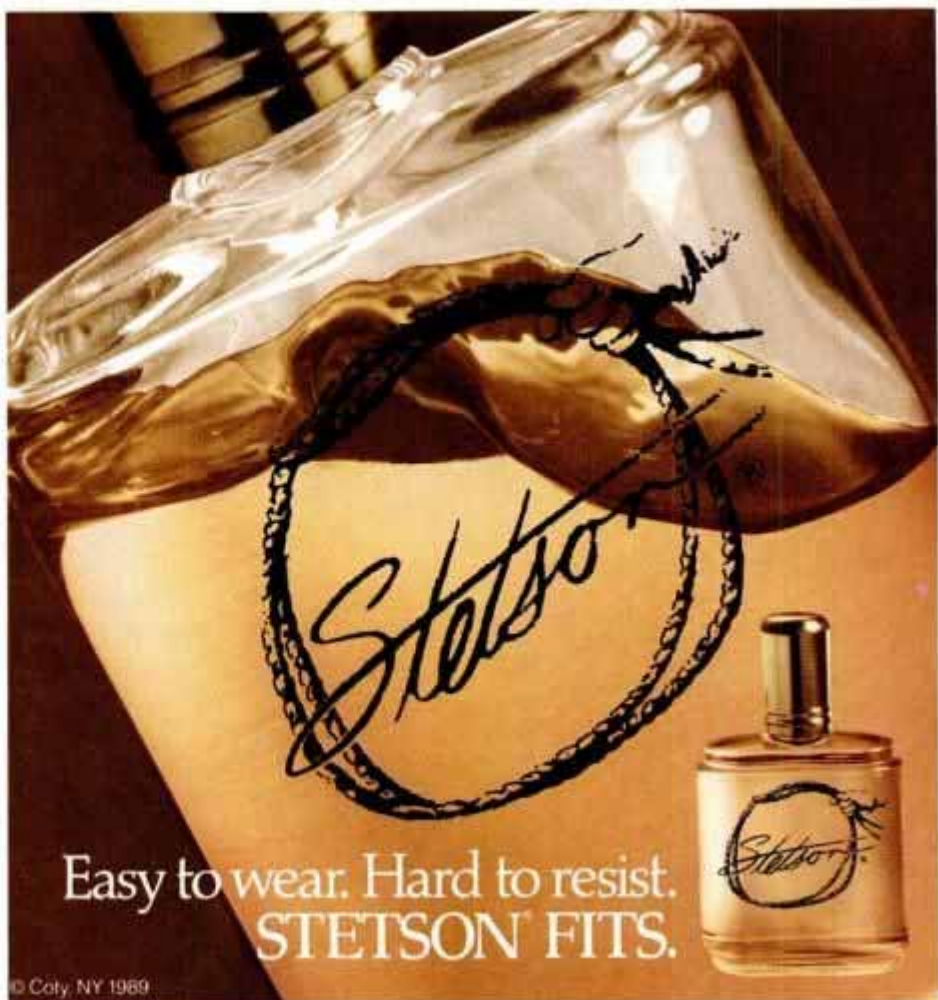
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LETTERS

Gas Attack

I READ WITH interest your article "Fuels In Your Future" (page 55, Nov. '89). In your first sentence under the "LPG" head, you say LP gas stores at high pressure. I would define 100-200 pounds per square inch gauge (psig) moderate pressure when compared to 2400-3400 psig, the storage pressure of compressed natural gas (CNG).

In your second sentence, you say: "an even bigger drawback to LPG is that it is 10 times more expensive than gasoline." I don't know where you got your information, but it's incorrect. According to the Department of Energy, LPG costs about half as much as gasoline. LPG may not be the panacea to the U.S. alternative fuel problems. No singular fuel is. But LPG can play a significant role for fleets and inner-city markets.

J.R. ANDERSON
MARKETING COORDINATOR
TEXAS LP-GAS ASSN.
AUSTIN, TX

I recently finished reading the article "Fuels In Your Future." You choose to tout as one of methanol's advantages the fact that it "is now more commonly synthesized from coal or natural gas." Yet, "an even bigger drawback to LPG is that it is primarily associated with natural gas" That seems to be a contradiction.

CAROL A. McADAM
DIRECTOR, MARKETING &
PUBLIC INFORMATION
NATIONAL PROPANE GAS ASSN.
OAK BROOK, IL

During the editing process, an incorrect cost for LPG was inserted. It costs approximately half the price of gasoline. LPG is primarily associated with refinery processing, and not as a product from natural gas. That it is derived from the distillation of oil is the major drawback to LPG becoming a major long-term alternative to gasoline. Harmful emissions are generated during the refining process, and more importantly, any fuel derived from petroleum is automatically of limited long-term viability.

An LPG infrastructure is in place,

and it could be expanded. But again, LPG, for the reasons already mentioned, cannot be considered a long-term alternative.

The intention of the article was not to unequivocally state that methanol is the only alternative fuel in our future. Rather, it emphasized the many strong points (along with some weaknesses) methanol offers, chief among them the way it can be used in conjunction with gasoline in flexible or multifuel vehicles. That could mean short-term improvements in emissions in heavily polluted areas such as the Los Angeles basin.

Flexifuel vehicles can be operated with no restraints based on availability while methanol is made as available as gasoline. The technology to allow mass production of efficient and environmentally acceptable flexifuel vehicles is close to being perfected.

As Anderson wrote, no single fuel is a panacea, and certainly LPG will continue to play an important role, especially for fleets and inner-city use where vehicles return to "base" each evening for easy refueling.

One thing is certain, as was stated in the opening paragraph of our fuels report: Gasoline is on its way out, and right now methanol is the long-term alternative fuel that is most closely barking at its heels.

Credit Is Due

I would like to personally thank you for having Neal Barrett compose such a professional and informative article on building a quality pool table ("Rack 'Em Up," page 74, Dec. '89).

The hours that Mr. Barrett and I spent touring our facility, together with my personal attention in answering his questions, appear to have been quite helpful in writing this article. However, the lack of crediting those responsible for much of the detail was very disappointing.

ROBERT J. GRIMALDI
CORPORATE VICE PRESIDENT
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EAST NORTHPORT, NY

We apologize for the oversight in crediting your help in the development of this excellent PM project.

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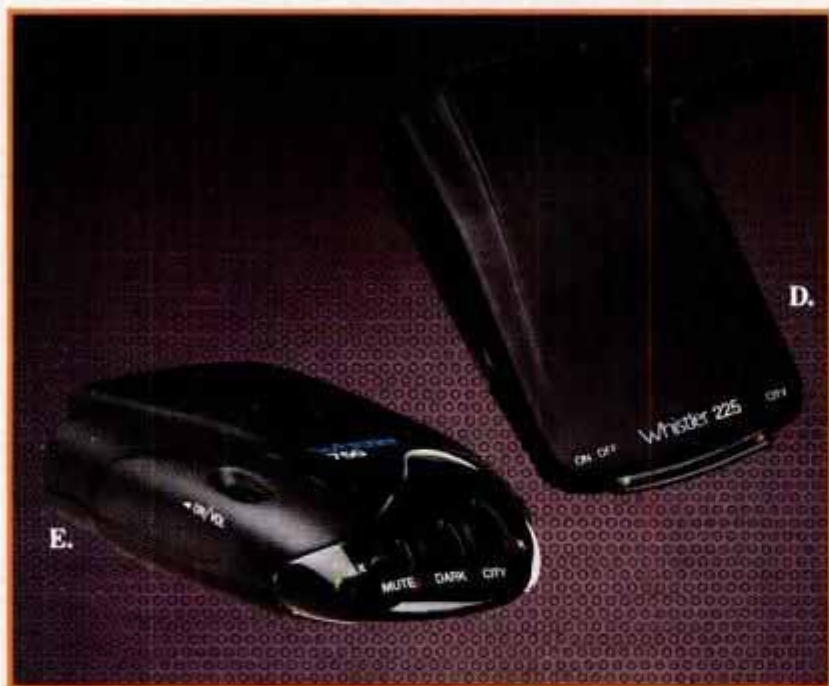
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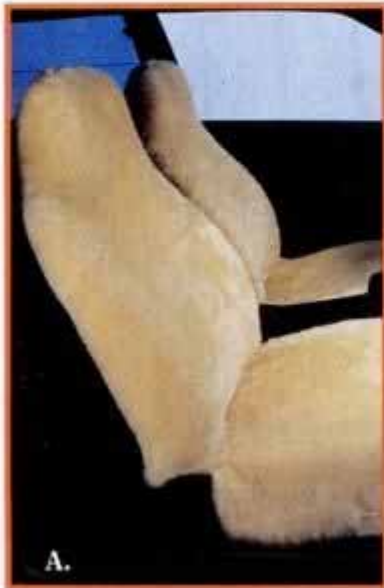
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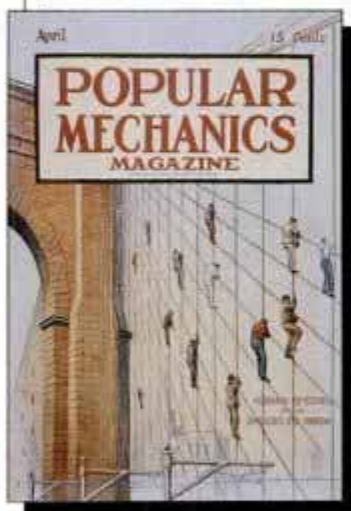
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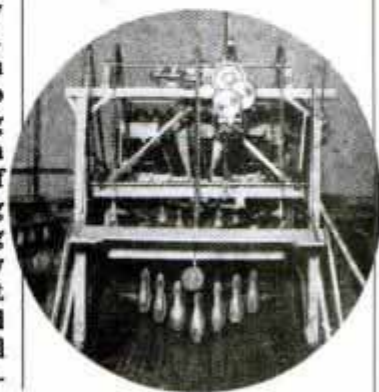
High-Wire Act

Our April issue's cover story focused on the workaday heroism of the men who scaled the dizzying heights of the Brooklyn Bridge to protect it from the elements. About 117,000 pounds of paint were required to sheathe its miles of steel cable and structural members. Every four years the task had to be repeated by "human spiders" who dangled from scaffolds jostled by the mastheads of passing ships, or clambered to the peaks of the 272-ft. towers.

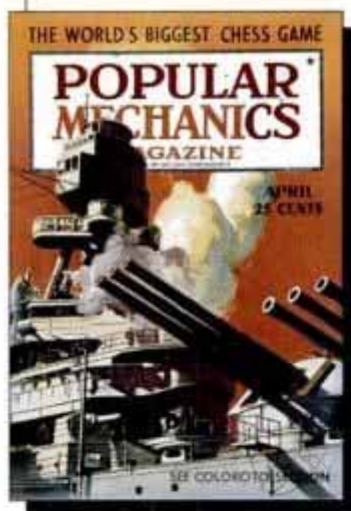
Demise Of The Pin Boy

The days of the pin boy were numbered with the advent of a device that automatically reset pins in bowling alleys. The elaborate contraption used electromagnets to grip the tops of pins still standing after a throw, lifted them clear, then swept the alley of dead wood, before replacing the standing pins. Offering the bowler considerably more flexibility than present machines, the device had buttons to choose individual pins to leave standing. Alter-

natively, one could opt for a whole new set of pins, or just to have the dead wood removed.



50 YEARS AGO: APRIL 1940



The Outer Bulwark

With war on the horizon, PM's cover story inventoried the weapons making up our first line of defense: 15 battleships, five aircraft carriers, 37 cruisers, 230 destroyers and 96 submarines. Eight new battleships, considered to be the backbone of the fleet, were under construction, along with 58 warships of other types. But even on the brink of war, we were still well short of the 600-ship Navy former President Reagan recently aimed for.

Atomic Speedway

Twenty years after its invention, the mass spectrometer was busily at work in American industrial labs. One example, used to test gases in fluorescent lamps, was wrapped in 7000 ft. of copper tubing that could be charged to form an electromagnet. Ions from gases in the center of the device were shot at 16,000 mph through the evacuated tube by an electric charge. Heavier ions were not diverted as much by magnetic field. So by measuring the amount of current need-

ed to run them through the tube, the weights of a gas's different components could be determined.



25 YEARS AGO: APRIL 1965



A Garage To Live By

Voicing our conviction that the contemporary garage fell far short of its potential, we put forward a plan to transform it from a humble storage area to a focus of family life. Called the PM Patio Garage, the project merged space for the family auto with a full kitchen that opened out onto a concrete patio. Closets were provided for a barbecue and patio furniture. Running through four issues, the plans took the reader from the first shovel of dirt to the last swing of the paintbrush.

Osprey's Ancestor

Twenty-five years ago, an experimental tiltrotor aircraft demonstrated the capabilities that are only now approaching production in the form of Bell-Boeing's V-22 Osprey. Called the XC-142, the aircraft was built by Ling-Temco-Vought for the three armed services. Four 3000-hp turbines lifted the 18-ton plane into a hover. Unlike today's V-22, the whole wing tilted along with the engines, producing cruise speeds of 430 mph.



O N L Y O N



*The Championship-winning Eagle Talon TSi AWD.
Exclusive tires: Goodyear Eagle "Gatorback" street radials.**



*The Eagle Talon TSi AWD.
Exclusive tires: Goodyear Eagle GT+4 all-weather performance radials.*

EAGLES.



*Both of these Eagle Talons get their grip from one, and only one, make of tires: Goodyear Eagle street radials.**

When the Eagle Talon was designed, its engineers cut no corners.

Hence the fact that every new Eagle Talon TSi AWD comes on Goodyear Eagle GT+4 high-performance radials. Exclusively.

Which is one of the reasons the Talon handles so well. Especially in the corners.

In fact, in independent testing, the Eagle Talon TSi AWD out-performed its competition. And, in the slalom, it performed virtually the same in the wet as in the dry.

Credit its fully independent suspension. Its quick-ratio steering. Its all-wheel drive.

And its all-weather Eagle GT+4 radials.

The race-prepared Eagle Talons of Bobby and Tommy Archer also use just one make of tires: Goodyear Eagle street radials.*

And in 1989, the Archer brothers won the SCCA Endurance Championship. Finishing first and second in A-Class competition.

All of which helps to prove there really is a difference in performance tires.

And that difference is a major reason why these Eagle Talons get their grip from the Goodyear Eagles. Exclusively.



A Goodyear Eagle "contact patch." Where an Eagle demonstrates its superiority.

*Tires shaved to racing depth. Before you race on Goodyear street radials, write The Goodyear Tire & Rubber Company, P.O. Box 9125, Akron, Ohio 44305 for preparation recommendations and procedures.

GOODYEAR

BECAUSE THERE REALLY IS A DIFFERENCE.

WE MAKE EARNING MONEY FOR COLLEGE AN EDUCATION IN ITSELF.

How does earning over \$18,000 for college sound? That's what you can get if you qualify for the Montgomery GI Bill and add that to your pay during a standard enlistment in the Army Reserve.

You can get help in paying off some or all of a qualified student loan, too, through the Student Loan Repayment Program. And, while you're getting help with college costs, you'll get a chance to train in a useful skill.

You serve part-time, usually one weekend a month, plus two weeks a year. So you can continue your education and pick up some valuable lessons from us. The kind of education that comes from experience.

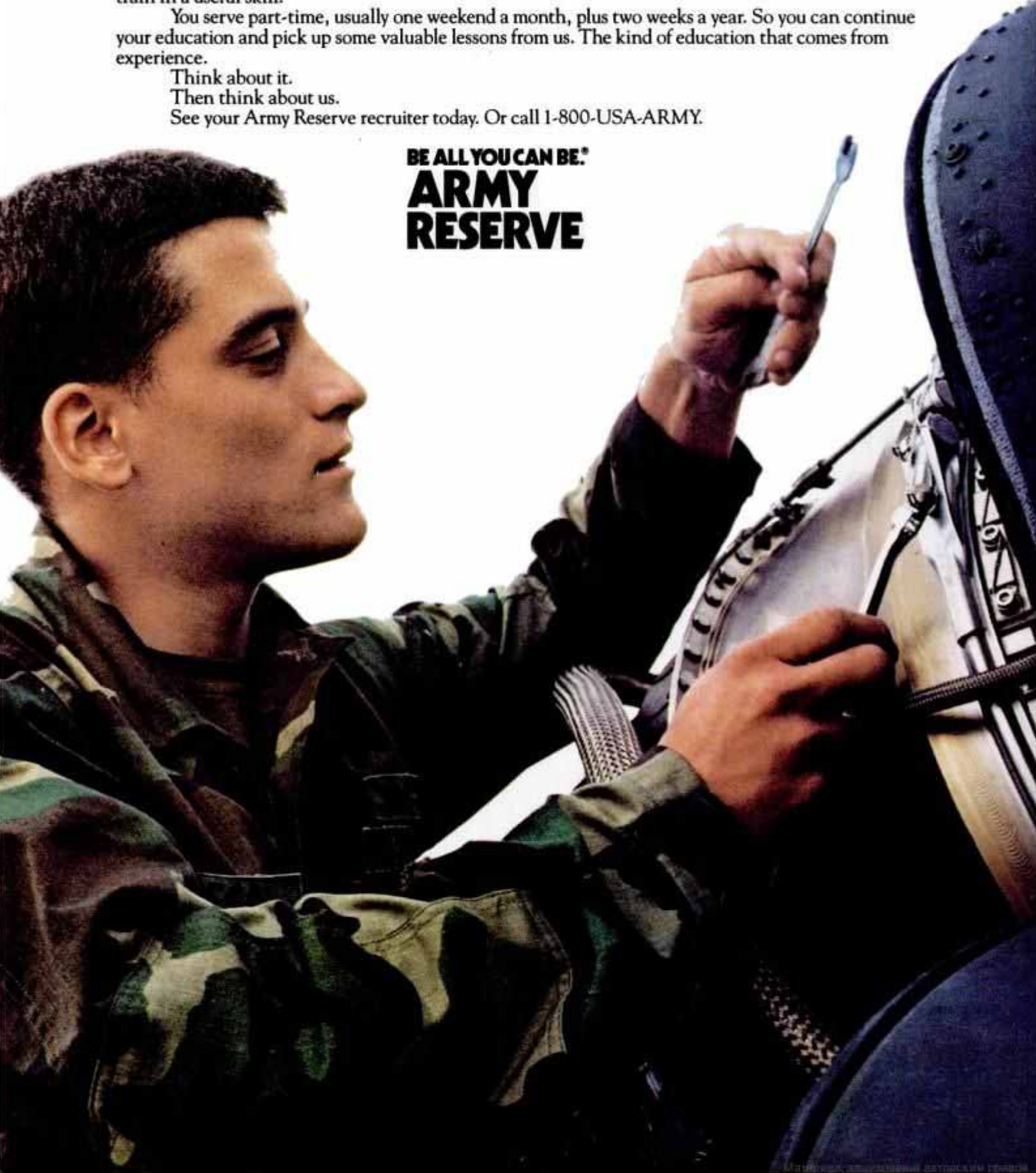
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Then think about us.

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TECH UPDATE

News Of Tomorrow's Technology Today



NPP technology, shown here retrofitted to a current Los Angeles-class attack sub, could counter a variety of airborne and surface threats.

PM ILLUSTRATION BY ED VAUGURSKY

Fiberoptic Threads Turn Subs Into Hunters

WASHINGTON, D.C.—Submarines of the future may strike back at marauding aircraft by firing guided missiles now being developed by the United States and three European allies. Key to the capability are fiberoptic links that enable sub commanders to communicate with missiles and sensing platforms on the surface, while remaining hidden at full ocean depth.

Farthest advanced among the programs is a U.S. effort funded by the Defense Advanced Research Projects Agency. Known as the Non-Penetrating Periscope (NPP), the program aims to use fiberoptics one-tenth the thickness of a human hair to replace conventional periscopes, and to give subs a variety of new reconnais-

sance and attack options.

Beyond anti-aircraft capability, these options might include firing sensor-equipped unmanned aerial vehicles through torpedo tubes for airborne surveillance. Unmanned underwater vehicles could lay mines, or guide subs through mine fields. The system closest to a conventional periscope would be a towed buoy called the Remotely Operated Platform Electronic, or ROPE.

None of these devices would require the bulky external structure of a normal periscope, and they would thus permit sleeker sub designs. The first NPP prototype is scheduled for delivery by Kollmorgen Corp. this

summer. If tests are successful, the technology may be added to next-generation

Seawolf attack subs, the first of which is scheduled for launch in 1994.

Highlights This Month

- **Shuttle News**—Recovered satellite points the way for future space construction.
- **Beam Me Up, Scotty**—Ground-based lasers provide get up and go for future spacecraft.
- **The Deep Frontier**—Graphite composite hulls give American deep-diving subs the edge.
- **21st-Century Airliner**—New technology revives the dream of an economical SST.
- **Life In The Fast Lane**—Space Shuttle camera records searing results of hypersonic reentry.
- **Medical Tech**—An artificial lung undergoes its first human trial.

Editor: Abe Dane
Contributors: Mike Fillon, Gregory T. Pope, John Rhea, Steven M. Shaker

Airborne Wind Tunnel

EDWARDS AFB, CA—NASA is using a modified F/A-18 to explore the aerodynamically uncertain realm known as high angle of attack flight. Referred to as HARV (High Angle of Attack Research Aircraft), the plane flies at low speeds with its nose pointed upward at angles approaching 55°. In such attitudes, aircraft become nearly uncontrollable, be-



cause air no longer flows smoothly over their wings and stabilizers.

Equipped with smoke generators, fabric tufts and a system that releases a thick

Fabric tufts and smoke plumes show air currents with HARV at 30° angle of attack. Later flights will go up to 70°.

dye that flows along the fuselage surface, the plane indicates airflow patterns that are nearly impossible to predict through normal wind tunnel or computer modeling techniques. Future phases of the program will involve fitting HARV with thrust-vectoring paddles and movable strakes that may permit it to retain control at angles as high as 70°.

Stealth Missile For Key Targets

NEW YORK, NY—With arms control treaties cutting into the number of nuclear warheads available for tactical use, the Navy and Air Force are funding research into weapons that can carry out complex missions and deliver conventional ordnance to far-off targets.

Four companies have been awarded 18-month, \$3-million concept-definition contracts. The aim is to develop a weapon that can launch from a plane, ship or submarine standing a safe distance

from a target. The missile must then approach at low altitude while maneuvering to avoid defenses, find the target and attack with a high degree of accuracy, either by dispensing submunitions or ramming with an attached warhead.

Most details of the project are still classified or undetermined. When these have been settled on, the contractors will enter a 3-year demonstration and validation phase, followed by full-scale development.



Texas Instruments concept shows long-range conventional stand-off weapon to be launched from planes, subs or ships.

Reusable Satellite For Living Cargo

NEW YORK, NY—NASA and two of its contractors are sketching out plans for a satellite that would shuttle

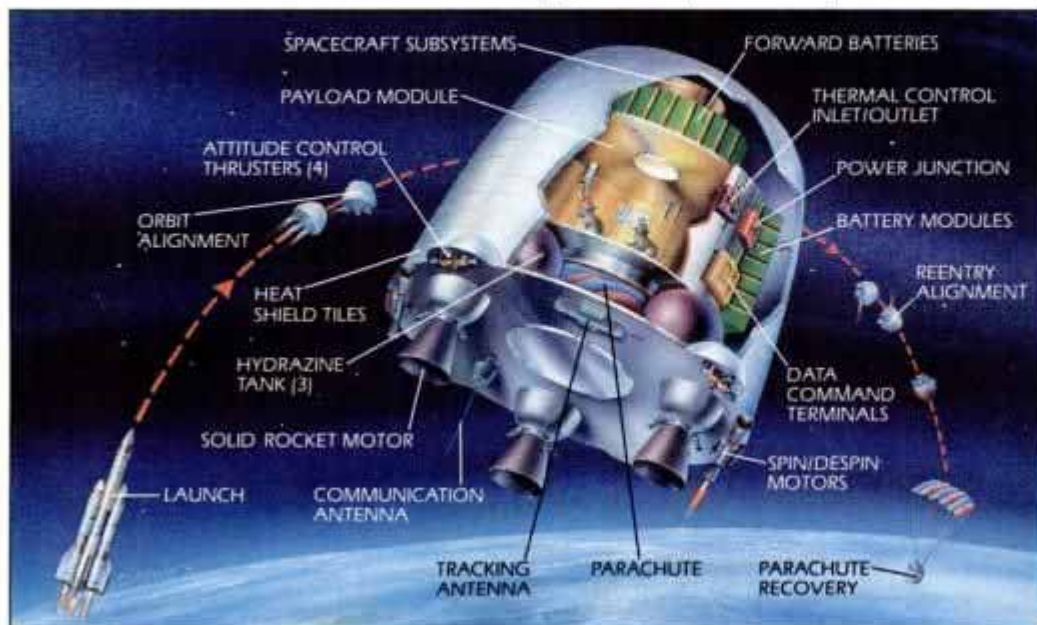
rodents, plants and other biological payloads into orbit for experiments. Able to sustain life for 60 days, the heat-

shielded habitat known as Lifesat could subject them to radiation, weightlessness and varying degrees of artificial gravity, before returning them safely to Earth.

Although designs are still preliminary, NASA is clear on what they want from the satellite. It should be able to fly three times a year over a 10-year lifespan. Time required to refurbish the craft between launches should be no more than 60 days. Spin thrusters will be needed to produce artificial gravity ranging from 0 to 1.5 G.

A typical mission would begin with launch aboard an expendable rocket into a circular orbit between 200 and 550 miles high. Reentry would be accomplished by firing the main engines to de-orbit, then maneuvering to face the heat shield forward. Parachute recovery through the controlled airspace over White Sands Missile Range is leading landing scenario.

Preliminary Lifesat concept uses blunt, nonlifting shape similar to the Air Force Discoverer vehicle.





The Ultimate Fish Finder.

There are more than a handful of interesting gadgets around designed to help you catch fish. Not to mention the numerous secrets fishermen have shared over the years.

But if you really want to catch fish, knowing where they are is only part of your problem. Getting to where they are completes the equation, and that's where Evinrude® outboards come in.

To begin with, our outboards are designed with the specific needs of the fisherman in mind. That's why our gear case water intakes resist plugging in weeded areas.

We also realize that if you want to keep up with

a fish, you've got to have a few moves up your sleeve. So thanks to fuel-injection starting, you can always count on starting up fast. And with our patented VRO²™ oil injection system, we'll keep your outboard running smoothly no matter how many fish you're after.

To find out more about the outboards that hook more fishermen, call 1-800-255-2550 for the name of the Evinrude dealer nearest you.

You always thought you could fish with the best of them. As it turns out, you were exactly right.

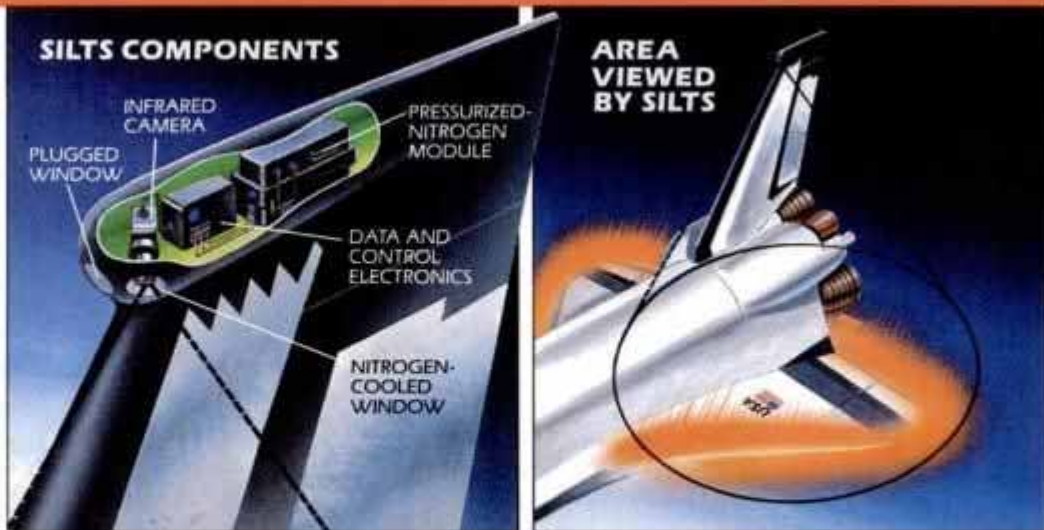


Evinrude Owners Are Born, Not Made.

Camera Shows Heat At Mach 25

HAMPTON, VA—An infrared camera peering down through a nitrogen-cooled port atop the tail of the Space Shuttle *Columbia* is providing information on the atmospheric maelstrom that accompanies the orbiter's hypersonic plummet back to Earth. Called the Shuttle Leaside Temperature Sensing (SILTS) experiment, it records the distribution of heat over the spacecraft's left wing and engine cowling as air slows the craft from about Mach 25 to Mach 8.

Carried aboard *Columbia* on the STS-28 mission last August, and STS-32 this January, the instrument has already provided pictures of the violent world outside the orbiter. With specific colors assigned to certain temperature ranges, the digitized images plainly show an 1100° F hot spot between two con-



SILTS pod on stabilizer (above) produces false color images (right) showing hot-spot temperature of 1100° in red.

control surfaces on the wing's trailing edge. The cause is believed to be a jet of air rushing from the high-pressure area below the wing to the low-pressure area above. Heat is also concentrated in a V-shaped area behind the leading edge, where the orbiter's bow shockwave inter-

acts with that from the wing.

Scheduled to fly again on STS-35 this month, and STS-40 in August, the SILTS pod will provide data to verify computer codes that engineers will use in designing the next generation of space vehicles, including the National Aerospace Plane.



PM ILLUSTRATIONS BY ADOLPHE BROTHMAN

NASA GRAPHIC

Wristwatch Pagers Introduced

NEW YORK, NY—Two companies are entering the market with numeric beepers that bring us to the verge of realizing the Dick Tracy wrist-radio fantasy. Manufactured by Motorola and AT&E, in partnership with two wristwatch companies,

Motorola Pager shows a phone number on the lower portion of its 2-line display. Additional messages can be stored in the watch's memory.

the pagers operate like normal digital watches, but when triggered by a radio signal they display phone numbers or other messages on tiny LCD screens.

Unlike most pagers, the AT&E unit will receive messages anywhere in the U.S., and in many foreign countries. The key is a paging network based on FM subchannels—unused portions of the frequency bands as-

signed to radio broadcasters, which are rented by the paging company. The network also dispatches periodic time updates that adjust the watch, and reset it when it crosses time zones. Sold through Seiko dealers, the pager will cost \$200, plus \$8 a month for the paging service.

Motorola's unit ties into a more conventional Radio Common Carrier network, and will be sold through Timex dealers at \$300, plus \$10-\$65 a month for service.

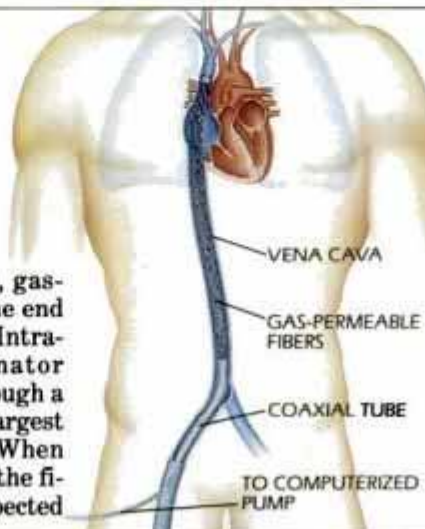


Artificial Lung Enters Trials

SALT LAKE CITY, UT—A device meant to supply life-saving oxygen to the blood of patients whose lungs temporarily cease to function properly has been implanted in a human for the first time. Suffering from a hopeless case of Adult Respiratory Distress Syndrome, the patient survived nearly five days before succumbing. The manufacturer termed the experiment highly successful, and plans to continue trials in pursuit of FDA approval. Consisting of

Pump sucks oxygen through IVOX fibers in the vena cava via a coaxial tube threaded through the femoral vein.

a bundle of hair-thin, gas-permeable fibers at the end of a coaxial tube, the Intravascular Oxygenator (IVOX) is snaked through a sheaf into the body's largest vein, the vena cava. When the sheaf is removed, the fibers unfurl and are expected



to satisfy 50 percent of the body's need for oxygen and 50 percent of its need for carbon dioxide removal.

The key advance is the membrane that makes up the fibers. A polypropylene substrate is sheathed with a half-micron film of gas-permeable polymer, which in turn is coated with anticlotting substance. Able to remain in place for up to a week, the fibers may help save victims of smoke inhalation, near-drowning, pneumonia and other conditions that temporarily disable the lungs.

PM ILLUSTRATION BY PAUL COCHRAUER

**ONE TOUGH MOTOR OIL
ANNOUNCES
ONE TOUGH GUARANTEE...**

TWO HUNDRED FIFTY OR TEN



Use Quaker State exclusively in your new car, and our limited guarantee will cover lubricated engine parts for 250,000 miles or ten years, whichever comes first.



How tough is today's Quaker State? Tough enough to make this promise: Use only Quaker State in your new car's engine, and if any lubricated engine part not covered by the manufacturer's warranty or extended-service contract suffers an oil-related breakdown during its first 250,000 miles or ten years, Quaker State will pay for the repair. That's any time: after 5,000, 50,000, 150,000—up to 250,000 miles or ten years, whichever comes first.

We'll guarantee lubricated parts in engines of all sizes—domestic or imported.

Quaker State's limited guarantee covers lubricated parts in engines of every single imported and domestic car or light truck sold in the United States, no matter how big or small—four cylinder, six cylinder, V-8 or V-12. It even covers the deductible on any extended warranty you might have purchased from your new-car dealer. Enrollment is absolutely free.

250,000 MILES OR 10 YEARS.

250,000

See a copy of limited warranty and enrollment details at participating service centers.

Complete details and enrollment forms for the Quaker State 250,000-mile or ten-year guarantee are available at participating Quaker State service centers. These include many new-car dealers, automotive service centers and fast lubes nationwide.

To participate in the guarantee program, enroll your new car at a participating service center within six months or 6,000 miles of purchase. Use only Quaker State Motor Oil, and have your oil and filter changed at licensed service centers according to manufacturer's instructions for severe driving conditions but not to exceed 4,000 miles or four months between changes. Save your receipts. Then, if any engine part fails due to lubrication failure at any time



during your car's first 250,000 miles or ten years, Quaker State will pay for the repair, unless covered by the manufacturer's warranty or extended-service contract.

How can Quaker State make a guarantee this tough?

Today's Quaker State has proven its toughness over and over again in the most rigorous tests the world's auto makers have thrown at it. Result: Quaker State actually exceeds lubrication specifications for every single car sold in the United States. (A fact that's vitally important for every car you own, regardless of mileage, age or who changes the oil.) It takes a tough oil to offer a guarantee this tough. But Quaker State is One Tough Motor Oil.

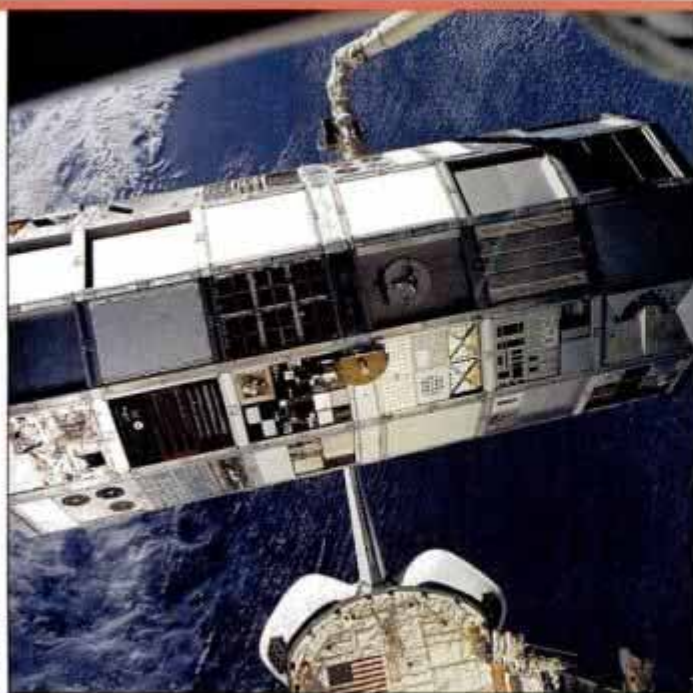


The Big Q is One Tough Motor Oil.

**IT TAKES A TOUGH OIL TO OFFER
A GUARANTEE THIS TOUGH.**

**BUT QUAKER STATE IS
ONE TOUGH MOTOR OIL.**





NASA PHOTO

LDEF Rescue Marks High Point For Shuttle Program

EDWARDS AFB, CA—Researchers around the country breathed a sigh of relief as their experiments came home safely nestled in the cargo bay of the Space Shuttle *Columbia*. With the 10.5-ton Long Duration Exposure Facility (LDEF) back on Earth the scientists can now set about the task of examining the patchwork of 86 samples spread over the satellite's skin. The materials tested include epoxy, magne-

sium and aluminum composites, which are now being considered for use aboard Space Station *Freedom*.

Columbia's latest mission was in many ways her severest trial yet. Not only was she called on to perform strenuous maneuvers to catch the falling LDEF, but the satellite's substantial bulk made for a landing weight 10,000 pounds greater than for any previous mission. Lasting 11 days, the mission was also the second longest of the Shuttle program—a test of 16-day Extended Duration Orbiter capabilities scheduled to become available in 1992.

Grappled by Challenger's remote manipulator arm, LDEF got a thorough photographic survey, before being lowered into cargo bay.

Tail-Rotorless Copter Flies

MESA, AZ—The first production helicopter to use the McDonnell Douglas NOTAR (no-tail-rotor) tailboom has made its first tentative hops, and is now entering regular flight testing. The system, which works by jetting fan-compressed air out through slots in a hollow composite tailboom, is expected to ease flying in certain maneuvers, and will do away with the

hazards that accompany a conventional tail rotor.

Fitted to the McDonnell Douglas MD 530N, a variant on the MD 500s the company has been selling since the early 1960s, the NOTAR control system will go on the market at the beginning of 1991.

MD 530N's first flight included about 15 minutes of hovering and low-speed maneuvers.



MCDONNELL DOUGLAS PHOTO

SDI Lasers Could Power Spacecraft

TROY, NY—NASA and the Strategic Defense Initiative Organization (SDIO) are sponsoring research on a space vehicle that will ride into orbit on the beam of a

powerful ground-based laser. Tremendous efficiency advantages might arise from the fact that energy can be supplied from the ground, rather than being carried

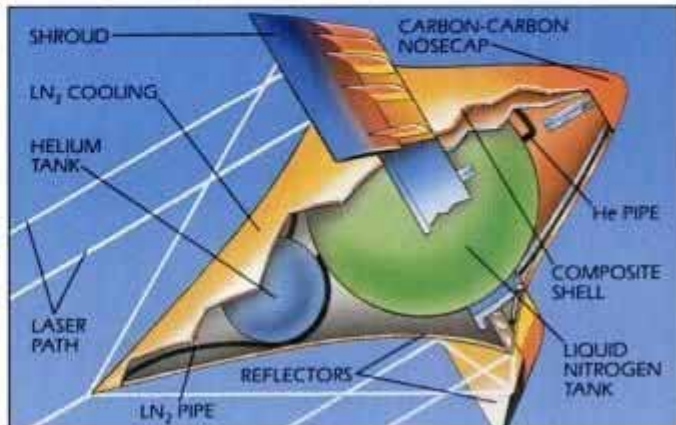
aloft in the form of fuel.

In one concept, air itself would act as fuel, compressed around the craft's conical forebody, then entering a skirtlike combustion chamber. There, it is exploded into plasma by laser light

concentrated by parabolic reflectors covering the spacecraft's tail. Ten American engineering schools are working on lasercraft projects, hoping to produce a flying unmanned demonstrator by 1995.



RPI ILLUSTRATION



RPI ILLUSTRATION BY HANK IKEN

Rensselaer Polytechnic's idea for lasercraft would burn air until reaching space, then would switch to internal fuel supplies.

Composites Transform Subs

OAK RIDGE, TN—Techniques for forming graphite composites into hulls with five times the strength per pound of steel will radically change the shape of submarines to come. An outgrowth of nearly 30 years of research at Oak Ridge National Labs, the technology has already gone into an unmanned Navy sub, and will be key to the success of Deep Ocean Engineering's *Ocean Everest* (see "Deep Flight," page 70).

Up to now, fabrication hurdles have prevented the composites from finding submarine applications. The problem arises out of the fact that trying to take advantage of graphite fiber's theoretically high compressive strength is essentially like pushing on a string.

Oak Ridge uses a computer numerically controlled winding station to wrap a preimpregnated strand of



Navy's computer-guided Advanced Unmanned Search System (top) reaches 20,000 ft. with hull made at Oak Ridge (above). Composite sample (left) weighs 82 lbs., steel would weigh 429.

12,000 fibers around a mandrel. Precise control over the winding process, the viscosity of the resin, and curing temperature prevents voids, kinks and other defects that would reduce the fibers' load-bearing capability.

Unlike steel or titanium, composite sub hulls are positively buoyant, eliminating the need for bulky syntactic-foam buoyancy devices that limited the mobility of earlier deep-diving craft.

Next-Generation SST

LANGLEY, VA—NASA, Boeing and McDonnell Douglas are exploring whether the technology is ripe for another crack at a supersonic transport. Under the High Speed Civil Transport (HSCT) program, they aim to design an aircraft able to carry three times as many passengers as the current Concorde, without producing the noise and



emissions that stalled earlier SST efforts. Ticket prices should be comparable to subsonic fares.

Since the Concorde, aerospace technology has advanced on many fronts. Composites have lowered

Artist's rendering incorporates features under study for the HSCT, including leading-edge apex flaps, a blended wing and strakes near the nose.

takeoff weights, engines have become more powerful and quieter, and computational fluid dynamics techniques have improved aerodynamics.

If such advances will allow the HSCT to meet its performance and environmental goals, the plane may fly as early as the year 2000.

2-Way Triangular Monorail

FAIRFAX, VA—A unique elevated people mover that could thread its way above urban streets, interfering only slightly with sunlight and existing structures, has been displayed in a mockup at Tulane University. Called System 21, it uses a single concrete guide beam only 6 ft. wide, far narrower than the elevated sections of the recent Washington, D.C., Metro and Detroit people-mover installations. Cars

holding 48 passengers each whiz in either direction on the 2-sided track, and can be linked into trains of up to four cars during peak hours. Powered by 600-volt electric motors, the cars travel at speeds in excess of 55 mph. A working prototype with 1.5 miles of track is now being planned for the New Orleans area.

System 21 cars grip guideway with 8-rollered outriggers that also act as power pickups.



OAK RIDGE NATIONAL LAB ILLUSTRATION AND PHOTOS

BOEING ILLUSTRATION

PM ILLUSTRATION BY PAT RUGGERO

*Taste and
Compare!*



LOW
PRICE

Cambridge

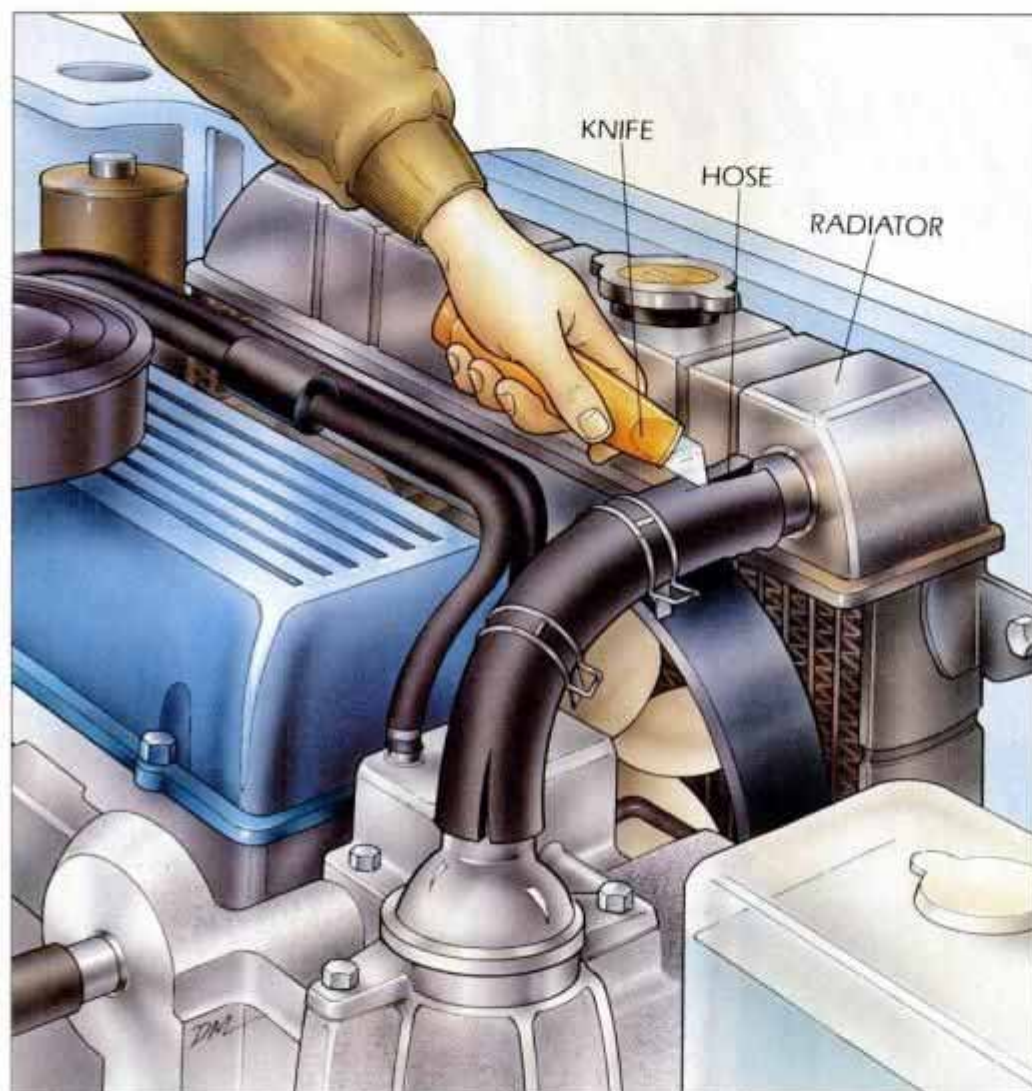
SURGEON GENERAL'S WARNING: Smoking Causes Lung Cancer, Heart Disease, Emphysema, And May Complicate Pregnancy.

© Philip Morris Inc. 1989

Kings: 17 mg "tar," 1.1 mg nicotine—100's: 17 mg "tar,"
1.2 mg nicotine av. per cigarette by FTC method.

CAR CLINIC

BY MIKE ALLEN, Assistant Auto Editor



PH ILLUSTRATION BY DON MANNES

A Sticky Situation

I NEEDED TO replace the lower radiator hose on my pickup truck—which isn't a job that I normally would try myself, but it seemed like it was pretty straightforward. I was going to be draining and replacing the antifreeze anyway, a job that I usually do myself.

My wife was pretty darn frosted when I broke the hose connection clean off the radiator. Wound up having the car towed, the radiator replaced, and the whole mess cost almost \$400.

Save my marriage, and tell

me this is one of those things that just happens.

JOHN CASTE
SHREVEPORT, LA

I'm not Dear Abby—you'll have to make peace domestically yourself. And I can't tell you that it's one of those things—you needn't have broken the radiator. But I can tell you a couple of things that might have helped.

If the radiator hose sticks, don't try to pry it off with a screwdriver or some other implement. If you can't lightly twist it off, don't take a chance

on breaking the fitting off the radiator. Just use a sharp knife and cut off the hose. Simple, yes?

And it's probably too late to help you much now, but other ham-fisted Saturday mechanics might profit from this tip—you probably didn't have to scrap the radiator. Any competent radiator or welding shop could have soldered the fitting back onto the tank for a few dollars.

Travelin' Van

I do a lot of traveling in my Dodge Caravan. The owner's manual says to use 5W-30 oil, but while traveling, I've

been told by several Dodge dealers that the oil is too thin, and the engine will freeze up if I continue to use it. A dealer in Southern Texas said to use straight 30-weight, while another dealer in Arizona said I should use 10W-40. The dealer here in California said I would void my warranty if I didn't use the 5W-30.

I'm really in the dark.

DON ST. AUBIN
LONG BEACH, CA

Don, your letter is typical of about 15 percent of the Car Clinic mail I read daily. People are really confused about what kind of oil to use in their car or truck, how often to change it and whether they really need to use some kind of snake-oil supplement to make their engines last as long as the manufacturer intended. Your engine won't freeze up if you use the recommended oil in ordinary service.

To you, and everyone else who is confused about what to do—here's the definitive advice: Read the owner's manual. Use what it says, and change the oil at least as often as recommended for severe service, usually every two or three thousand miles.

Now, here's why Dodge, and most of the car manufacturers are recommending 5W- and 10W-30 oils instead of the thicker viscosities of a decade ago. It's to improve fuel mileage by lowering viscous drag and pumping losses, and that represents money in your pocket.

Before anybody gets upset that they've shortened the lifespan of your engine to save a few pennies, it's not a big deal. When the industry started to lower viscosity recommendations, they changed surface-hardening specifications, clearances and a lot of
(Please turn to page 26)

225 horsepower at 4200 rpm. 300 ft. lbs. of torque at 3200 rpm. Gas-pressurized struts up front. Quadra-Shock system in the rear. And four patches of extra fat rubber on the pavement. Mustang GT. Grab onto the five-speed and make your move. It's a kick in the tranny.

Best-built American cars.

The best-built American cars are built by Ford. This is based on an average of

consumer-reported problems in a series of surveys of all Ford and competitive '81-'89 models designed and built in North America. At Ford, "Quality is Job 1."

All 1990 Mustangs are equipped with a driver air bag supplemental restraint system.

Ford Mustang GT

225 horses are bound to kick something.



Buckle up—together we can save lives.

Have you driven a Ford...lately?



other things internally to make the new oils work.

There's usually a temperature scale of oil viscosities in the manual, which suggests slightly more viscous oils in really hot climates. Read and follow the recommendations.

Some manufacturers have identified premature engine-wear problems with 10W-40 oils. A 10W-40 is basically a 10-weight oil with a viscosity-index improver (VIP) added to prevent it from thinning excessively at higher temps. The VIP tends to break down, leaving critically thin oil. To compound this problem, VIP isn't oil—and modern engine lubricants are sometimes compounded with as much as 20 percent additives. So, avoid using oils with excess amounts of VIP.

Running A Flashing Yellow

I have a 1984 Cutlass Ciera 6-cylinder sedan with over 90,000 miles. Sometimes, months apart, the yellow CHECK ENGINE light will flash at speeds between 30-40 mph. Mr. Goodwrench has checked and checked, and says the circuit setting is okay. If I stop, and restart the car, the light stays off.

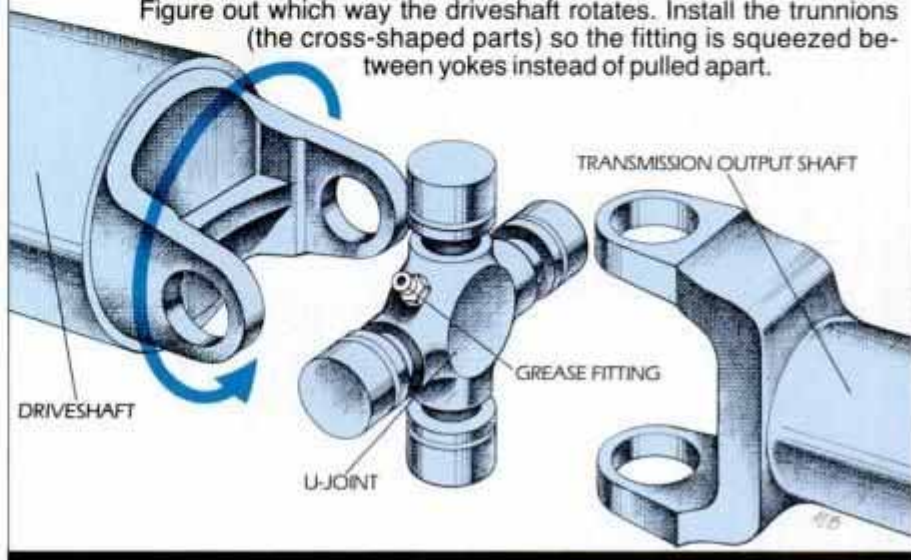
H.H. HOLMES
HYDE PARK, VT

Don't Get Crossed Up

Installing replacement U-joints is pretty straightforward—just unbolt the driveshaft at the axle and pull the whole driveshaft out from under the car. Now you can stand up comfortably at your workbench and pull the snap rings, replace the old joints and reinstall. That's 20 minutes, tops.

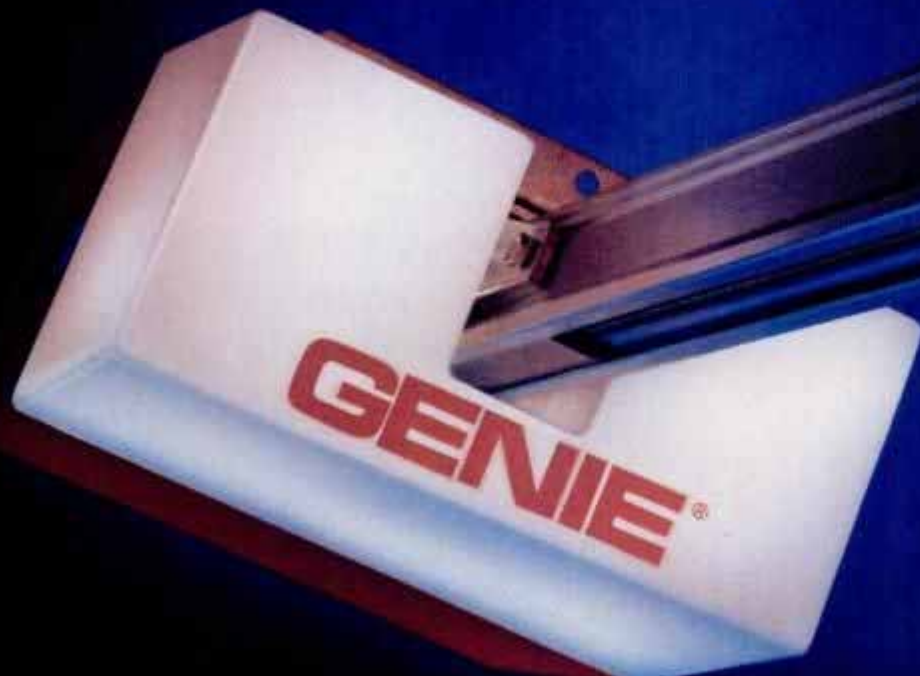
But, there's a good chance that the original joints you're replacing didn't have grease fittings (which is probably why you had to replace them when they finally ran dry). Just remember when installing the new ones to put the fitting in compression, not tension.

Figure out which way the driveshaft rotates. Install the trunnions (the cross-shaped parts) so the fitting is squeezed between yokes instead of pulled apart.



PM ILLUSTRATION BY ADOLPHE BROTMAN

Install A Genie® Garage Door Opener, And We Guarantee It Will Screw Up Your Door.



Your Cutlass's problem is obviously intermittent. The computer is supposed to trap an error code whenever it spots a problem—that's the "circuit setting" Mr. Goodwrench says is okay. Apparently the problem is transient enough for the computer to consider it forgettable.

There is a tool, called a scan tool, that can be hooked up to your computer that will read the computer's error codes while the light is flashing. But you'll have to convince a mechanic to drive your car around until it starts to malfunction, or loan you the tool to leave hooked in and recording.

Since this happens only every few months, neither of these seems like a good possibility. If your car is otherwise working properly, I'd let it slide until you have a symptom, or the light stays on.

Cheap Guy

I got into something of a discussion with a bunch of the guys around the shop, and I hope you can win a bet for me. I think we're being fed a lot of hooey by the antifreeze manufacturers who tell us that antifreeze has to be replaced every two years. All that really wears out is the antirust ingredients, and I feel that all I need to do is add a can of antirust and never drain the perfectly good coolant.

NAME WITHHELD

Kind reader, your letter is representative of several I've received in the past few months. I've omitted your name because I don't want you to be the only one I call foolish. You others know who you are.

The antirust, or more correctly, anti-corrosion additives in commercial coolant are added to prevent not only rust from the iron parts of your cooling system from plugging things up, but also to prevent corrosion in the nonferrous parts, as well as electrolysis caused by dissimilar metals. They are exhausted by combining with the metals, leaving soluble salts instead of sludge.

After awhile, even these soluble salts will build up into a high enough concentration to settle out. And you need to remove them from the system, not just dump more in. Also, there's a certain amount of insoluble junk that builds up, which is why coolant looks muddy after awhile.

Stop being so cheap—fresh coolant will set you back about \$15 every other fall. Which is probably less than the bet you lost.

FM

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

SERVICE TIPS

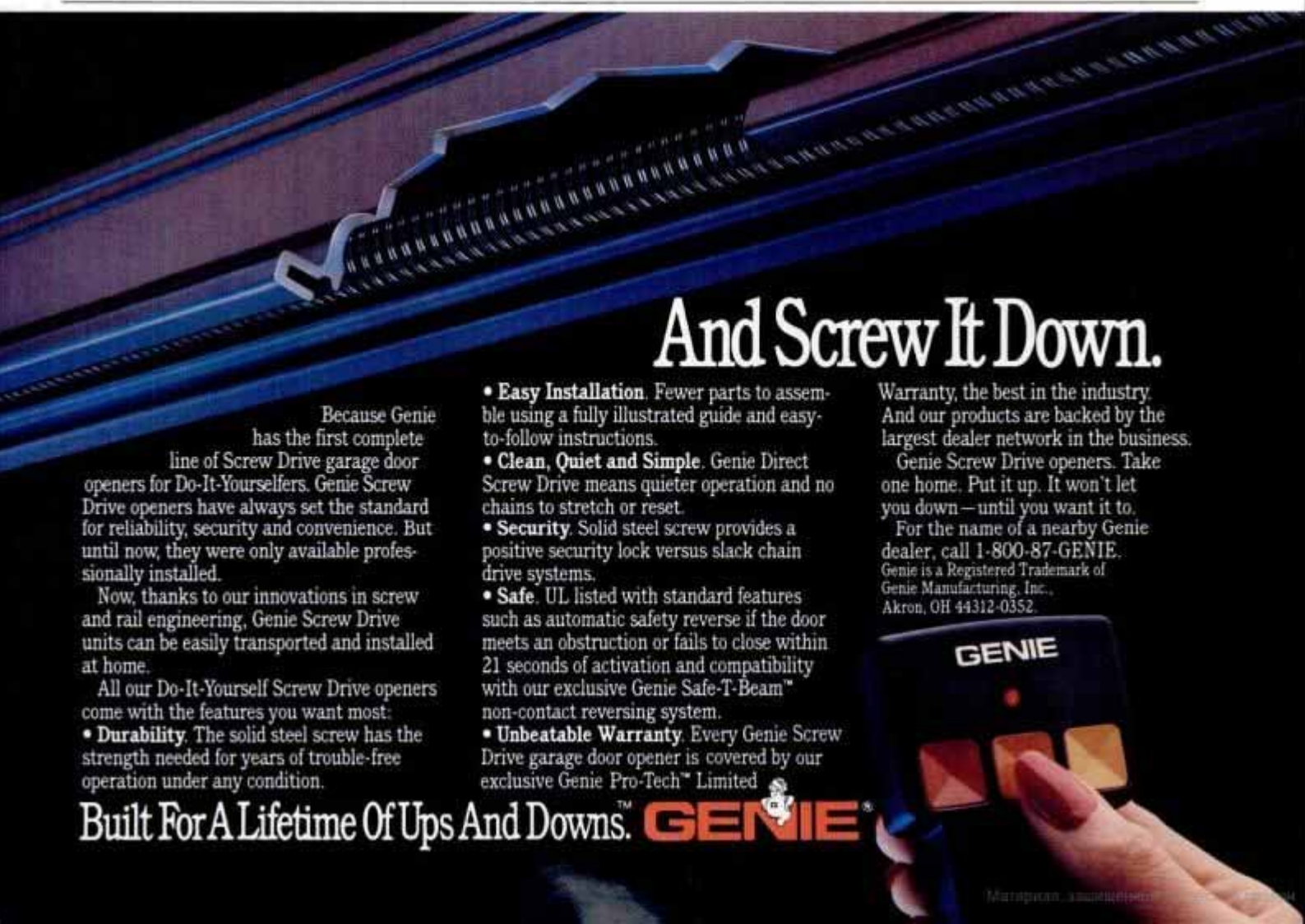
■ Chevrolet TSB 89-01-3A tells about the importance of 4-wheel alignment, including what kinds of symptoms customers might complain about if their vehicles need alignment. Even cars and trucks with nonindependent rear suspensions occasionally need alignment.

■ If your Mercury Tracer or Ford Festiva has a chirping or squeaking noise, TSB 89-5-13 details installation of a new 2-piece timing belt guide plate to reduce the contact between the plate and timing belt.

This TSB also shows how water, poured onto the belt when the engine is running, can be used to diagnose the problem.

■ Peugeot has a sticker to attach to the B-pillar of your 405. It'll be used to let mechanics know how many of the factory's authorized warranty/recall modifications have been made to the car without the mechanic needing to look up the car's records.

■ TSB 18-54-88 details how to correctly adjust the throttle-position sensor on '86-'88 Jeeps with 2.5L and 4.0L engines. This should cure high idle/sluggish acceleration complaints.



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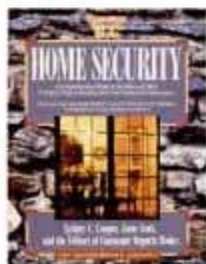
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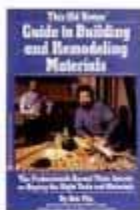
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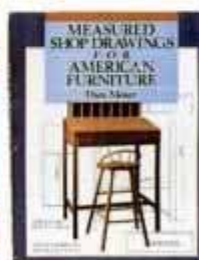
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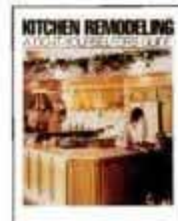
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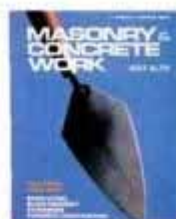
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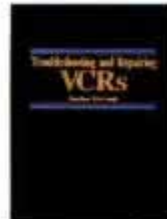
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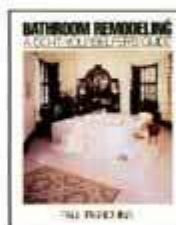
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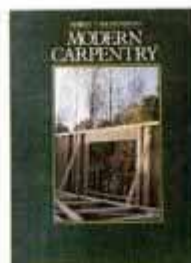
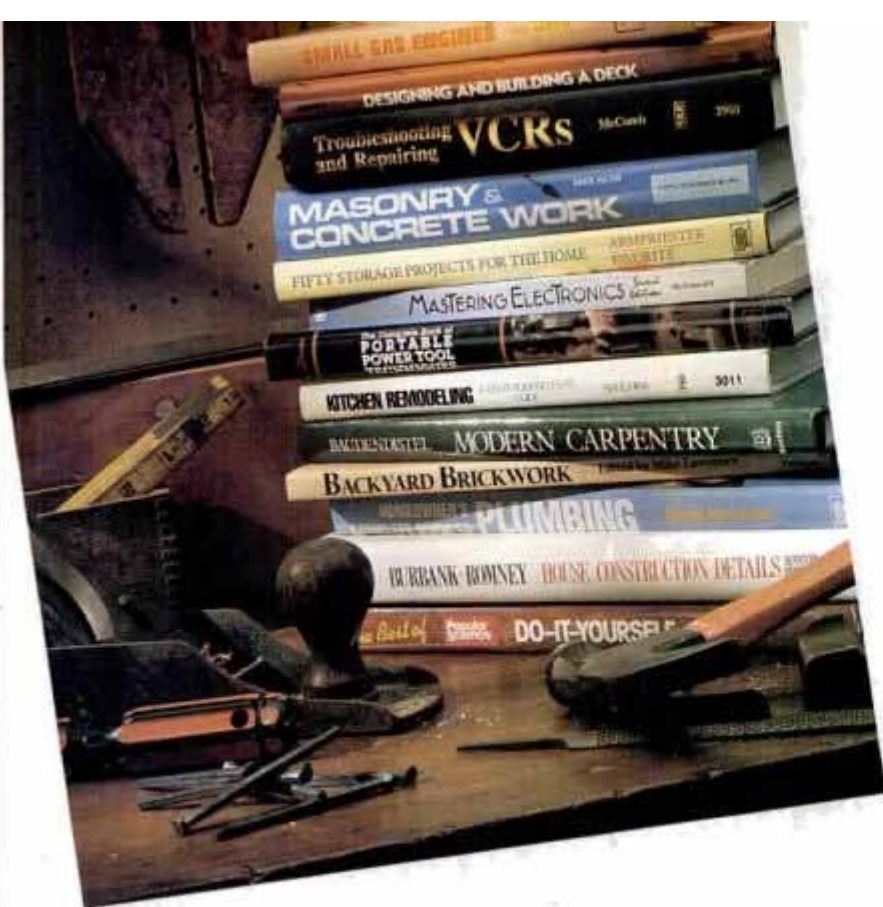
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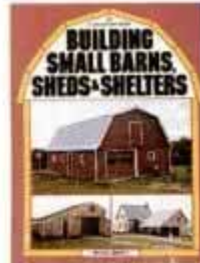
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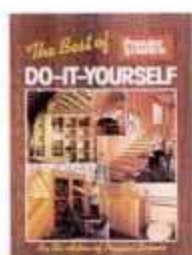
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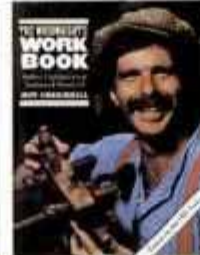
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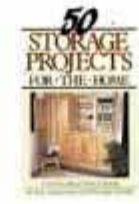
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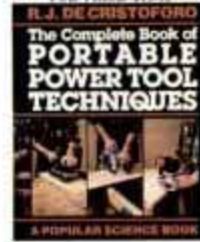
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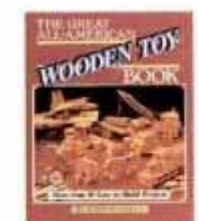
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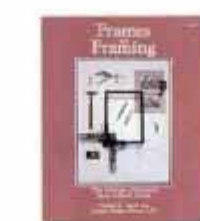
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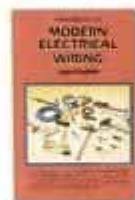
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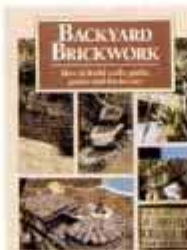
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POPULAR MECHANICS

OLD HOUSE RESTORATION

BY BOB VILA, Contributing Editor



ARMSTRONG WORLD INDUSTRIES PHOTO

Floorcloths And Linoleum

WHEN IT'S TIME to think "flooring" in your restoration, don't overlook two of the more colorful ways to treat an old-house floor: floorcloths and linoleum.

Since they follow one another historically in the evolution of flooring materials, I tend to group the two together. Plus, both lend an unmistakable air of days past to a room.

Understanding what was

commonly used years ago, along with a brief look at what's available today, will help you decide what's appropriate for your home.

Floorcloths

A popular, but expensive, 18th- and 19th-century floor covering, floorcloths were commonly found in parlors, dining rooms, great rooms, service areas, hallways and stairways. The best floorcloths were made of one solid piece of good-quality canvas. The cloth was painted many

times over on both sides with oils. Because so many coats of paint were used—it was not unusual to find canvas that had been painted from four to seven times—the finished product was actually hard, like linoleum.

Many floorcloths were hand painted or stenciled. The earlier floorcloths were generally composed of simple, geometric designs, like squares, blocks, cubes and diamonds. Some were only one color, with or without a designed border. Marbleizing of both types was also popular. As time went on, floorcloth de-

New vinyl flooring adaptations of old linoleum designs—like Armstrong's Black Tie product—have just been introduced.

sign became even more ornate or complex. Busy designs, like those encompassing florals, can be found on some of these later cloths, which were often block printed.

Fortunately, there are several companies that specialize in making the hand-painted and stenciled canvas floorcloths today. One I'm familiar with, The Olde Virginia Floorcloth & Trading Co. (P.O. Box 3305, Portsmouth, VA 23701), specializes in custom reproductions of 18th-century designs. Another, Pemaquid Floorcloths By Kathleen Mack (Round Pond, ME 04564), makes floorcloths in traditional and country designs.

Linoleum

Perhaps a better-known flooring material, and one with quite a bit of nostalgia tied to it, is linoleum. A natural organic wood product, it's generally composed of cork and linseed oil that's pressed onto a jute or burlap back. Invented in England in 1863, linoleum production came to America 12 years later. It was an inexpensive, durable and easy-to-clean alternative to the painted floorcloth. Historically, linoleum tended to replace floorcloths in high-traffic areas like entry halls and kitchens.

Early linoleum patterns were seen as attractive in that they emulated better flooring materials on a cheaper basis. For example, it was possible to buy this organic flooring patterned like tiles, carpeting, wood parquet or hardwood. Most middle-age readers are probably familiar with some of the more popular types of linoleum—their de-

Contributing Editor Bob Vila hosted public television's "This Old House" for 10 years.

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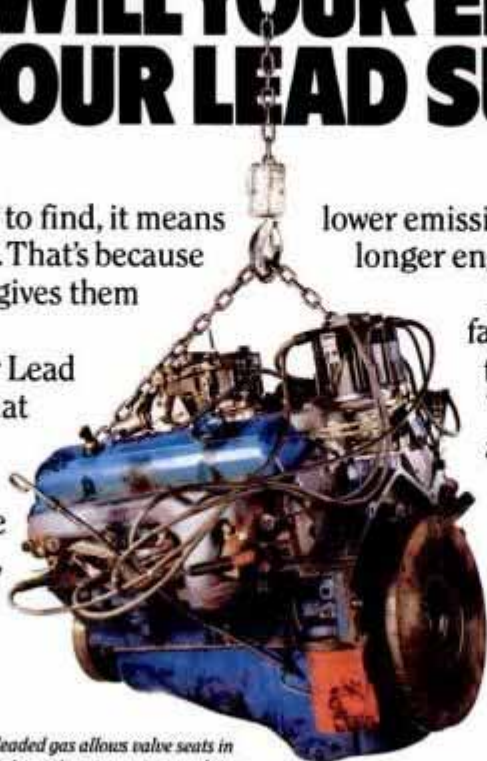
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descriptions alone can bring back memories of childhood kitchen and bathroom floors.

Perhaps one of the most popular linoleum designs is a pattern composed of different shaped, irregularly arranged, small rectangular reddish bricks. Other popular patterns include black-and-white tiles, octagons, florals and diamonds, as well as swirled, marbled designs.

Although American production of this flooring ended in the early '70s, several types of linoleum are still being manufactured in Europe and imported. This includes different gauges of solid and marbled rolls and tiles. Battleship linoleum, the heavy-gauge plain flooring material you'll find today, is a homogeneous solid color all the way through to its canvas back. Its thickness and durability made it a popular choice for the flooring in public buildings years ago. Today, it's available in a variety of colors, including gray, light brown, beige and terra red.

There are a handful of companies that sell linoleum in the U.S. today. Two that I'm familiar with are Linoleum City (5657 Santa Monica Blvd., Hollywood, CA 90038; 213-463-1729) and Bangor Cork Co., Inc. (William and D Streets, Pen Argyl, PA 18072; 215-863-9041).

As far as I know, no one is manufacturing printed linoleum that replicates the patterns of the past, like florals and tiny tiles. About the closest you can get to du-

plicating these old floors is with some of the patterned vinyls made today.

Today's vinyl lookalikes

The biggest drawback to using a vinyl floor in place of linoleum in a restoration is that the modern material has a finish and texture unlike that of linoleum, which was smooth and virtually untextured. You should consider, too, that the printing process used years ago was not as sophisticated as our current technology. So the level of variation and detailing of printed linoleum was plainer and simpler than some of the materials you'll find today. However, since most of you aren't working on a museum-quality restoration, choosing a vinyl adaptation of an old linoleum pattern is a perfectly acceptable way to add some interior period flair.

Although most vinyl floors aren't marketed as such, a glance through some of the major manufacturers' product catalogs shows several patterns that are definitely adaptations and in some cases reproductions of old linoleum designs.

For example, you'll find vinyls that imitate that irregularly arranged, small reddish brick pattern I mentioned earlier. Considered the best-selling floor of all time by some of today's leading floor manufacturers, this vinyl design is a good enough substitute for linoleum in an early 20th-century kitchen. Other patterns

available in vinyl include black-and-white diamond tiles, white tiles with black corner blocks, wood planking and octagonal-type designs.

While I was writing this column, Armstrong World Industries, Inc. (Lancaster, Pennsylvania) announced it was bringing back some classic linoleum patterns of the '30s and '40s in its new Encore Collection. The new geometric patterns include a traditional checkerboard pattern set on the diagonal and small square blocks of color set in the corners of larger neutral-colored blocks.

No matter what type of treatment you're interested in for your old-house floor, a good book to consult before you make a final decision is *Floor Coverings For Historic Buildings*, by Helen Von Rosentel and Gail Caskey Winkler (The Preservation Press, 1988). If you can't find it in your local bookstore, you can order it direct from the publisher: National Trust For Historic Preservation, Mail Order Dept., 1600 H St. N.W., Washington, D.C. 20006; (202) 673-4200. It costs \$14.95, plus \$3 shipping and handling.

Knowing more about floorcloths and linoleum can only help you make the right choice when it comes to dealing with your old-house floors. It's nice to know both materials are still available, and also that some of today's newer materials make a fine substitute for the latter.

PM

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FREEWHEELING

BY MIKE ALLEN, Assistant Auto Editor



PHOTO BY MIKE ALLEN

Back To The Future

THE SPEEDO WAS camped on an even 260 km/h. As I passed the sign announcing the impending approach of the Swiss border, I grabbed the gearshift lever, lightly flicking it an inch to the right and then back an inch.

I know, I know. Even taking one hand off the steering wheel at 160+ seems like idiocy to most American drivers in the post-OPEC era. But this was West Germany, where top speeds on the autobahns often outrun single-engine Cessnas.

The Carrera 2 that I was driving is the replacement for the car that made Porsche a household word, and the Stuttgart automaker felt that the best way to get to know it would be to drive from Frankfurt to Nice. Autobahns, twisty mountain roads and 5-star meals at intimate little French chateaux—hey, it's a tough job, but somebody.... And they were right—it takes more than a few miles on a test track to appreciate the considerable engineering effort that the Carrera 2 reflects.

The comfortably familiar looks of the 25-year-old Jell-

O-mold 911 belie the total re-vamping of the chassis. A full 85 percent of the car is absolutely new, owing only the roof, glass, doors and interior to the previous car. Porsche started with a completely new 3.6-liter 250-hp, air-cooled flat Six, finally realizing that the original 2.0L of similar concept wasn't up to another overbore. This new powerplant delivers as much torque, 228 lb.-ft., as most 5-liter V8s, and still retains that wonderful flat-Six song through the gears.

The MacPherson-strut front suspension was abandoned for upper and lower control arms for better road-holding during hard corner-



Porsche Carrera 2 Cabriolet retains smooth lines of coupe.

PHOTO BY MIKE ALLEN

ing. Power steering is standard. In spite of all the changes, it still lets you feel the road through the wheel—a Porsche trademark.

The rear suspension still uses a semitrailing arm, but now has coil springs, instead of the time-honored torsion bars. The interior is almost

unchanged, right down to the anachronistic position of the key on the dashboard to the left of the steering column. One welcome change is the complete revamping of the heater and a/c controls, replacing the older car's forest of inscrutable levers.

As you can see, the exterior facade still is derived directly from the original 1965-vintage 911 coupe. Porsche was very intent on retaining that silhouette—so much so that even the sugar-scoop and whale-tail rear wings were inappropriate.

Borrowing a trick from the masters of

techno-chic, the Japanese, the engineering staff found a way to retain the shape without leaving the car with a highly positive coefficient of lift over the rear wheels. A small electric motor deploys a spoiler over the rear deck when you hit 50 mph, and pulls it back in when you've slowed to 6 mph. For those of you who like to impress the gang at Burger Chef, there's also a switch on the console to run it up and down at whim.

Tiptronic's microprocessor calls for shifting someplace in five colored areas (numbers 1 through 5), depending on engine power, rate of acceleration, cornering, vehicle speed and several other factors. Conventional transmission would shift either for (E)conomy or (S)peed, controlled only by engine speed and throttle position.

TIPTRONIC TRANSAXLE SHIFTING FROM 3RD TO 4TH GEAR

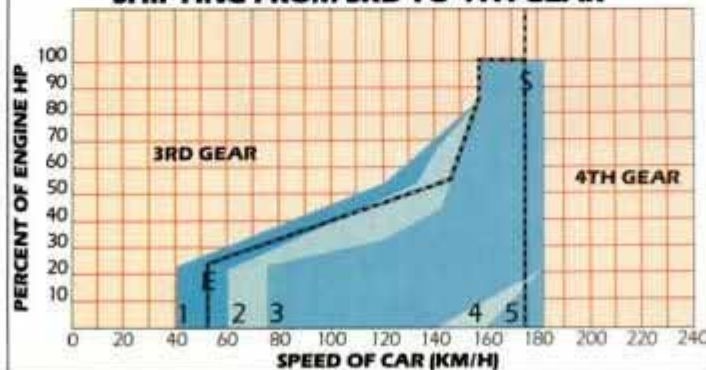


PHOTO BY MIKE ALLEN



Rear-deck airdam extends and retracts automatically.

Like any rear-engined car, the mass of the engine cantilevered out past the rear wheels will keep you conscious of your mortality if you drive like an idiot. But two things do work in your favor: The tail is much less likely to pass you up, as the car is much better-balanced than the old 911, especially older, '60s and '70s vintage versions. Porsches do deserve their reputation as a driver's car, one that will bite you if abused. Secondly, the new car has such high limits of roadholding and handling that only somebody who is going much too fast will ever get into trouble on the road.

The purist Porschiste are undoubtedly clicking their tongues over the entire concept of an automatic-transmissioned 911—as they did when the easily forgettable Sportomatic semi-auto came and went in the '60s.

In the metal, the Tiptronic is nothing more than a conventional 4-speed planetary automatic transmission, driven by a locking torque converter and sprouting a bellhousing/differential case and external driveshaft to turn it into a transaxle. Porsche actually buys the transmission elsewhere, but as the nerds say, it's all done in software.

Porsche spent years developing its PDK transaxle for use in turbocharged Group-C endurance racers. With two separate clutches and computer control, the gearbox would change when the engine reached the appropriate rpm, allowing full-throttle shifting of the peaky turbo motor, and allowing the driver to keep both hands on the wheel during twisty bits. The Tiptronic shares no technology with the PDK (which had more in common internally with a conventional 5-speed manual box), but the user interface is similar.

Back to Zurich

Bombing along the autobahn at the aforementioned 260 km/h, I had the Tiptronic's selector in DRIVE—no surprises there. You could loan this car to the teenager next door, and he'd have no trouble driving it immediately (although you'd have a hard time getting it back, I'm sure). But just to the right of DRIVE is a second vertical gate. There's a short throw forward, marked with a

plus sign, and another to the rear marked with a minus sign. So, a little tip of the shifter forward shifts up one gear, and back, downshifts one gear. Usually.

The software knows, sometimes better than an excitable driver, when *not* to shift. It won't let you shift down if the result is overrevving the engine. If you slow down to a stop, it will shift down to prevent the engine from lugging. This is great at tollbooths—or border crossings—just leave the shifter alone, and it will automatically upshift at the redline. The bottom line is that shifting can be controlled by you, but the software won't let you float the valves or lug away from a traffic light.

It reads your sole

Porsche felt the Carrera 2 deserved better than a conventional full-auto, to improve driveability and performance. So, the electronic controller has five different subroutines, instead of one or two. A conventional trans shifts depending on engine rpm, throttle position and manifold vacuum. This is usually okay, but leads to some annoying habits. Backing off the throttle on the entry to a turn results in an upshift as manifold vacuum increases—and then a downshift in the middle of the corner as you put your foot on the gas.

Tiptronic knows rate-of-change of your foot, not just position. If you lift smartly, it assumes you want to slow down, and remains in the lower gear. There's also a lateral and linear accelerometer, so there won't be any unnecessary shifting in the middle of a turn. Porsche considers the details proprietary, and wouldn't give more specifics.

At any rate, three days of living with the Tiptronic, driving it back to back with identical cars equipped with 5-speeds, have made me rethink my attitudes about automatic transmissions. Stepping into vehicles with conventional transmissions is frustrating.

Progress has its price. Tiptronic Carrera 2s command about a \$3000 premium over the manual's \$58,500. The Cabriolet with Tiptronic is \$70,000. But for topless driving along the beach in St. Tropez traffic, seventy grand seems like a bargain.

PM

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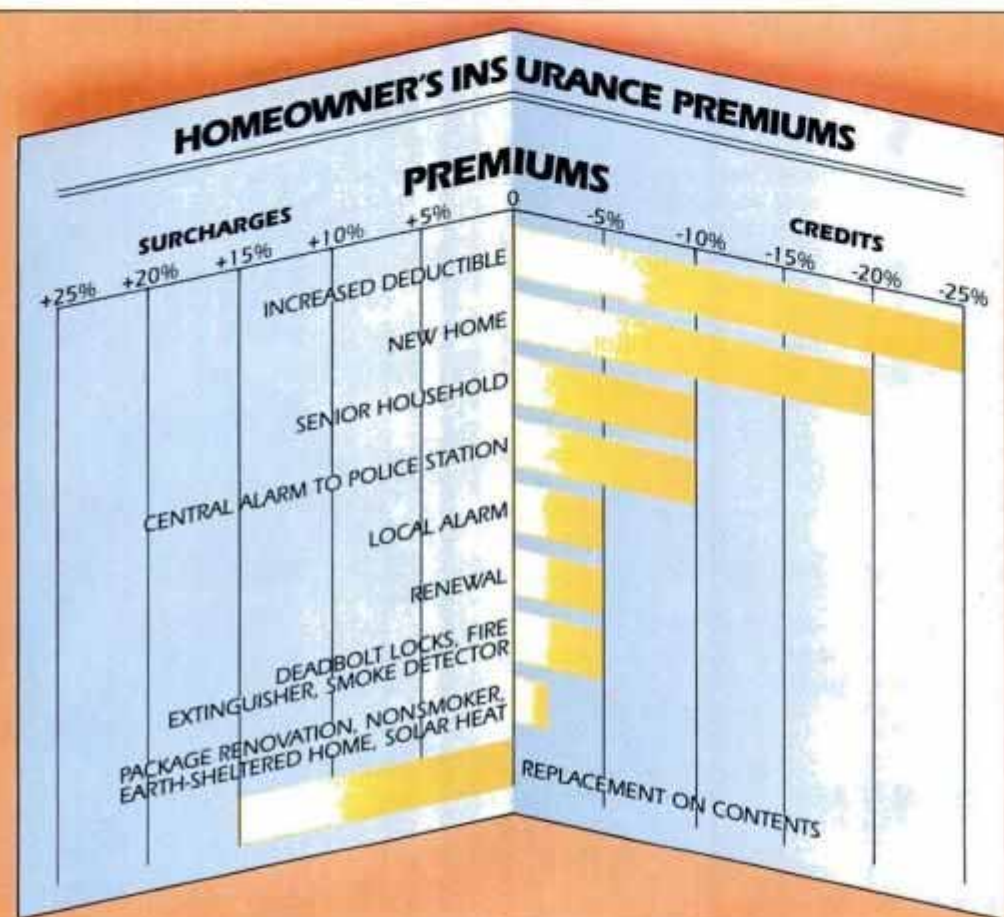
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HOME FINANCE

BY DAVID ELIAS



PM ILLUSTRATION BY HANK IKEN

Homeowner's Insurance

GET TWO insurance experts talking about homeowner's insurance and you'll probably hear three opinions. If the experts can't agree, how is the average homeowner going to know?

Insuring a home is anything but a cut-and-dried proposition. The subject is a complex quagmire of rules, ratings, provisions, provisos, endorsements, exclusions, ipsos and factos.

But there are some simple guidelines a homeowner can follow to make sure he or she is getting the best coverage at the lowest possible cost.

House value

Before you start thinking about saving money, first make sure you're spending

enough. Make sure your house is valued at what it would cost to rebuild *today*.

The first step is to understand exactly what you are insuring. Lots of people initially assume that this figure is the market value of the home. But that value includes one big tangible item—the property the house is built on—and lots of intangibles, like quality of neighborhood and school system, which you shouldn't include in the valuation. As one agent told us: "Land doesn't burn. And if your house is blown down, it's unlikely the school system will be blown away with it. You are insuring the structure and its contents."

Insurance policies are

priced according to factors including the amount of the risk, the material your home is built of, the volume of claims in your neighborhood, the efficiency of your local fire department, the proximity of your house to a water supply, and so forth. Ask the average homeowner what his house is insured for and, in a lot of cases, you'll be greeted with a blank stare. It's possible that the owner of a home built and insured in 1970 for \$50,000 could be going merrily along in 1990 with his original policy at a *bargain* 1970 valuation. That's fine until disaster strikes, and that same owner is forced to replace a 1970 house at 1990 building prices, and receives only enough money to build a 2-car garage where a 2-bedroom ranch house once stood.

It's the same kind of bargain as you'll get from a surgeon who—if you can't afford the operation—will offer to touch up the X-rays for much less.

There are a number of different ways to come up with an accurate valuation of replacement cost. Sources include a local insurance agent, builder, building department or tax office. You can also hire a professional appraiser.

If you're picking an insurance agent, by the way, you'll have two choices: the captive agent who sells one company's policy, and the independent agent who sells the policies of many companies. Logic holds that the independent agent is the better choice because he or she has access to policies with a variety of features, but the local Allstate or State Farm agent will give you a thousand reasons why this isn't true.

Our New York agent suggests the easiest way to value a home is by the square foot. He also takes into consideration the *quality* of the structure. In the area of New York City he operates in, for instance, building costs can range from \$80 to \$110 per square foot. By multiplying your local building costs by the square footage of your house, you'll have a good ballpark replacement figure.

Contents value

Next, inventory the contents of your home and add this to the total for the building. Contents are usually figured at half the cost of the structure, but the burden of proof is on you should disaster strike. While inventorying the contents, consider making a videotape as you go along. Although some companies won't accept a video

(Please turn to page 45)



Make good money in a challenging career as a security electronics technician— even start a profitable new business of your own



Now NRI trains you to be today's expert security electronics technician as you install and troubleshoot state-of-the-art security systems in your own home and auto.

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ELECTRONICS

BY FRANK VIZARD, Electronics Editor



The Flavor Of CES

THEY COME FROM all directions and all places as if on a religious pilgrimage to Mecca or Lourdes. In this instance, though, their destination is Las Vegas. They don't come to gamble, although there are plenty of gamblers among them. They move apart from the normal flow of tourists and residents. They can be identified during a 4-day span by badges pinned to lapels and blouses. They are attendees of the Winter Consumer Electronics Show.

What is CES, as it is commonly called? Think of it as a World's Fair for consumer electronics held twice a year. One show is held in Chicago each June, but it is the Las Vegas show each January that has the biggest impact on the senses.

Much of the show's impact has to do with Las Vegas itself. The neon madness that passes for Las Vegas streets seems to strangely complement the huge assortment of

consumer electronics equipment on display. Consumer electronics devices, of course, can be major light shows in and of themselves. With so many machines on display against what seems like a neon background, your eyes can be overwhelmed.

Your ears aren't spared either. The parking lot outside the Las Vegas Hilton Convention Center is packed with cars outfitted with killer autosound systems. One pickup truck, for example, packed 25 speakers powered by 12 amplifiers made by Pioneer. Add in a chorus of another two dozen vehicles sporting monster systems, and you're left with sound levels that will massage your heart at 100 yards. To sit inside one of these cars is to risk possible physical injury of the type once delivered by enforcers for organized crime: There's no physical evidence of a beating, but your insides have turned to mush.

The biggest ever

This CES happens to be the largest ever in terms of exhibit space. Exhibitors occupied 1489 booths totaling 803,457 sq. ft. By the end of Day 3, your feet feel like square blocks. You don't dare think of all the miles you've walked. No one, incidentally, talks in terms of days of the week. Everyone thinks Day 1 through 4. Depending upon how well you're doing, some people pray for Day 4 harder than others.

There are over 1600 journalists covering the show, which translates as more than one per booth. Each journalist tries to see as much of the show as possible. This is no easy feat since CES sprawls out of the Convention Center and the adjacent Hilton Hotel into other hotels around town. The Riviera, Sahara and Mirage hotels hold the bulk of the spillover, but press conferences, technical briefings and receptions are held all over town. The newly

opened Mirage turns out to be a popular exhibit, thanks to a manmade volcano erupting every 15 minutes in front of the hotel and a small colony of white Siberian tigers in residence. The Sahara also becomes an oasis of prurient interest to many, as it houses a contingent of adult video exhibitionists.

Stars all around

While the geography is daunting, you also have to muscle your way through the 70,837 people from 80 countries the Electronic Industries Association (EIA) reports in attendance. At this CES, some notable sports personalities are lending their names to different products. They include ex-basketball great Wilt Chamberlain, boxer Roberto Duran and former football greats, Walter Payton and Roger Staubach.

By Day 4, you feel as if you've bumped into everyone—some maybe twice. CES is not open to the public, so everyone you see is somehow connected to the consumer electronics business. Much of their activity is reported in the dailies—trade newspapers put out by three different publishing organizations just for CES.

Like newspapers in any city—and that's what CES is like—some are more informative than others. One, *Twice Today*, makes you do a double take since it's only published once a day. *Twice*, you learn, is an acronym for a weekly trade paper called *This Week In Consumer Electronics*. *Twice Today* is a special CES edition. Of course, you don't have to read the dailies. CES-TV is available on hotel room televisions and also appears on monitors around the show.

(Please turn to page 44)

NEW
TECHNOLOGY



Radar Warning Breakthrough

Digital Signal Processing (DSP) allows new ESCORT to warn you of traffic radar much sooner than previously possible

When we introduced the original ESCORT in 1978, its superheterodyne technology provided an incredible increase in warning distance. One magazine said we "struck panic into the whole radar detector industry."

Our new ESCORT will have the same effect.

History repeats itself

Since 1978, we've continued to advance the science of radar warning, and our original ESCORT and PASSPORT have won test after test. But we've never stopped working to develop another breakthrough to redefine radar detection again. And now we've done it.

Incredible new technology

Our all-new ESCORT provides an incredible increase in detection distance. And it's only a fraction of the size of the original ESCORT. The key is Digital Signal Processing (DSP), an incredible computer technology.

DSP is used by NASA to create detailed space photos from blurry images. It's used to deliver sharp images of internal tissue from medical scanners. It's used by military radar to distinguish enemy from friendly aircraft.

And now we're using DSP to find radar signals too weak to be detected by conventional technologies.



The heart of ESCORT's DSP circuitry is a custom version of the Motorola DSP 56000. This 20 MHz 24 bit parallel HCMOS processor is capable of 10.25 million instructions per second, and is also used in Steve Jobs' new \$10,000 NeXT computer.

How It works

The new ESCORT's DSP circuitry samples incoming radar signals 50,000 times a second, slicing them into discrete bits of information. This information is digitized and continuously analyzed by an incredibly fast signal recognition computer. The end result is remarkable.

Breakthrough performance

ESCORT's advanced signal processing provides an incredible increase in sensitivity on both bands. Quite simply, this means that the new ESCORT picks up radar signals further away than was ever before possible, even distant instant-on radar signals. And its advanced City/Highway circuitry lets you optimize ESCORT's warning system for either driving environment.

"The new Escort packs ultimate sensitivity into a small package. Nothing else even comes close, and no wonder... No analog device can hope to match this performance."

BMW Roundel

Intuitive warning system

ESCORT's warning system keeps you fully informed. Upon radar contact, ESCORT's alert lamp glows and its variable-pulse audio begins a slow warning. Simultaneously a bar graph of Hewlett Packard LEDs shows radar proximity.

As you get closer, the audio pulse quickens and the bar graph lengthens. You'll understand ESCORT the first time you use it.

No compromise design

We've spared no expense in making ESCORT the best equipped radar detector ever. A photocell adjusts the visual display for the light level in your car (there's also a Dark mode for more discreet operation).

ESCORT's adjustable volume and Mute switch let you adjust the audio level, and we've added a new "AutoMute" that automatically turns the volume down after the initial alert.

ESCORT's aluminum housing, finished in non-glare black, provides ruggedness that will last for years and years, unlike plastic housings. And ESCORT comes complete, period.



The new ESCORT is only 7/8" high and 3 1/4" wide.

All accessories included

For installation, ESCORT comes with both visor clip and windshield mount. For power connection, we supply both a coiled and a straight cord to plug into your car's lighter. There's also a cord for permanent wiring into your car's electrical system, if you prefer.

We even include a leather carrying case, which fits easily in a coat pocket or briefcase, so you'll always have ESCORT with you.

Test-drive ESCORT at no risk

For more information, or to place an order, just call us toll-free. We only sell direct from our factory to you, and we guarantee your satisfaction.

After you receive ESCORT, if you're not completely satisfied within 30 days, just return it. We'll refund all your money and your return shipping costs. There are no hidden charges.

With the new ESCORT, we've revolutionized radar detection again. But don't take our word for it. Order today and see for yourself.

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Our new Digital Key security system will help keep your new Escort yours.



Actual size cutaway of Digital Key

Many of this year's show-goers were drawn to this CES because it is the first of a new decade. The consumer electronics industry had a big influence on people's lifestyles in the 1980s. The video cassette recorder made its big splash in the last decade. Over 79 million VCRs were sold during the 80s and a new business, the video rental store, was created. The 1980s also witnessed the development of digital sound on compact discs, cellular phones, camcorders, personal stereos and other products that have affected our lives.

Not every product introduced at CES is destined to have a great impact, of course. An \$8 digital watch shaped like a handcuff introduced at this CES under the name TimeCuf is strictly a novelty. At the other end of the novelty spectrum, Mitsubishi introduced a 120-in. projection television—the biggest ever marketed—that costs \$20,000 installed. While the 1990s will hold some surprises, no doubt there is some evidence of the shape of things to come at future CES exhibitions.

One product already written about extensively is High-Definition Television (HDTV). While still some years away, the debate over which standard to use and the level of government involvement in its development continued

at CES. Panel discussions involved several members of Congress and industry representatives. However it all shakes out, HDTV and the widescreen viewing it promises seems destined to happen.

Another video product that seems certain to become a reality is the flat-screen television that utilizes liquid-crystal displays (LCD). While the picture quality of small LCD televisions is now pretty good, the quality doesn't extend upwards into larger sizes just yet. Look for this problem to be licked in the coming years.

Just as in 1980, there's still a lot of talk about the marriage of audio and video. While audio and video are clearly dating, they're not quite hitched. "Home theater" is likely to become a catch phrase in the years to come, particularly if an aging population starts to cocoon around the hearth as industry pundits predict.

Home automation

Perhaps destined to have more of an impact on lifestyles is the concept of home automation. The idea is to have a control center with mastery over every electronic device in the house. All household devices that plug into a wall could be accessed via a television monitor and control box in the kitchen, for example.

You'd also be able to access the control center via telephone so that an air conditioner could cool a room before you arrive home, for instance. Standards are being formulated this spring by the EIA.

Personal electronics is also an expanding category. The Sony Walkman was just the tip of the iceberg. The future looks tiny. As CES ended, Sony announced plans to market by year-end a digital audio memo recorder that uses a 2-hour cassette the size of a postage stamp. Look for more personal video products as well as business-related devices like electronic organizers, pocket computers and personal fax machines.

Attendees of future CES events will also have some type of car navigation system that will direct them to the show and to the best restaurants in town. All the information needed to get around Chicago or Las Vegas will be on a CD-ROM disk for display on an in-car monitor. Blaupunkt demonstrated a prototype car navigation system like this at CES in Las Vegas, which gives you the feeling that this product and many more are just over the horizon. Certainly a lot more will happen than the organizers of the first Consumer Electronics Show in 1967 had ever envisioned. **PM**

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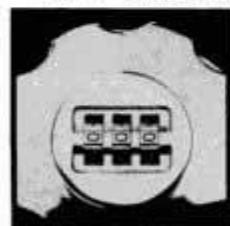
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as proof, it's a good thing to have. Keep receipts for the contents in one place, as long as that place isn't inside the house in question. If, the house burns down, it won't do much good if the receipts go up in smoke with it. Try a safe deposit box.

For an additional 15 percent added to your policy, you can get what one agent told us is one of the greatest values in homeowner's insurance. It is called *replacement on content* and means that for the surcharge, the company will agree to reimburse you for the replacement cost (read that the *new* cost) of your possessions. Otherwise, you'll get the used, depreciated value of your sofas, beds, hi-fis and everything else, which can be considerably less.

Credits

With these figures in mind, you're ready to start saving money. *Credits* are insurance lingo for discounts you can get if you meet certain conditions.

Probably the biggest reduction—up to 25 percent—comes off when you opt for a bigger deductible. If, for instance, the standard deductible—the amount you have to lose before you start collecting—is \$100, taking a \$500 deductible can save you a lot of bucks on your policy.

Allstate, for instance, will give you

another 15 percent if you go all-out to protect your home from fire and theft with sophisticated security hardware. You get 10 percent for maintaining a central alarm connected directly to the police station (5 percent for a local alarm system), and another 5 percent for installing a fire extinguisher, smoke detector and dead-bolt locks.

Some companies offer a new-home credit, in some cases for homes up to 20 years old. This can be either a fixed discount, or calculated on a sliding scale that drops a percent for each year. For instance, if a brand-new house gets 20 percent off, the discount will be down to 15 percent when it's five years old.

A renewal credit of 5 percent will be given by some companies simply for re-signing with them on the anniversary of the policy. Other companies offer a discount for customers who have more than one type of policy with them, such as home and auto insurance. This is known as a package credit and can represent a 2-percent discount.

For an older home, you may be eligible for a discount if you install a new roof, updated heating or make electrical improvements. A typical discount is 2 percent per renovation.

Nonsmokers can be eligible for a discount, the rationale being that if you

don't smoke, you are less likely to light up your house. The savings can be 2 percent, plus what you save on cigarettes.

A good-risk discount is sometimes available to a homeowner who goes for at least three years without making a claim. This can also amount to around 2 percent.

Special 2-percent discounts are sometimes given for earth-sheltered homes which are resistant to fire and violent weather. Solar heating also comes in for a discount in some cases.

A relatively new discount being offered is the senior household credit. The 10-percent discount, in Allstate's case, is available to retired people over 55 years of age. The assumption is that retirees are at home more often, therefore reducing certain risks such as damage by fire and burglary.

The most important decision you'll make in purchasing homeowner's insurance, however, is picking a knowledgeable and conscientious agent. It's best to go with an agent who comes with the personal recommendation of someone you know, and has a history of good service in your community. In addition to getting you the best policy for your buck, the experienced agent will be ready and able to fight for you when it comes time to making a claim. **FM**

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BOATING

BY JOE SKORUPA, Boating/Outdoors Editor

PM PHOTOS BY JOE SKORUPA



Anatomy Of A Boat Test

YOU'VE DECIDED it's time to buy a boat. You start with recent issues of **POPULAR MECHANICS** and read the boating stories to begin gathering information. But you still have questions. What do you do?

You're not alone. I receive letters on the subject regularly. Many of the questions are about PM test procedures. What do we look for? How do we wring out a boat?

Here's how. Some test procedures can be applied at your local boat dealer or boat show. Some can't because of equipment required. But by understanding how we put a boat through its paces and reach our conclusions, you'll be in a better position to ask the right questions.

Kicking the prop

The best way to explain PM test procedures is to go through a test, in this case, on a Pro-Line 230 Chinook, a versatile walkaround, bluewater fishing boat new for 1990 that's 23-ft. 8-in. long and 8-ft. 6-in. wide.

First impressions count on blind dates, but not on boats.

Take note of aesthetics, such as the 230's sporty colors and low, racy profile, but save them for later. Instead, spend the first few minutes getting acquainted with the boat, preferably while it's under way.

While moving out of the no-wake zone, begin to take serious mental notes. Do you have to make wheel corrections to maintain a straight line? This is a common problem on most deep-V boats equipped with a single stern-drive engine, the exact setup

on the Pro-Line 230. It's caused by prop torque and bow steering at below-planing speeds. Surprisingly, the 230 held straight and true at all speeds, a good sign.

Wide-open throttle

This is where we pull out the equipment and test for hole shot—the time it takes to reach a midrange speed beyond planing speed, but less than top-end. The in-dash speedo tells us the 230 runs about 40 mph, so we've designated 0-25 mph as our acceleration test. (If we were testing a 60-mph sportboat, a



Quiet, 5.7-liter Yamaha sterndrive sits low against transom.

more challenging hole-shot test would be 0-40 mph.)

PM hole shots are the result of averaging four good runs (two each in opposite directions) from a dead stop with two adults aboard and a half tank of gas (about 50 gal. in this case, since the 230 holds 109 gal.). One crewman holds the radar gun and stopwatch and one drives. On signal, the driver hammers down the throttle and clicks the stopwatch. The boat races toward a landmark—a building or bridge to provide a solid radar echo—and when the gun reads 25 mph, the stopwatch is clicked again.

Why test hole shot on an offshore fishing boat? For that matter, why test top speed? Granted, few use these rigs this way, but pushing a hull to its limits reveals efficiency and how it handles unusual circumstances. A boat that behaves well when stressed will behave well in everyday conditions.

Average time to reach 25 mph for the Pro-Line 230 was 7.71 sec., which is excellent for a single-engine boat weighing 3600 pounds. Throttle response was immediate, and the bow dropped down on plane quickly. For maximum thrust, I kept the drive tucked all the way under the hull. The prop bit instantly without digging a hole in the water.

Pushed to the limit

Next test is top-end speed. Same parameters: two adults aboard, half tank of fuel, average of four runs (two each in opposite directions), best trim angle, radar gun aimed at solid landmark. The Yamaha-powered Chinook topped out at 42 mph at 4600

(Please turn to page 48)

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BOATING (Continued from page 46)

rpm, which is swift for a heavy boat with a 19-in.-pitch prop on a midsize 5.7-liter, 270-hp sterndrive engine.

At WOT (wide-open throttle), the 230 tracked true with no hint of hooking, chine walking, bow steering or wandering. In fact, in both hole-shot and top-end tests, the 230 was a smooth and flawless performer.

For most test sessions, the PM team lays out three buoys about 150 ft. apart in a triangular pattern. We call this the performance course. It encompasses a hard right, hard left and 180° turn. We run it WOT if possible.

But for an offshore cabin boat, like the 230, I decided the performance course wasn't applicable. Instead, I chose to head into the Gulf of Mexico, off Florida's Captiva Island, to do what the boat was built to do—fish.

In 2- to 3-ft. rollers, we executed hard-running, trolling and backing-down maneuvers in both following and quartering seas. The first thing I noticed was that the 230 is a dry boat. Water is thrown well away from the boat, thanks to effective reverse chines, and the cockpit fends off waves due to a 28-in.-deep freeboard and closed transom.

How's fishability? Like all good fishing boats, the deck has a nonskid pattern and the transom and side areas have unobstructed fighting space. There's no step to trip on at the helm and only a short one to the wide (12.5-in.) sidedecks. There are two scuppers.

However, the quiet and efficient Yamaha sterndrive occupies valuable deck space midtransom. This breaks with tradition, but I see it as a legitimate alternative to outboard rigs. First of all, it eliminates the possibility of line entanglement in the outboard engine when you bring a fish with plenty of fight in him to boat. Secondly, the padded engine cover is a useful steadying point or comfortable seat in rough seas.

Other outstanding fishing features are built-in, 2-drawer tackle box, two 40-quart live baitwells in transom (one with cutting-board cover), four rod holders in the gunwales, two triple rod racks under the coamings and an 80-quart fish box.

Sound-level and fuel-flow measurements are next. We measure sound levels from the helm, unlike the Coast Guard which measures it from shore. Frankly, it matters less to us how a boat sounds to passersby as it does to passengers. At idle, we measured 65 dB-A and at WOT, it was 91 dB-A. Is this good? It's excellent. I've tested boats that registered as much as 95 dB-A on top end.

A rule of thumb to estimate gph (gallons per hour) in marine engines is about 10 hp to 1 gph. The more a rig falls on the low side of this standard the better. The 270-hp Yamaha, theoretically, should

burn 27 gph at max rpm. In fact, at 4600 rpm, the Cruisemaster fuel-flow meter, made by Flo-Scan of Seattle, Washington, registered an efficient 23 gph.

Now it's time to study design features and layout, and I still prefer to do this away from the dock. In fact, the only analysis I do on land is to look at the glasswork when the boat's on a trailer. In this case, the 230 had a rich, smooth, flawless hull, which Pro-Line guarantees for three years.

The most distinctive feature on the Chinook 230, which Pro-Line believes is well suited for Great Lakes fishing (hence the name), is a superbly designed deck unit that contains a 2-person padded bench seat for the helm station and a galley unit aft. The galley consists of a single-burner alcohol stove, cold-water sink (10-gal. capacity), cutting board, icebox and handheld shower. A built-in, 2-drawer tackle box is located deck level on the port side.

The galley unit is a strategic element, according to Pro-Line, because it and a Porta-Potti in the cabin enables the 203 to qualify as a second mortgage as far as the taxman is concerned.

Like most PM boat tests, I'm running out of space to report all observations. Here are five that shouldn't be overlooked: 1. visibility forward and of instruments and gauges is excellent, 2. sleeping pad in cuddy is a full 7 ft. long, 3. ventilation and lighting in cabin is superb due to two side hatches and one overhead (all open), 4. red and gray upholstery and decor overall shows a designer's touch (uncommon, but welcome in a fishing boat, especially for 2-income families) and 5. hardware is well anchored and substantial in a boat that exhibits topnotch fit and finish.

No boat is perfect, and it wouldn't be honest to skip over areas that could stand improvement. The wheel and throttle, for example, are a bit low for tall boaters to comfortably drive standing up. The same goes for a head-bumping overhead electronics box. Boaters of any size will find the windscreen too low to help in a rainstorm, but that's why Pro-Line includes a snap-on curtain. And finally, the 4-ft. 3-in. headroom in the cabin is on the short side, although overall the interior feels roomy.

Unlike the PM test team, readers have to write out a check if they find a boat that meets their approval. The Pro-Line Chinook, which is a fully loaded package (including hardtop, compass, depth recorder, windshield wiper and lots of other goodies), retails for about \$32,500. Is it worth it? Like many things, value is in the eye of the beholder. But the Chinook 230 emerged virtually unscathed from PM's rigorous battery of tests. Does that tell you anything? It sure does to us. **PM**



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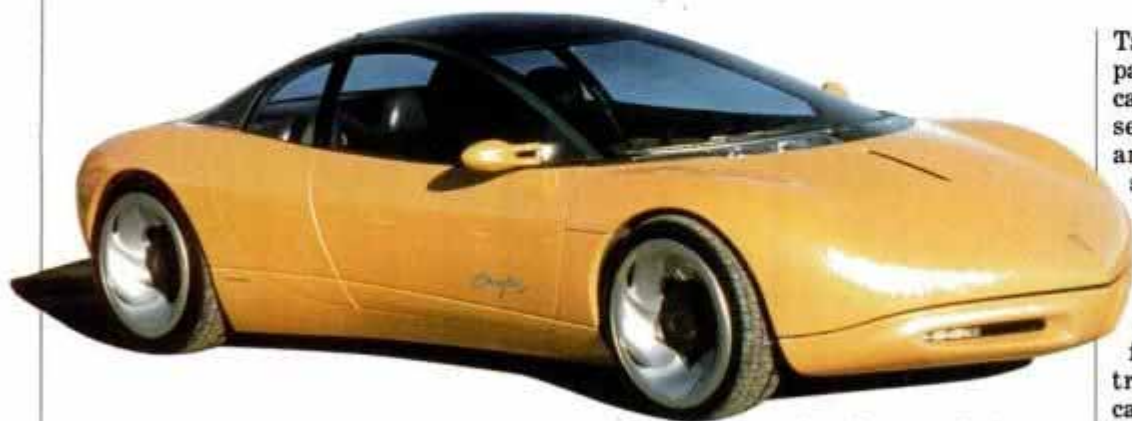


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DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Pontiac's 4-Door Coupe

A COUPE with four doors may be difficult to imagine. But Pontiac's Sunfire concept car makes it all work. Sunfire is a typical car-of-the-future that displays ideas for car designs of the late 1990s. Its unique door arrangement has captured the attention of this country's top auto stylists. In addition to the two full-size doors, Sunfire has two more half-doors that swing out when the front doors are opened, making for a wide entrance corridor to the rear seat. Close the front doors, and the half-doors close automatically. A second advantage of the Sunfire design is a short B-post. All four doors lock against posts that rise no higher than the front cushions. Yes, as in most 2-plus-2 coupe layouts, the rear seats are no more than child-size. But the ease of entry and exit that the half-doors offer make the area much more usable. Front-seat passen-

gers can even remain in place while rear-seat occupants easily climb in or out.

The Cadillac Difference

While some concept cars are nonfunctional design studies, you can crank up the Cadillac Aurora and drive it off the floor. This could easily be a real Cadillac of the future. Aurora's sleek, aerodynamic body is mounted on a standard DeVille chassis, but the driveline is one-of-a-kind. The off-the-shelf 4.5-liter, 200-hp Cadillac V8 is set in a north-south position, and all-wheel drive with viscous coupling between front and rear axles is standard. Antispin control and antilock brakes are included in the package. What's really unique about the Aurora is its front-drive layout. To get the hood set down low, the engine doesn't sit above the front driveshaft. Instead, the shaft runs through the

engine oil pan—a design proposed for the original Toronado back in the early 1960s. The concept saves 3 to 4 in. in hood height. A guess at the price of Aurora would be in the \$50,000 range, or competitive with the best sedans from Germany and Japan. There's a good chance of

Taurus of the Pentastar company. Optima's shape is typical of what you'll be seeing on sedans of the future: large and sharply raked windshield, massive front and rear bumpers designed to eliminate a number of body panels, doors that extend into the front wheelwells to reduce front-fender size, and extremely short hoods. It's called the cab-forward look. All Chrysler nameplates should have a version of this car in 1992½. But don't look for Optima's 4.0-liter, 32-valve V8 engine and rear-wheel drive to ever make the showrooms. Chrysler will stick with its 3.8-liter V6 and front-wheel drive to save on development costs.



Cadillac Aurora sports a 200-hp V8 and could be out by 1994.

Auroras rolling into Caddy showrooms, and that could be as early as 1994, if the go ahead were today.

Eagle's Dream Come True

Take a close look at the Eagle Optima concept car that Chrysler unveiled at the Detroit Auto Show earlier this year. It's close, if not identical, to the new line of cars Chrysler will put in showrooms in mid-1992. If Chrysler's plans work out, the Optima (code-named the LH platform) will become the

Back From The Dead

The Pontiac Fiero went out of production last year, but that's not going to keep it from being recalled. All 244,000 4-cylinder Fieros will receive modifications to minimize the possibility of throwing a rod and starting engine fires. Owners will, at last, it is hoped, be able to R.I.P.—rev in peace.

Tiny 2-Stroke

Walbro Corp. claims it has a 1.2-liter engine on test in a [\(Please turn to page 52\)](#)



Eagle Optima has a 4-liter, 32-valve V8 and rear-wheel drive.

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DETROIT SPY REPORT

(Continued from page 50)

Ford Escort that develops the same horsepower as Ford's 1.9-liter, 4-stroke engine. The 2-stroke has three cylinders, while the Escort engine has four. The advantages of the 2-stroke are smoother operation, lighter weight, smaller overall engine size, fewer parts and a cost savings of perhaps \$200. While 2-strokes have yet to meet government emissions standards, they are almost a sure bet for showrooms by '95.

Return Of The Roadmaster

While Buick officials say the Roadmaster name is not a sure thing, the car is a definite. There will be a full-size, rear-wheel-drive Buick sedan in production within two years. When work started on the car about a year ago, Roadmaster was the project code name. But there were some at Buick who felt that the old name didn't mean anything to today's buyer and would not add to the car's appeal. But in spite of new names being offered, there's still a good chance the big Buick will wind up with the Roadmaster nameplate. Look for this car to use the same chassis as Caprice, but with a 3.8-liter V6 engine and an electronically controlled automatic transmission.

Engine Antics

Cadillac's modular engine is still a year and a half away, but Caddy buyers won't have to wait for the '92 models to get more performance. Cadillac is coming out with a larger, 4.9-liter V8—an expanded version of their current 4.5-liter engine—in its 1991 models.

Huge Tires

They're coming. If show cars tip off the future, Detroit is planning bigger diameter tires for the cars it's designing now. Pontiac's Sunfire coupe showed up with outsize 21-in. tires in the rear, 19-in. in front. A Dodge show car, the R/T, had 17-in. wheels all around. The biggest tires now are on Corvette, and they measure 17 in. Besides changing a car's handling and traction, bigger tires strongly influence styling.

Cab-Forward Cars

Truckers call them cab-forward jobs—those highway semis built with the driver's cab set close to the front bumpers. That look is now cropping up in passenger cars, the new Honda Accord and Eagle Optima concept car we mentioned before being two examples. Chances are you'll be seeing many more cars with this look. Sports-car styling is a different story. Some models, especially those midengine foreign jobs, put

the driver up front like the fastest race cars. Others, like American musclecars, still have the long hoodline that intimates big engines, lots of power.

Toronado 4-Door

The old idea of a 4-door Toronado was recently revived, and now it looks like a sure thing for 1993. Olds was left out of GM's special vehicle plans in the 1980s while other divisions enjoyed their own exclusives—Allanté, Corvette, Fiero, Reatta. It was no secret that, for a long time, Olds executives wanted a prestige car like Seville. The idea was to build a European-type sedan that would be the division's flagship. The timing for the new car shapes up like this. Cadillac will have a completely redesigned Seville ready for the 1992 model year. GM will grant Cadillac a 1-year exclusive with that model, then Olds will be permitted to use the Seville chassis in 1993.

Saturn's Prices

A Saturn executive confirmed the price structure that we reported in our January '90 issue. Most of the Saturn models will fall in the \$10,000-\$12,000 price range. "It'll be below on some, above on others," according to the insider. Detroit observers look for a bare-bones, 4-door sedan at \$9500. Fully equipped models may be above \$13,000. **PM**

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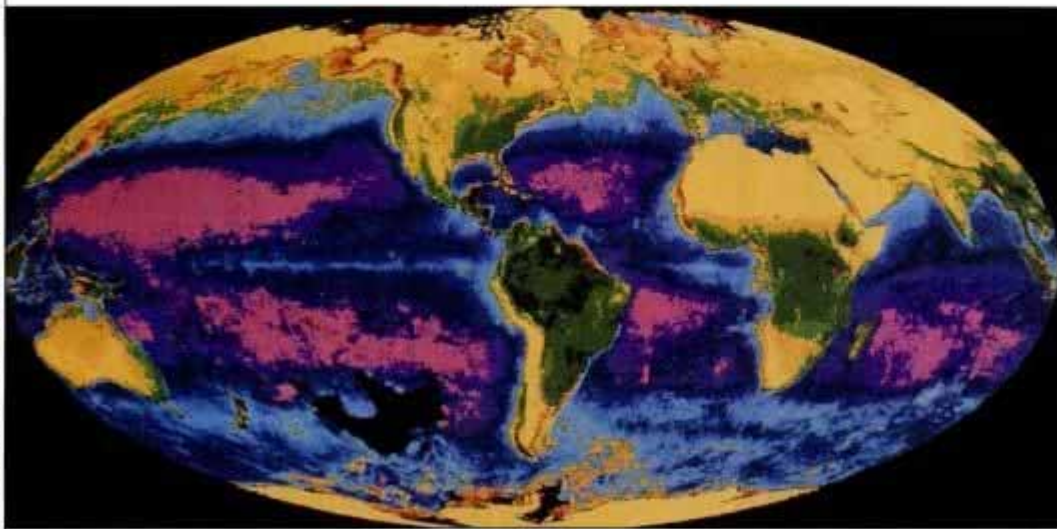
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SCIENCE

BY ABE DANE, Science/Technology Editor

C.J. TUCKER, NASA/GODDARD SPACE FLIGHT CENTER GRAPHIC



Composite of 30,000 satellite images shows global biosphere. Dark green is rain forests; light green, thinner vegetation; yellow, desert; and purple, phytoplankton.

Earth Day, Then And Now

WHAT IN THE world is Earth Day? Everyone you ask will give you a different answer. And it's not surprising. The concept is at heart a broad one. As near as I can figure, though, it goes something like this: For one day everyone wakes up, confronts the reality of our deteriorating environment, and responds like a rational human being. Then, of course, we all slide back into the same old habits that are gradually making the world a less habitable place—but perhaps not all the way back.

The images on this page symbolize two faces of the vaguely defined event we call Earth Day. On the one hand, it's a grab bag of loosely organized, grass-roots initiatives—demonstrations, recycling drives, essay contests and the like. On the other hand, all this boisterous activity adds up to a force for change at a more measured and deliberate pace. It filters up into the institutions of government and influences the focus of science, where there's the chance of a more lasting impact.

For many, the first Earth Day, celebrated 20 years ago

this month, reflects the irreverent temper of the time. The tactics employed in many parts of the country on that day bore a close resemblance to those earlier directed against the Vietnam War and racial injustice. But the effects have outlasted the turbulence of that era.

"The first Earth Day really did give birth to the environmental movement," says Chris Desser, executive director of Earth Day 1990, one of two major organizations planning anniversary events.

Along with awareness of the deteriorating environment as a national issue came a host of pioneering efforts to direct technological and economic progress toward arresting the deterioration and then, perhaps, even reversing it. Nineteen-seventy saw the establishment of the U.S. Environmental Protection Agency and passage of Clean Air Act amendments that brought us into the modern era of antipollution legislation. Two years later, the Clean Water Act became law, followed by the Resource Conservation and Recovery Act, regulating solid

waste disposal, in 1976. Superfund, meant to provide for the cleanup of toxic waste dumps, came in 1980.

Some of the rules worked well. Others did not. But the overall message is that, with well-crafted and sensible regulations, it is possible to spare the environment without giving up the comforts of a technologically advanced society. In fact, technology can be a positive boon to the environment.

Technology's place

It is this realization that provides the most striking contrast between this Earth Day and the last. For all the enthusiasm that accompanied the original event, relatively little was known about the actual state of our biosphere, and what sorts of measures were needed to protect it. There were obvious problems like trash along the highways, DDT and mercury poisoning, and choking urban smog. But the more subtle and ultimately more dangerous disease underlying these symptoms was a complete mystery.

That's changed dramatically. And although originally formed to expand man's horizons outward, NASA

has probably done as much to inform and inspire our interest in the home planet's welfare as any other agency. First, it was *Apollo 8's* stunning photos of the Big Blue Marble, contrasted with the bleak lunar surface in the foreground. Since then, a flood of satellite data has brought a deeper and more detailed understanding of the intricately interlinked forces that govern the conditions for life around the globe.

The Mission to Planet Earth

The success of these efforts has inspired NASA to propose a new direction for itself. Called the Mission to Planet Earth, it would constitute the largest, most expensive civilian unmanned space effort ever undertaken. And it would collect



The 1970 rally was long on enthusiasm, if short on science.

BLACK STAR PHOTO

about one thousand times more data than all recent U.S. Earth-monitoring missions.

As part of a 23-percent increase in NASA's funding (the largest requested for any federal agency), President Bush has called for \$260 million to get the program in next year's budget. The money will go toward the development of the Earth Observing System (EOS), a package of 19 instruments to be placed in a Sun-synchronous orbit, two in a Sun-synchronous orbit, two on polar platforms, and two on polar platforms, aided by the European Space Agency and Japan, will form the cent

EOS platform will carry instruments that represent substantial advances over those currently in use. Likely to receive high priority will be the moderate-resolution imaging spectrometer, which will be used to check on broad areas in the visible and near-infrared wavelengths to check on the Earth's biology changes with the sun. When a closer view is needed, high-resolution imaging spectrometers will come into play. Approximately the size of a small car, it has a 1-meter diameter telescope powerful enough to pick up biological changes in small lakes. Other key EOS instruments include a laser ranging system that bounces light off Earth-based reflectors to track movement of glaciers and the Earth's crust; an infrared sounder for measuring the moisture and temperature of the air at different altitudes; and a radar altimeter for data on ocean currents.

Under the current plan, the 40x15-ft. polar platforms will be joined by smaller geosynchronous satellites, which will provide constant monitoring of specific areas of the Earth. Vanguard of the Mission to Planet Earth will be a series of small Earth probe satellites performing specialized missions as early as 1993.

The result of this exhaustive monitoring should be a great step toward unity and coherence in what has been a fragmented and uncertain picture. Nagging doubts that have stood in the way of decisive action on our most pressing environmental issues—global warming, ozone depletion, rain forest burning and the expansion of global deserts—will very likely be resolved early on.

Meanwhile, back on Earth

In keeping with the broader perspective afforded by our efforts in space, the organizers of this year's Earth Day emphasize the global scope of the affair. Where an estimated 20 million Americans turned out the first time round, they now hope to encourage participation of 200 million people worldwide. More than 100 nations have formed com-

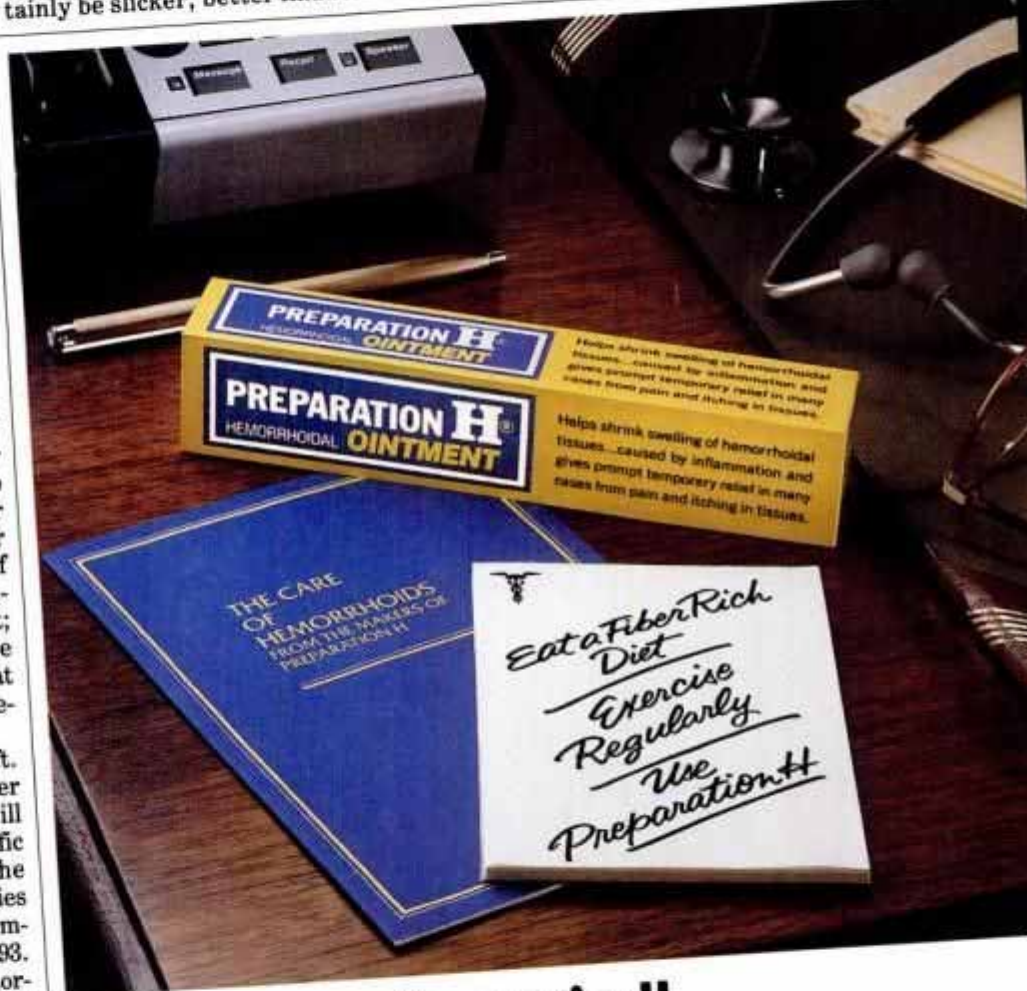
mittees and organized activities. Symbolically, Earth Day 20 is sponsoring a joint U.S.-Soviet-Chinese expedition to climb Mount Everest. Timed to reach the peak on April 22, its goals include the removal of garbage left at the summit by previous climbers. And Earth Day 1990 chairman Denis Hayes, who coordinated the first Earth Day, will be concentrating exclusively on international activities, leaving the U.S. to Dessler, his second in command.

Go ahead, make Earth's day

All in all, this year's Earth Day will certainly be slicker, better financed and

better informed than the original. Politicians, large corporations and celebrities of all kinds have all been scrambling for months to assure themselves a prominent place on the environmental bandwagon. And that's all to the good. But it's also important to remember that Earth Day will still hinge on a kaleidoscope of acts by individuals, each expressing concern in his or her own way. It took an overwhelming groundswell of public support to give birth to environmentalism 20 years ago. And it will take nothing less to propel the idea into maturity as the 20th century draws to a close.

PM



Preparation H. When your doctor says you don't need surgery.

If the agonizing pain and burning itch of hemorrhoids makes you feel you might need surgery, the very first thing you should do is see a doctor. Most likely, your doctor will tell you that your problem is not that serious and a simple regimen of care can alleviate the problem.

Thousands of doctors distribute this hemorrhoidal care guide from the makers of Preparation H. It advises a fiber-rich diet, regular exercise, and, for flare-ups, Preparation H to help shrink the swelling of hemorrhoidal tissues and often provide temporary relief of pain and itch.

Don't suffer the pain of hemorrhoids or the anxiety of surgery. Consult your doctor today.



Doctor recommends
PREPARATION H
Hemorrhoidal Ointment
Use only as directed

HOT TUB.



Had a tough week?

How about some liquid refreshment for the whole family, compliments of the Kawasaki Jet Mate™ watercraft? With 52 jet drive horsepower, a Jet Mate watercraft will take you fishing or cruising or picnicking faster than you can say "load 'em up, move 'em out." Safer, too, because its no propeller jet drive lets you breeze through

shallow water without a worry in the world. Jet Mate's a cinch to drive and trailer behind your car. And best of all, it's Kawasaki reliable and available right now at your friendly, neighborhood Kawasaki Marine dealer.

But you'd better hurry. Just think how stressful it would be if some other lucky family got the last one.

Call 1-800-661-RIDE for the Kawasaki dealer nearest you. Kawasaki believes safety begins with us and ends with you. Drive responsibly. Jet Mate boats are "Class A" inboard boats and their use is subject to all applicable state and local boating laws. All on board should always wear a USCG approved personal flotation device, eyewear and other appropriate safety apparel. Respect the rights of shoreline residents and other marine recreationists. Specifications and price subject to change without notice.

Kawasaki
Get the good times wet.



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Scheduled for launch aboard a Titan 4 in 1997, the first EOS platform will carry instruments that represent substantial evolutionary advances over those currently in operation. Likely to receive the heaviest use will be the moderate-resolution imaging spectrometer, which will survey broad areas in the visible and infrared wavelengths to check on how Earth's biology changes with the seasons. When a closer view is needed, the high-resolution imaging spectrometer will come into play. Approximately the size of a small car, it has a 1-meter telescope powerful enough to pick up biological changes in small lakes. Other key EOS instruments include a laser ranging system that bounces light off Earth-based reflectors to track movement of glaciers and the Earth's crust; an infrared sounder for measuring the moisture and temperature of the air at different altitudes; and a radar altimeter for data on ocean currents.

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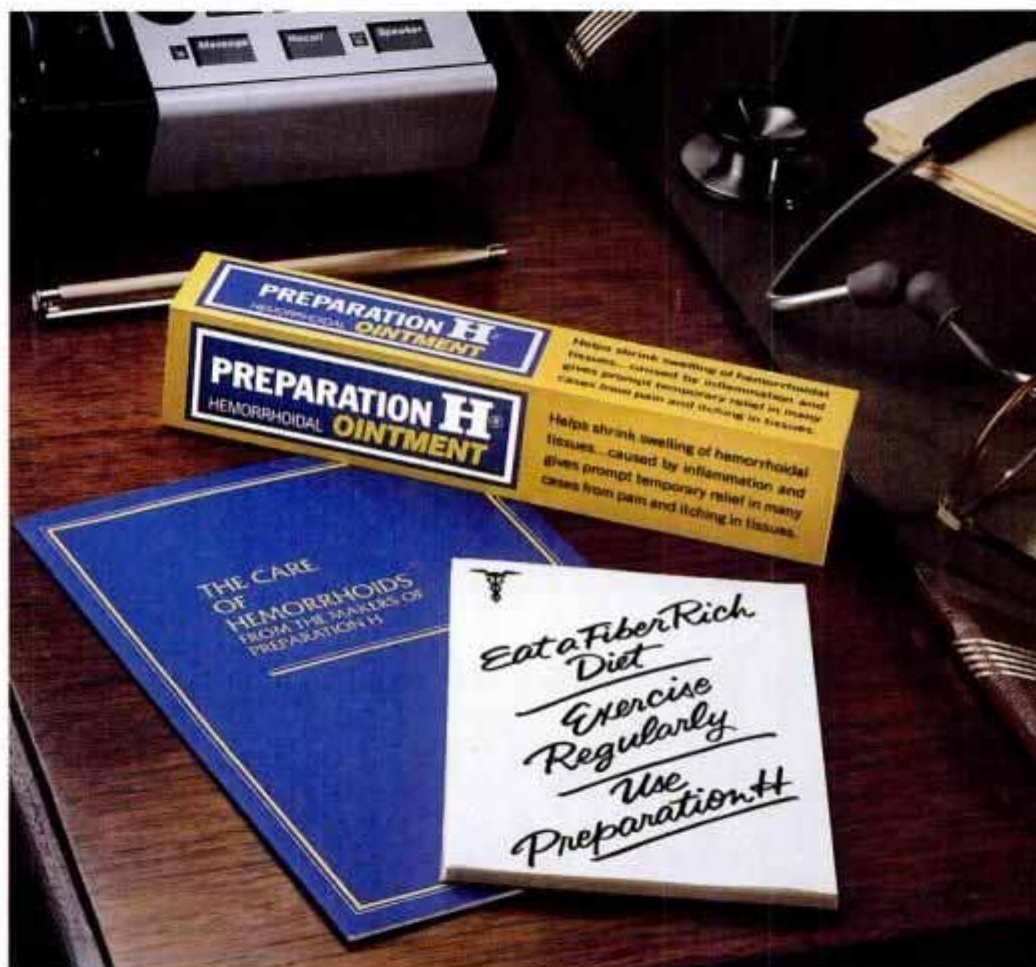
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Doctor recommended
PREPARATION H
Ointment and
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HOT TUB.



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Kawasaki
Get the good times wet.



CAR BIZARRE

One man's vision of future transportation.

BY MICHAEL LAMM,
Contributing Editor
PM Photos by Ron Hussey



UTAH 5



UTAH 8

SWISS industrial designer Luigi Colani wants to make a point—that there are many more ways to configure a car than are now being addressed.

He's saying we needn't all drive Bimmers and Blazers. Or even Sprints and Escorts. There are times and places when pedal power will do. And other times when one or two small, fuel-efficient engines in extremely lightweight motor vehicles make a lot of sense. Commuters, for example, have no business marshaling 100-plus horses in 2 tons of steel and plastic just to carry one person from congestion to gridlock.

"The world needs a better system of transportation," says Colani. "In America and Europe, cars absorb the pressure from the unavailability of good public transportation and the

lack of high-speed trains. Airplanes are fine for long-distance travel, but they do nothing for local traffic. If we continue to rely so heavily on automobiles, we need new categories of cars—new types."

To call attention to his point, Colani has designed and built 13 vehicles of various shapes, sizes and power configurations. Late last year, he brought 12 of them to the U.S. on a nationwide tour that culminated at the Bonneville Salt Flats in Utah. At Bonneville, he attempted to set speed and fuel-economy records with some of his creations. Unfortunately, he set no records, but he did make points.

Colani believes in organic shapes and minimal body configurations. He named his vehicles Utah 1 through Utah 13. Utahs 1 through 4 are high-speed bicycles, engineered and built

by Colani's assistant, Sebastian Kummer. Tour-de-France bicycle racer Kummer has considerable experience with human-powered conveyances. He and Colani believe that, in some instances, small hybrid vehicles using pedals plus small auxiliary engines are the way to go. For short hops to the mall, or if the office isn't too far from home, such hybrids make pleasant, practical commuters.

Utah 2 is one such vehicle configured for two people. It has, in addition to twin sets of pedals, an air-cooled, 30-cc Fichtel & Sachs 2-stroke 1-lunger rated at 2.5 hp. The rear-mounted engine can be rope-started quickly to augment muscle power on inclines or for acceleration away from stops.

Kummer and I tried Utah 2 together. After pedaling over the salt for 10 minutes or so, we decided to crank up

CAR BIZARRE



Luigi Colani



UTAH 2



UTAH 9



UTAH 11



UTAH 12

UTAH 4

UTAH 8

the engine. It started on the first pull and engaged easily through a centrifugal clutch. When running, it made pedaling comfortable and almost effortless. It's a fun little car to drive, plus it provides good exercise.

Another interesting concept vehicle is the Utah 6, which uses asymmetrical body styling. It shows that cars don't have to look the same side to side. The Utah 6 is a midengine 2-seater sport coupe that uses a VW Rabbit engine mounted amidship.

The most fascinating engine in Colani's Bonneville collection was the Lilliputian 47-cc quad-cam V8 in Utah 4. You read that correctly: The engine really does displace a mere 47 cc. Designed and built by a Swiss machinist named Schlimmer, the water-cooled V8 lies transversely at the tail of the streamlined bicycle and provides additional power to the rider, who lies face forward and on his belly.

Colani has some far-out ideas about

commercial vehicles as well as cars. His Mercedes-based truck tractor, Utah 12, with its insect-like cab, gets downforce at higher speeds. The 3-bladed wiper in the center of the windshield bubble rotates via a motor-driven flexshaft. Utah 12 didn't set any records but, thanks to good aerodynamics and the very small space between cab and trailer, it did average 8.9 miles per gallon on the salt and mustered a top speed of 91.4 mph, not bad for an 18-wheeler.

Other members of the Colani traveling road and salt show include: Utah 1 (not shown)—a 17.6-pound aerodynamic bicycle, Utah 3—a streamlined bicycle that the Swiss designer hopes will pedal past the current class speed record of 65.02 mph. Utah 5 is a 2-wheel motorbike that will shoot for the 80-cc record. Utah 7, with its 50-cc engine, has the lowest drag coefficient (C_d 0.18) ever recorded for a 4-place vehicle. Utah 8 is a swoopy 2-seater with a

BMW K-100 turbocharged 150-hp engine. Utah 9 is the electric vehicle of the group and is built on a Citroën 2CV chassis. Utah 10 is a record seeker, hoping to run over 175 mph with its Honda 500-cc racing engine. Utah 11 is designed strictly for speed and acceleration tests on the salt, and with its turbocharged and nitrous-injected 1300-cc engine, is obviously not for the faint of heart.

One caution that Colani recognizes is that, except for the truck, none of his vehicles meets federal safety and pollution standards. He acknowledges that it's easier to build concept vehicles than salable ones.

In the future, Colani plans to challenge other visionaries worldwide and extends an open invitation to join him for what he calls Automorrow '90, an event that, next October, will show more of his brainchildren, plus those from others who have designed and built alternative vehicles.

PM



UTAH 7



UTAH 3



UTAH 6



UTAH 2



UTAH 5

UTAH 6

UTAH 9

UTAH 7



UTAH 10

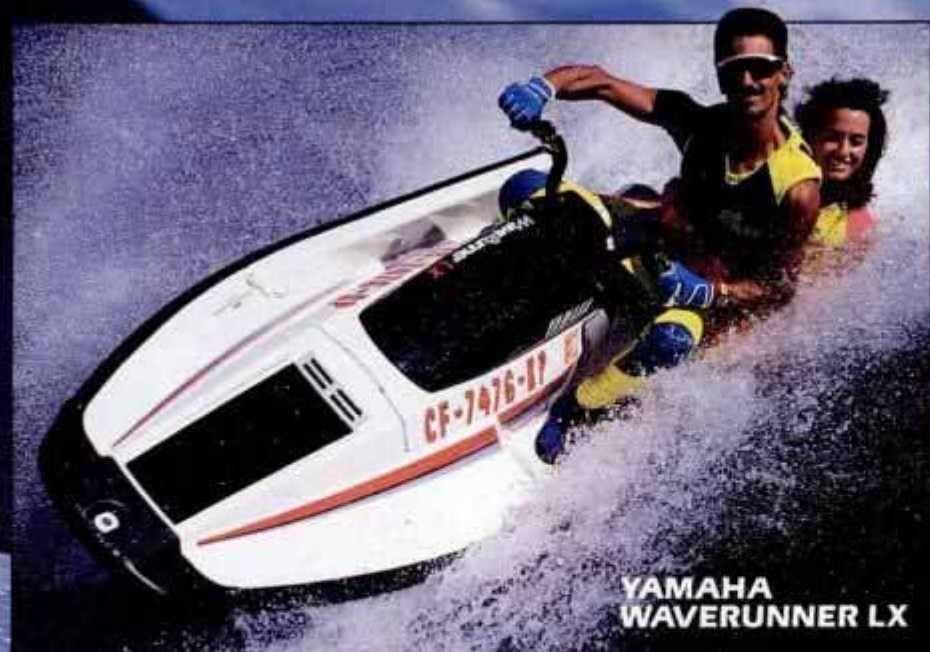
COMPARISON TEST

MAKING WAVES



Two-up personal watercraft have come of age. We try six of the hottest new wavebusters.

BY JIM YOUNGS; PM Photos by Rich Cox



**YAMAHA
WAVERUNNER LX**



**BOMBARDIER
SEA-DOO SI**

IT'S EARLY MORNING, there's glass-smooth water and you've got a responsive water scooter at your command. You launch. Your best girl climbs on back and you blast off for an adventure unmatched by any other vehicle. You carve tight turns and shred rolling swells, then creep into shallows to tour hidden worlds where few boats can go.

This is 2-up personal watercraft (PWC) riding at its best. It's the kind of freedom and complete assault on the senses found only in personal-sized sport vehicles.

Our last PWC comparison test ran less than two years ago (see "New-Wave Watercraft," page 79, Sept. '88), but the booming sport has come a long way since then and new models are appearing with impressive frequency. This year's PWC shootout, at SoCal's Lake Perris, was designed to determine the best from a distinguished group of vehicles. The results were close, and any one of these scooters would be a worthy personal choice. Here's what we found.

Sea-Doo Si

King of the hill for 1990 is the Sea-Doo Si (stainless impeller). Because of its penchant for power, the Si captured top rankings in every measurable performance evaluation, most of them by wide margins. It also led the pack in fit and finish and fun factor, which is a subjective combination of ease of use, stability with two riders, handling and responsiveness.

The 580-cc Rotax engine of the Si and the original Sea-Doo tested in 1988 (which also emerged as a comparison-test winner) are basically the same. But as many as 200 modifications to the earlier model were made, so the Si qualifies as new.

The Si is only one of two vehicles in the fleet with oil injection, which eliminates the need to mix a gas-oil cocktail (the other is the Kawasaki TS). Other elements we like are a huge 8.72-gallon fuel tank, for long-range cruising, and easy-to-reach storage bin in front of the handlebars.

About the only criticism we had is the size of the engine compartment, which is a bit tight for access, and the short neoprene pads at the back of the footwells (for comfort when reboarding), which should be longer.

The truth is that we had a difficult time trying to find shortcomings in the top-performing Sea-Doo Si. Isn't this the definition of a champ?

Yamaha WaveRunner LX

The original Yamaha WaveRunner opened up the world of PWCs to thousands of newcomers by making riding

MAKING WAVES

ULTRANAUTICS
SEAFLASH

KAWASAKI
JET SKI TS

WETJET
SPORT II

SPECIFICATIONS AND DIMENSIONS

OVERALL RANKING/ MANUFACTURER/MODEL	PRICE AS TESTED	ENGINE/ DISPLACEMENT	ENGINE HORSEPOWER	JET PUMP THRUST	LENGTH/BEAM HEIGHT/WEIGHT	FUEL CAPACITY/ RESERVE
1. Bombardier Sea-Doo Si 1 Rue de la Montagne, Valcourt, Quebec, Canada JOE 2L0	\$4829	Rotax/580 cc	55 hp @ 5500 rpm	520 lbs.	96"/41.5" 36.2"/365 lbs.	8.72 gal./2.18 gal.
2. (tied) Yamaha WaveRunner LX 6555 Katella Ave., Cypress, CA 90630	\$4725	Yamaha/633 cc	42 hp @ 5500 rpm	385 lbs.	109"/40" 34"/379 lbs.	5.8 gal./1.06 gal.
2. (tied) Wetjet Sport II 23 Washburne Ave., Paynesville, MN 56362	\$4395	Brut/432 cc	45 hp @ 6750 rpm	340 lbs.	108"/44" 39"/357 lbs.	5 gal./1.5 gal.
3. Kawasaki Jet Ski TS 9950 Jeronimo Rd., Irvine, CA 92718	\$4699	Kawasaki/635 cc	52 hp @ 6000 rpm	415 lbs.	109.4"/42.1" 38.2"/463 lbs.	6.3 gal./1.1 gal.
4. Ultranaautics Seafash 620 W. Huenele Rd., Oxnard, CA 93033	\$4895	Suzuki/798 cc	60 hp @ 6000 rpm	450 lbs.	108"/44" 45"/450 lbs.	9 gal./3 gal.
5. Wildcat 10621 N. Kendall, Suite 206, Miami, FL 33176	\$3995	Cuyuna/428 cc	45 hp @ 6750 rpm	340 lbs.	96"/40.25" 26.5"/290 lbs.	5.5 gal./1.5 gal.

All speed and timing data are result of averaging four test runs. Acceleration scores are time it takes to run 200 ft. from dead stop.

virtually struggle-free. For 1990, Yamaha transformed the relatively tame WaveRunner into a hot challenger by beefing it up with a big 633-cc engine. The result is a new LX model that's a solid competitor in every test category and a close second overall (tied with Wetjet Sport II).

The LX has an adjustable ride plate at the stern, which can modify the planing surface to accommodate one or two riders. Other outstanding features are convenient seat handles for the passenger, copious storage, stout wraparound bumper and superb engine access due to a wide cowling. Upholstery and trim are well finished, and the glass work is flawless.

Handling the LX is much improved, thanks to the adjustable ride plate. Throttle responsiveness is also

excellent in all rpm ranges.

Like the Sea-Doo, we'd prefer a longer pad in the footwell. A larger fuel tank would also be a plus. And, no doubt, many riders would appreciate hassle-free fuel injection.

WaveRunner set the pace for sit-down PWCs and the LX has all the same fun attributes. The big difference in the exciting LX is that it's quicker and more challenging.

Wetjet Sport II

The sleeper of the fleet is the American-made Wetjet Sport II, which nipped at the transom of the speedy Sea-Doo in all performance rankings. In fact, the Sport II's marks in all categories were high enough to earn it a surprising second-place tie with the Yamaha LX.

We tried everything we could think of to get the Sport II to misbehave at speed, but it wouldn't cooperate. Handling on the performance course (ranked second) was outstanding. Also, it was the driest of the top three performance machines.

The Sport II is unique because of its butterfly-style steering wheel. Throttle is controlled by a trigger on the right grip. Steering is quick and precise and the feel, with elbows tucked tight to the body, is distinctly different from the other craft. The test team split on whether the butterfly wheel was an effective alternative to standard handlebars.

Among many superb design features is the front cowling and dash, which lifts up as a single unit with the aid of a gas strut to provide the fleet's best engine access. Equally impressive is the solid hull, which has an innerliner and injected foam.

Again, the test team would prefer padding in the footwells, and the Sport II would benefit from a grab handle for the tandem rider. But, these are small nits to pick in a dark-horse model that stacks up surprisingly well against the big-names.

Kawasaki Jet Ski TS

Kawasaki and performance have been synonymous since the beginning of PWCs. Now the TS (Tandem Sport) has arrived, and it's destined to be in the forefront of PWC touring, which many believe to be the future of the sport. Despite sacrificing some performance for fleet-leading stability, the TS was still quick enough to vie



BOMBARDIER SEA-DOO SI

YAMAHA WAVERUNNER LX

WILDCAT

TEST RESULTS							
RANKING/TOP SPEED SOLO	RANKING/TOP SPEED DOUBLE	RANKING/ACCELERATION SOLO	RANKING/ACCELERATION DOUBLE	RANKING/PERFORMANCE COURSE SOLO	RANKING/STABILITY DOUBLE	RANKING/FIT & FINISH	RANKING/FUN FACTOR
1/38.62 mph	1/36.75 mph	1/3.92 sec.	1/4.47 sec.	1/13.6 sec.	4 (tied) Mod-V hull a bit tippy	1 (tied) Superb workmanship throughout	1 (tied) Easy to use and a screamer
3/36.5 mph	4/33.55 mph	4/4.37 sec.	3/5.17 sec.	3/17.46 sec.	3 Best of sport machines	1 (tied) Best dressed of fleet	1 (tied) New LX ups excitement
2/37.5 mph	2/34.5 mph	2/4.2 sec.	6/5.77 sec.	2/15.7 sec.	4 (tied) Second person makes big difference	3 (tied) Subdued graphics, no footpads	1 (tied) Darkhorse is a top performer
6/33.62 mph	6/32.75 mph	3/4.23 sec.	2/5.09 sec.	6/18.99 sec.	1 Ultrastable in all conditions	1 (tied) Big seat, padded footwells	3 Leader among touring machines
5/34.12 mph	5/33.43 mph	6/4.41 sec.	4/5.33 sec.	4/17.91 sec.	2 Rock solid, especially reboarding	2 Many features unique in fleet	5 More nimble than it looks
4/35.0 mph	3/33.6 mph	5/4.37 sec.	5/5.76 sec.	5/18.34 sec.	5 Best suited for solo thrills	3 (tied) Excellent glass work and graphics	4 Requires muscle and wet suit

Performance course is 1/8-mile run with hard right, hard left and 180° turns.

with the leaders in acceleration.

The ergonomics of the TS are aimed at comfort, dryness and accommodating the extra bulk of tandem riding. The tall seat, for example, handles two adults with plenty of room left over. Footwells are fully padded. In the unlikely event that riders fall off, there are handles and a rail at the rear to facilitate reboarding.

Even though the hull maneuvers on the tame side, throttle response is crisp, thanks to the torquey 635-cc engine. Two storage compartments, one ahead of the handlebars and one in front, are large and well placed. Access to the engine is excellent, since the whole seat is removable.

Although the TS finished third overall, it is clearly the performance winner among true touring vehicles.

Ultranautics Seaflash

Some called it the Winnebago of PWCs until they climbed aboard and felt the nimble performance of the ultrastable Seaflash. Although it appears somewhat chunky, it's actually lighter than the Kawasaki TS.

Seaflash has a high center of gravity and the big, boat-like hull handles chop like an offshore rig. It's easily the driest craft in the fleet.

Interestingly, Seaflash is the only 2-up scooter with Forward, Neutral and Reverse gears, which gives it an edge in slow-speed maneuvers. Another novel feature is a spring-loaded step that makes reboarding easy. Big fuel tank is a plus.

Two areas we'd like to see improved are engine access—the huge

798-cc Suzuki sits low and tight beneath the seat—and battery access, which requires removal of an under-seat storage tray.

Tandem touring is the hot new area for PWCs, and no craft accommodates two riders better than the Seaflash.

Wildcat

Though the Wildcat is billed as a 2-up scooter and, with a skilled driver, it can handle two riders, in our opinion, it's more suited to solo thrills. In fact, the economical Wildcat is the hunker-down café racer of the group. Even the raspy, full-throated growl of the Wildcat's 428-cc Cuyuna engine gives away its call-of-the-wild nature.

The Wildcat is the smallest vehicle in our fleet, but its distinctive pickle-fork design gives it a sleek, menacing

look of performance. We've ridden other low-seat, 3-point, hydrolike craft before and the Wildcat's seating is better than most, but it still requires the rider to bend his legs back and forces his knees to contact non-skid fiberglass in the footwell.

It's necessary to use body English and muscle through each turn with the responsive Wildcat, and when you do, curtains of spray fly with each maneuver. But that's all part of the fun of driving this snarling, body-hugging sport machine.

All vehicles showcased in our test are winners in their own right. The differences in fit and finish were like splitting hairs. Fun factor was equally close. PWCs have come a long way in the past few years and these six have come farther than most. **PM**



WETJET
SPORT II

AUTOMOBILES



MOTOWN

Detroit's new models roll when ready.

BY JIM DUNNE, Detroit Editor

IN YEARS PAST, eager car buyers waited until September to get a look at Detroit's new models. As regularly as back-to-school shopping, car showrooms shed their year-old displays, brightened up with new exhibits, traded in old price lists. It was the time of year, and the only time, to eye Motown's newest creations.

But that was then. This is now. Pressured by intense competition from abroad, Chrysler, Ford and GM are cranking out new wheels on an as-soon-as-ready schedule. No waiting.

This year, the trend to release-when-ready is accelerating. The number of half-year models, recently released for public viewing at the Detroit Auto Show, is the largest ever. And that trend is expected to continue in the future.

While the 1990s are still fresh in buyers' minds, a whole fleet of 1990½ and 1991 cars are in the delivery pipeline. You'll see them appearing in showrooms through this spring and into the summer, well ahead of the traditional fall intro season.

Here's how the 1990½ and early release 1991s shape up in detail.


Ford

How do you replace the best-selling car in the entire world? That's the dilemma facing Ford with its Escort.

Escort is all new for 1991. Underneath the skin is a new chassis that stretches the wheelbase 4 in. to 98.4 in. The floorpan is a duplicate of that used by Mazda's 323, but other features are all Ford in concept. They include front and rear (independent) suspensions, 13-in. wheels on base models, semiflush side glass, lower wraparound instrument panel, 5-speed manual standard transmission, and a 1.9-liter 4-cylinder engine. The



**GEO METRO
CONVERTIBLE**



**CHEVROLET
CAPRICE CLASSIC**

MIDYEARS

three carryover body styles—3-door coupe, 5-door sedan and station wagon—are all about 3 in. longer, in tune with today's market swing to larger cars. Even so, Escort is still considered a subcompact. Ford says the cars will now carry five passengers versus the four of earlier Escorts.

Escort's GT coupe is loaded with special equipment designed to appeal to sporty-car buyers. Underhood is a 1.8-liter, 16-valve ohc Four that is rated 127 horsepower, 39 more than the 1.9-liter standard engine. Backing up the single-overhead-cam engine is the same 4-speed automatic transmission or 5-speed manual trans that's available in other Escorts. The



**PONTIAC
FIREBIRD
FORMULA**

MOTOWN MIDYEARS

GT has an offset grille opening for better engine breathing, 15-in. styled aluminum wheels, and fat tires for much-improved handling. An all-business analog instrument cluster includes a tachometer, speedo and gauges for fuel and engine temperature.

Mercury's Tracer, an Escort twin, is also new for 1990½. While dimensions and drivetrain details are identical to those of the Ford subcompact, Tracer comes only in 4-door hatchback and station wagon styles.

Ford joins the sport/utility boom with its all-new 2- and 4-door Explorer. New styling, longer wheelbase, wider body, more interior room and a huskier engine are Explorer features that make you forget the Bronco II forever.

Under the hood, Ford has added more sizzle with a 4.0-liter V6 engine, replacing the 2.9-liter V6 as the top powerplant. The mill cranks out 155 horsepower and 220 lb.-ft. of torque compared to the rather wimpy 140 horsepower and 170 lb.-ft. of torque of its predecessor. A 5-speed manual transmission is standard, and a 4-speed automatic is an extra cost option. Rear antilock brakes are standard on all Explorers.

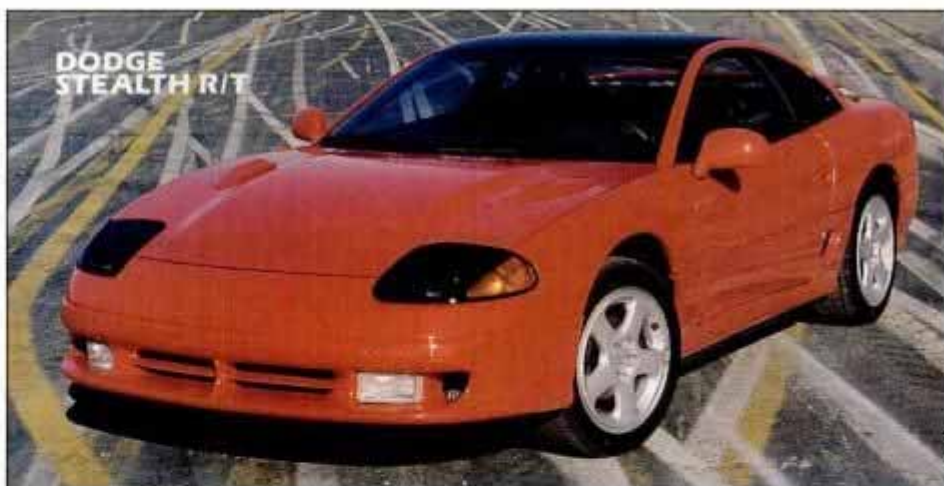
General Motors

Chevrolet's 1991 Caprice marks the first big change in the full-size sedan in 14 years. Although the big Chevy's styling was freshened up in 1981, the flagship has a sleeker appearance, is slightly larger overall and has more hip and shoulder room inside.

Caprice is still a big car, offering dimensions greater than almost any of the full-size import sedans. While wheelbase is the same as 1990's 116 in., and front and rear tread are identical, the car is over an inch longer and almost 2 in. wider.

Sleek body styling, especially in the angle of the windshield, brought major changes beneath the skin of the car. The air-conditioning system is no longer under the hood, but housed inside the passenger compartment under the instrument panel. Windshield wipers are no longer hidden under the hood, but exposed atop the glass. The low hood line allowed Chevy designers to attach the grille to the hood, a boon to mechanics who have to work on the coolant radiator.

Underneath the skin, chassis details are similar to Caprices of old. The tried-and-true 5.0-liter small-block V8 engine with 4-speed automatic transmission delivers 17 mpg



GM PHOTO

city and 26 mpg highway, according to the EPA.

The Caprice also continues with rear-wheel drive and separate frame and body construction. Added features for the new car include antilock brakes and a driver's airbag.

Inside, reduced wind noise results from the new flush glass in front and sides and from careful placement of the side-view mirrors, according to Chevrolet. Doors swing wider for easier entry and exit. Chevy designers may have dragged their heels in replacing the aging design of the 1977-1990 Caprice, but they did make the most of the opportunity.

GM's long-awaited addition of a 4-door to the Chevy S-10 Blazer and GMC Truck S-15 Jimmy lines will appear in showrooms this spring. Oldsmobile, in a surprise move, will also offer a similar 4-door sport/utility truck, the Bravada.

The new 4-door sport/utilities will have a 107-in. wheelbase, a stretch of 6½ in. over the 2-door version. This added room helps rear-seat passengers with additional knee room and with 15 in. more hip room in the 4-door, a benefit resulting partly from the relocation of the rear wheelwells to a point behind the rear seat. Cargo space is increased by 25 percent. The overall length of the 4-door Blazer/

Jimmy/Bravada is 176.8 in.—6½ in. longer overall than the 2-door models.

Standard equipment on all S-10 Blazers, S-15 Jimmys and Bravadas includes a 160-horsepower 4.3-liter V6 engine and 4-wheel antilock brakes. Special on the Bravada will be a full-time all-wheel drive, air conditioning, 15-in. cast-aluminum wheels and available leather interior. When it goes on sale in the fall, the Bravada will clearly be aiming directly at the Jeep Cherokee Limited market.

Camaro and Firebird both get a facelift for '91, and you'll see them in showrooms this spring. While drivelines, chassis and basic shapes of the body are unchanged, there is news for the F-bodies.

A Z28 model replaces the IROC-Z as the top model for 1991 Camaros. Special hood domes and an aerostyled rear spoiler that sticks up inches above the hatch door are obvious styling cues. Filling the wheelwells are 16-in. alloy rollers mounting huge 245/50R16 tires, while revised rocker panels conform to rear-wheel openings.

Two convertibles, one for Beretta the other for Geo Metro, round out Chevy's 1990-91 model changes. Beretta has what Chevy calls a targa bar that keeps the body sides in position

(Please turn to page 128)





FORD
EXPLORER



FORD ESCORT GT



MERCURY
TRACER

PHOTOGRAPHY BY JOHN LAMM

PHOTOGRAPHY BY JOHN LAMM

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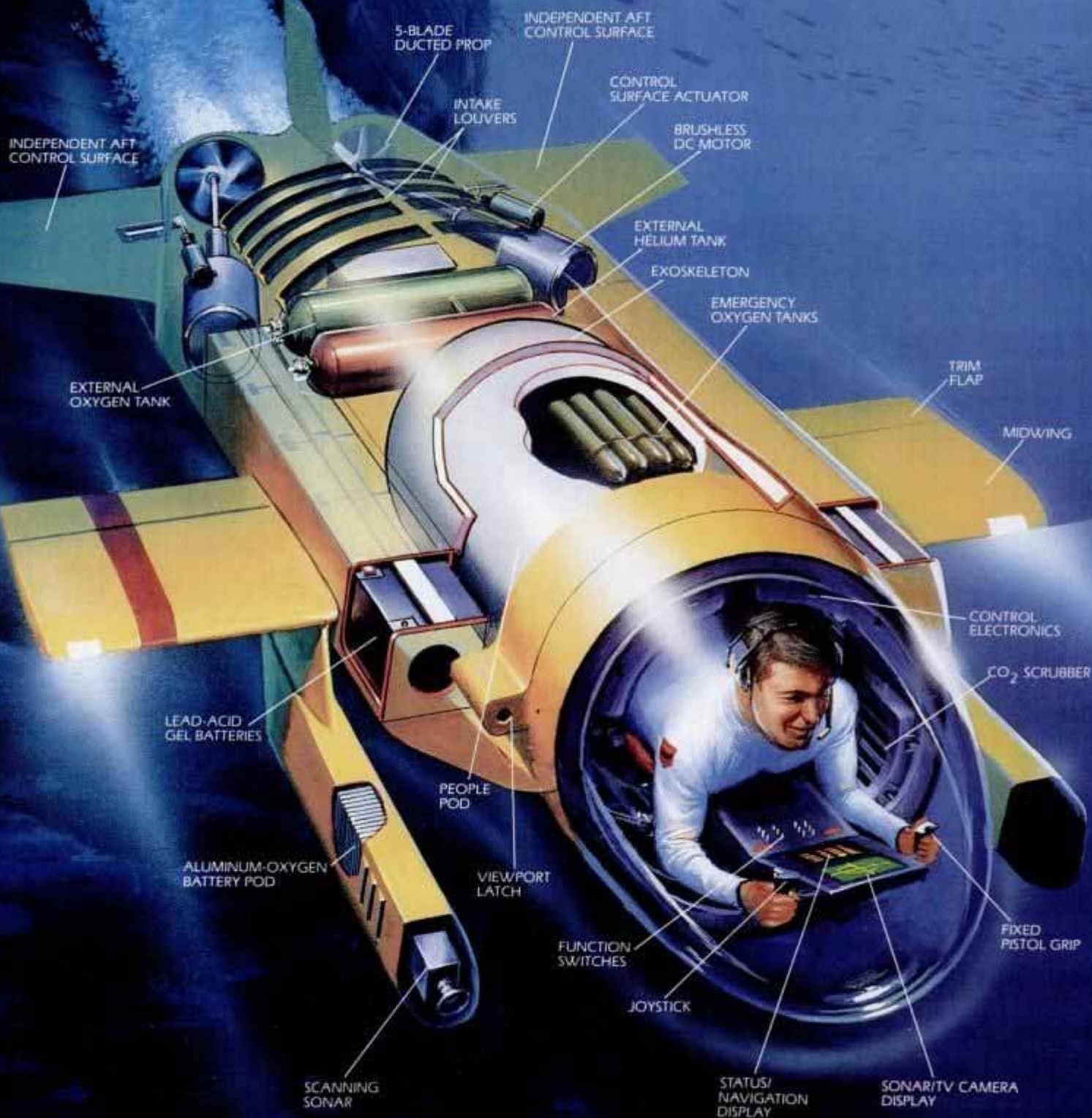
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*J.D. Power and Associates 1989 Compact Truck Initial Quality Survey.™ Based on owner-reported problems during the first 90 days of ownership. **See your Mazda Dealer for limited-warranty details.

COVER STORY

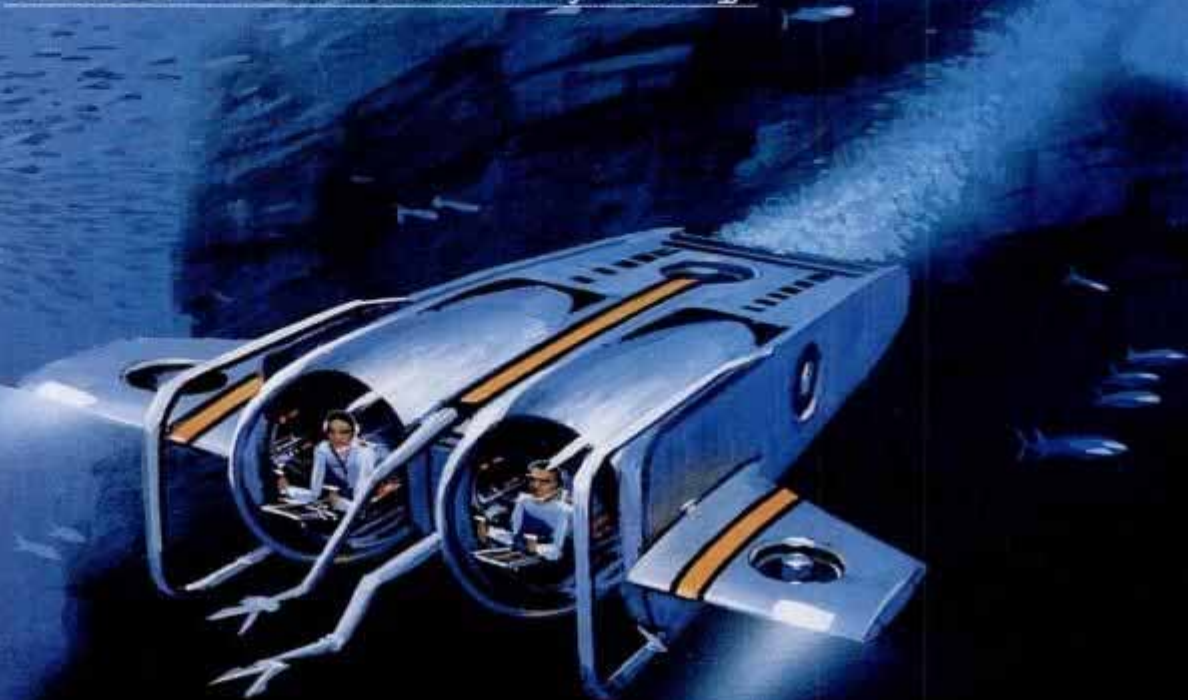


Packed with technology, *Deep Flight* (above) will blaze trails for more conservative, twin-pilot *Ocean Everest* craft (opposite). Shared innovations include exoskeletons containing jettisonable people pods and high-speed hydrodynamic maneuverability, provided by aft control surfaces.

DEEP FLIGHT

Soaring like an airplane thousands of feet down, a radical new sub will test technology for the next assault on the ocean's greatest depths.

BY GREGORY T. POPE; PM Illustration by Attila Hejja



THIRTY YEARS AGO, U.S. Navy Lt. Donald Walsh and Swiss oceanographer Jacques Piccard squatted in a 50-ton steel cocoon, looking for the first time at the bottom of the world. After a 4½-hour plunge, the Navy's bathyscaphe *Trieste* touched down at the base of Marianas Trench, 38,520 ft. below the Pacific, then began a 3-hour ascent to the surface. Since that day, January 23, 1960, no one's been back.

Now there's talk of sending submariners to the Trench again. Only this time they're not going to sink to the bottom—they're going to fly.

A man who's already cut a maverick reputation in the ocean engineering world is building what he calls the world's first underwater aircraft. As early as this fall, *Deep Flight I* and *II* will wing their way through the depths as technology demonstrators for a future Trench-diving craft. Graham Hawkes, the craft's designer, likens *Deep Flight's* departure from normal sub design to the difference between airplanes, which use aerodynamic lift to soar, and balloons, which use buoyancy and ballast to rise and fall.

"Think of them like NASA's experimental planes, like an X-1 or an X-15," he says, "in which they'd take aspects of flying and push them as far as possible." And Hawkes and his wife, marine biologist Sylvia Earle, will be the Chuck Yeagers of the seas, the first to pilot the twin *Deep Flight* subs.

But unlike a federally funded X-plane, *Deep Flight* is coming to life at night, on a shoestring budget, in the

hands of Hawkes and a crew of nine volunteers. They gather after working hours at the San Leandro, California, headquarters of Deep Ocean Engineering, Inc., a company cofounded by Hawkes and Earle in 1982. The cavernous subsea-robot manufacturing plant is littered with half-built remotely operated vehicles, fiberglass mandrels and machine tools.

Overseeing the work is Hawkes, an owlish 40-year-old Briton known best for his *Deep Rover* (see "Conquering Our Deepest Frontiers," page 86, Jan. '85), the bubble-shaped submersible, in which Earle and Hawkes set solo diving records of 3000 ft. three years ago. A decade in the San Francisco Bay area has tempered Hawkes' accent, but honed his drive to be different. "Part of this project is simply mischief, you see," he admits. "There's been so little innovation in the field, so little cross-fertilization between military and commercial submersibles. We're trying to stir things up."

In fact, he's throwing every innovation he can into *Deep Flight*. Each craft fairly bristles with technology. To strengthen the flight analogy, for example, Hawkes has plucked components from aircraft, such as an F-16's force input joystick, fly-by-wire electronics, a parachute-style restraint harness and low-weight, high-strength composite materials.

Barrel rolls with the whales

But the oversized rear control surfaces are what makes *Deep Flight* take off from conventional sub design. Jet-

DEEP FLIGHT

tionizing the concept of variable ballast for depth control, Hawkes is building *Deep Flight* to dive and ascend hydrodynamically like a sound-ing dolphin, the control surfaces determining pitch. The mid-hull wings are cambered like upside-down airfoils to provide a reverse lift. Since the sub is positively buoyant, it will enter an unpowered glide to the surface if propulsion fails.

What's more, the craft will pitch and roll through 360°. "Hydrobatic" is a favorite Hawkes coinage—another of his pet phrases is "doing barrel rolls with the whales at 4000 ft."

The pilot will lie in a pressure-resistant people pod, a thick fiberglass tube with a transparent acrylic viewport on one end. Nylon straps secure the pod to its exoskeleton, a free-flooding framework equipped with wings, propulsion, control surfaces and batteries. Exoskeletons will interchange, like suits of armor. Some will be built for speedy search and survey missions, others outfitted with sensory-feedback manipulators for detailed recovery work. If sea-floor detritus snares the exoskeleton, the pod can eject and float free.

The exoskeletons now under construction each house two thrusters that can push the craft along in 15-knot bursts. Underwater cruise speed will be a brisk 12 knots, and maximum dive and ascend speed a heady 600 ft. per minute.

Behind this subsurface muscle are twin pods of powerful aluminum-oxygen batteries. Scaled up from units that power emergency-buoy beacons, the batteries are simply rows of aluminum plates that touch off a strong current when doused in seawater. The AlOx pods, which can't be recharged, are detachable and won't be used for training and short trips. On-board reusable lead-acid gel batteries back up and buffer the AlOx power.

Also a factor in *Deep Flight's* nimbleness is lean construction. Fiberglass, impregnated with syntactic foam in the pilot's pod, has replaced metal for all structural components, and results in a sub weighing only 1½ tons.

Preparing for launch

Deep Flight's light weight will free it from the need for a dedicated mother ship, and it can even deploy via helicopter. Preparation will be a simple routine. The acrylic dome will be rolled out on its internal track assem-

bly, pilot will crawl in backward, and the dome racked back into place and sealed with a rubber O-ring. Then, the shipboard crew will test the hull's integrity by dropping pod pressure to $\frac{1}{5}$ of an atmosphere. Lying prone as *Deep Flight* flies the deep, the pilot will grasp the joystick with one hand, while the other holds a secondary grip with camera and light switches. Once



Hawkes models his partly assembled creation (top). The craft is being assembled by an all-volunteer crew, two of whom are shown above with Hawkes.

on a suitable course, the pilot can put the craft on autopilot while he attends to instrumentation, or just enjoys the view.

Voyage to the bottom of the sea

Should *Deep Flight* live up to its name, many of its features will be inherited by *Ocean Everest*, a dual-pod, bottom-diving craft that remains on the drawing board. *Ocean Everest* will be more conservative in design because, unlike *Deep Flight*, it must be insurable and ABS-certified, so that Hawkes can sell production models to the U.S. Navy and research organizations.

Ocean Everest will meld *Deep Flight's* innovations with more traditional sub features. Although the large rear control surfaces will remain, vertical thrusters will be added, allowing the craft to hover in place. The acrylic domes—cast from transparent ceramic—will be hemispherical to better distribute water pressure. Perhaps the only breakthrough on *Ocean Everest* will be the pods' thick-wall graphite-composite material, which is capable of rebuffing nearly 30,000 psi, giving a 2:1 safety factor at full ocean depth.

The resulting unlimited depth capability, along with its 12-knot speed, will put *Ocean Everest* at the pinnacle of submersible design—and in great demand. Right now oceanographers have a scant handful of deep-diving submersibles. None go deeper than about 20,000 ft., and all are hampered by sluggish subsurface speeds and the need for a dedicated mother ship.

"The tools we have," says Grant Gross, director of the National Science Foundation's ocean sciences division, "are functionally underwater elevators. Something like *Deep Flight* would open up avenues that we simply have not had."

Even as shallow as 4000 ft., Gross explains, $\frac{1}{2}$ -knot craft like Woods Hole's *Alvin* cannot keep up with the organisms under investigation. "Squid, whales, tuna, mackerel—just about anything can outswim a submersible," agrees Earle.

At greater depths, Gross says, the ability to survey much broader areas represents "an order of magnitude improvement in technology." *Ocean Everest* would open up detailed investigation of depths below 12,000 ft., which account for about 40 percent of the ocean's total volume. Even below 20,000 ft. lie areas, all unexplored, adding up to the size of the United States. "We should be thinking about setting aside areas of the ocean for various levels of protection," says Earle. "One thing we can do with a high-speed craft like *Deep Flight* is to scout and make knowledgeable decisions about protection."

But beyond conservation missions, Earle agrees with Hawkes that the "sheer joy of *Deep Flight*" will make the project worthwhile. "To be able to go swiftly through water in a vehicle that's more like a suit of clothes," says Earle, "will give a diver a new, intimate kind of relationship with the ocean." **PM**

FLIGHTS OF FANTASY

Giant, kit-built, radio-controlled planes blast higher and faster than ever before.

BY JOSEPH TRUINI
PM Photos by Don Poggensee

Here's a model of one of the most famous fighter planes in history—the P-40. The 1/5-scale, radio-controlled plane has a 7-ft. wingspan.

WHOOSH! I turned just in time to catch sight of a red, white and blue bullet streaking past at 125 mph. As it swept across the horizon and headed back toward us, I recognized it as an F-16 jet fighter. With the throttle wide open, Jack, the pilot, suddenly pulled up and rocketed the F-16 straight up into the bright, blue sky. The jet, climbing and spiraling simultaneously, continued to ascend until it nearly disappeared.

As I stared skyward, past the high midday sun, the jet's ascent slowed little by little until finally, it seemed to stop—frozen in midair at 1000 ft. Then, Jack killed the engine and the aircraft tumbled silently from the sky. Falling, drifting and playing off the wind, the jet somersaulted toward the ground. At around 600 ft., I listened for the roar of the engine. There was only silence. At 400 ft., the only sound was the wind trying to rip off the wings as the nosedive gained speed. As the jet plummeted to within 200 ft., I thought aloud: "Pull up, Jack!" Then, as the ground rushed up to meet the F-16, the engine roared and Jack skillfully guided the jet skyward once again. It had cleared the ground by no more than 15 ft.



A 1/5-scale C-74 Skytrain is walked out of hangar with a load of tiny paratroopers. This giant, custom-made model has a 19-ft. wingspan.



Pitts Special is ready to taxi out to the runway. The 1/5-scale aerobatic biplane model has a 68-in. wingspan and 1400 sq. in. of wing area.

FLIGHTS OF FANTASY

I looked over at Jack, who was standing a few feet away with the radio transmitter, and he flashed me a mischievous smile that only old pilots possess. It was at that moment that I realized radio-controlled airplanes had come a long way from the stick-and-tissue models that I recalled from boyhood.

Jack's F-16 Fighting Falcon is a radio-controlled, large-scale replica of the popular jet fighter that General Dynamics developed for the U.S. Air Force. Manufactured by Byron Originals, the jet comes in kit form and measures over 6 ft. from tip to tail with a 4-ft. wingspan. And, it's powered by a ducted fanjet engine. While it isn't a true jet engine, it's close. (We'll have more on ducted fan engines later.)

A case for kits

The first question may be, why are radio-controlled (R/C) aircraft kits so popular? To a certain extent it has to do with the satisfaction and sense of accomplishment that comes from building a flying machine. Although we've become jaded with the incredible advancements in aviation over the past 30 years or so, remember that Orville and Wilbur's fun-fly at Kittyhawk was only 87 years ago. Flying, even model flying, ties us to this bygone era of American ingenuity and pioneer spirit at its best.

However, the real magic, the true attraction for millions of model aviators, is that these amazing models give the freedom of flight to those who would otherwise be grounded. And



Corsair is held back awaiting runway clearance. Note the famous bent-wing design. Warbird models are the most popular aircraft kits.



A not-quite-light landing left this buzzard with a busted beak. Note broken propeller.

while it's true that many sport aviators are professional pilots, most modelers are not earning their living in the air. Many are veterans whose flying—not their love of flying—ended with their tour of duty. And, there's a growing number of modelmaking enthusiasts

that have never piloted a plane. Maybe they've never even seen a cockpit. But, their love of flying is as true and strong as Chuck Yeager's and model aircraft provides a way for them to experience the thrill of flying safely.

Today's modelmaker has a wide range of R/C aircraft kits from which to choose (see the list of kit manufacturers and suppliers at the end of this story). There are kits of popular civilian aircraft such as Piper Cub and Beechcraft. You can build an old biplane, aerobatic barnstormer or modern jet fighter. There are even gliders, helicopters, blimps and amphibian planes that take off from water. Some of the most popular kits, though, are the warbirds—planes used during World War II. Kits are available for a P-51 Mustang, F-6 Hellcat, P-47 Thunderbolt, Corsair and P-40 Kittyhawk. You can even build a Japanese Zero or Russian MiG. Not surprisingly, the warbird kits are most popular with veterans who flew the real, full-scale machines during the war.

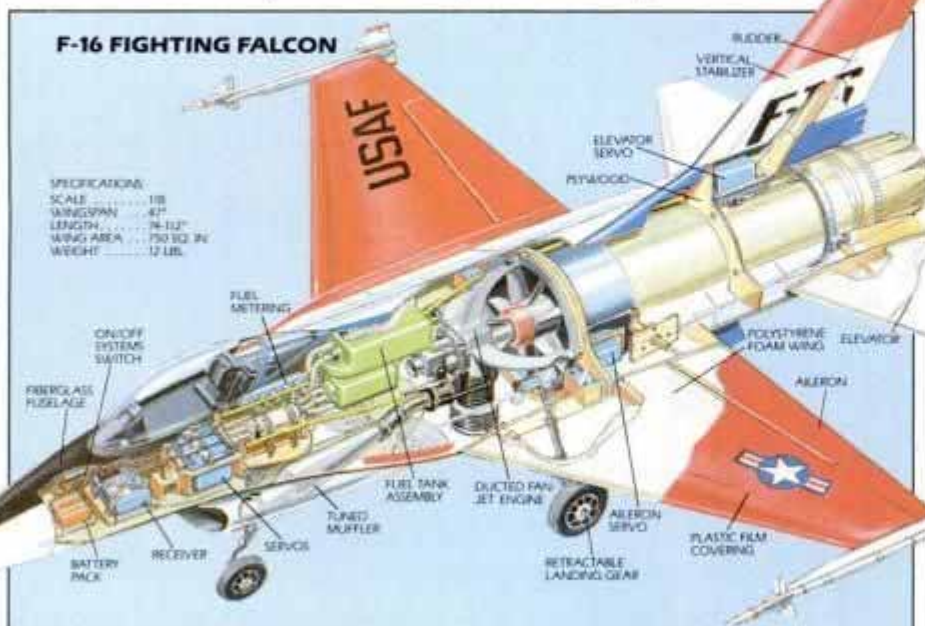
The large scale of these warbirds make them all the more impressive. For example, a 1/5-scale P-51 Mustang is about 6½ ft. long and has a wingspan of more than 7 ft.

While many models are still constructed with a skeleton of balsa wood, most giant-scale planes feature large components molded from tough, lightweight plastics and polystyrene foam. For example, the Byron Originals' F-16 model consists of a 2-piece fiberglass fuselage and injection-molded foam wings and tail. Since the jet's major components are molded, assembly time is reduced drastically. Most large models also feature plug-in wings that allow the plane to be dismantled easily for transport. The kits don't include mechanical components, just the parts for building the plane itself.

The engine, fuel system, landing gear, receiver and other mechanicals must be purchased separately.

Once assembled, the model is then covered with either fiberglass cloth and epoxy resin, or an iron-on plastic covering. Paint and authentic-looking decals add to the realism.

But, if you think that building a R/C plane kit is a piece of cake, it isn't. There's no substitute for time and patience, and you'll need plenty of both to finish your first kit. Many of the more complex aircraft kits, including



F-16 model is designed to keep weight down without sacrificing strength. Wings are made of polystyrene foam. Fuselage is fiberglass. Receiver in nose decodes signals from transmitter.

PM ILLUSTRATION BY FRED WOLFF



A colorful Christian Eagle biplane and handheld transmitter get their nickel-cadmium batteries recharged via a 110-volt hookup.



This pilot, up to his armpit in F-15, employed his pit pals for a preflight check. Real-plane details include fully retractable landing gear.

large-scale planes, should be tackled by experienced modelers only. The local hobby shop will be able to suggest the right kit for you. For many beginners, an introduction to R/C flying starts with an ARF (Almost Ready To Fly) plane that requires a minimum of assembly.

The cost of cruising

Now the obvious question: How much does a R/C aircraft kit cost? That's tough to answer because prices vary so much from model to model and from one manufacturer to another. Plus, if you're into customizing and high-performance flying, then the sky, so to speak, is the limit. It's not

unusual to find serious modelers at the airfield with \$2000 or \$3000 invested in their aircraft.

If you're just starting out, though, you may want to begin with a trainer aircraft—a forgiving, easy-to-fly plane that is specifically designed for R/C novices. You should be able to find one for under \$100.

Standard-size aircraft kits (average wingspan about 3 ft.) range from about \$100 to \$500. Large-scale aircraft kits are available in the \$400 to \$1000 range. Remember, these ballpark figures are for the kits only. And engine, mechanicals, servos, transmitter and receiver are all extra.

Now let's talk about the basics of R/C flying and the equipment needed.

R/C basics

First, you don't need a license to fly R/C models. You do, however, have to be familiar with regulations set forth by the Federal Communications Commission (FCC). All R/C systems operate on a particular band of frequencies. In order for a system to operate properly, the handheld transmitter and the receiver that's mounted in the plane must be broadcasting on the same frequency. Generally speaking, a transmitter has a range of about 1½ miles. Two planes can't be flown on the same frequency

Air Show Extravaganza

EVERY AUGUST, the little town of Ida Grove, Iowa, plays host to Aviation Expo—the world's largest gathering of radio-controlled aircraft. For anyone interested in R/C flying, specifically jets and giant-scale warbirds, this is a must-see event.

The 5-day air show is the brainchild of Byron Godberson, president of Byron Originals—manufacturer of giant-scale aircraft models. The Expo is held in Godberson's 240-acre backyard where he's built an impressive 1/5-scale airport complete with hangar, tower and 600-ft. runway. The show attracts about 60,000 R/C flyers and enthusiasts from around the world. Each day the sky is abuzz with radio-controlled flying machines of every imaginable description including the world's largest



est R/C aircraft—Godberson's custom-built, 1/5-scale B-29. This flying monster weighs over 380 pounds, with a 29-ft. wingspan. Other R/C wonders include 9-in.-tall miniparachutists, flying lawnmowers and Superman.

Daily attractions include the Cloud Dancers, an R/C precision flying team; the Eagle Aerobatic team of three full-scale Christian Eagle biplanes; and the Coors Light Silver Bullet, the world's smallest manned jet.

However, everyone's hands-down favorite attraction is the Striking Back show. Each day concludes with a 30-minute reenactment of a World War II air strike against a Japanese-held South Pacific oil refinery. The air is filled with R/C dogfights as B-25 bombers shell the refinery. It's a little of Hollywood, a little history and an exciting demonstration of R/C flying at its best. This year's Expo will be held Aug. 8 through 12. Contact, Aviation Expo, Box 253, Ida Grove, IA 51445.



Getting the world's largest R/C aircraft onto the runway is a 2-man chore. The 1/5-scale B-29 weighs 380 pounds with a 29-ft. wingspan.



"Striking Back" WW II set includes a man-made lagoon, 1/5-scale aircraft carrier and a fleet of radio-controlled, torpedo-firing PT boats.

FLIGHTS OF FANTASY

at the same time. Try this and you'll join the crash-and-burn club.

As of January 1989, there are 80 frequency channels set aside for R/C use. The 80 channels are divided into four groups, or bands. The 72 MHz (megahertz) band has 22 channels that are currently reserved for aircraft use only. Other bands are set aside for R/C cars and boats.

If you're just getting into R/C flying, the first step should be to join a local flying club where you'll meet modelmakers who are eager to share their knowledge. Choose a club that is chartered by the Academy of Model Aeronautics (AMA). The 50-year-old AMA is the national center for aeromodeling and the world's largest sport aviation organization. There are more than 2400 AMA-chartered flying clubs across the country. For details, contact the AMA, 1810 Samuel Morse Dr., Reston, VA 22090.

Other valuable sources of information are books and magazines devoted to aeromodelers. Two highly recommended books are *The Beginner's Guide To Radio Control Sport Flying* and *The Advanced Guide To Radio Control Sport Flying*. The books are authored by Douglas Pratt and published by Tab Books, Blue Ridge Summit, PA 17294. Some popular modeling magazines include *Model Aviation*, *Flying Models*, *Model Airplane News* and *R/C Modeler*, to name just a few.

The controls

In the basic R/C aircraft, a handheld radio transmitter, powered by rechargeable nickel-cadmium batteries, sends signals to a battery-powered receiver that's mounted in the plane. The receiver decodes the signals and relays them to servos (servomechanisms) which are tiny electric motors. The servos, in turn, obey the signals and perform specific mechanical functions. They move the rudder, operate the ailerons, raise and lower the landing gear, turn on lights and adjust the elevator. The more complex the aircraft, the more servos it requires.

Transmitters, like planes, are available in a wide range of models and prices. Most modelers use a 4-channel transmitter in the \$150 to \$250 range. The four channels control the ailerons, elevator, rudder and throttle. A typical transmitter, like

the one shown, has two swivel sticks that control the four channels. Separate trim levers function as fine adjustments for each channel.

Engines

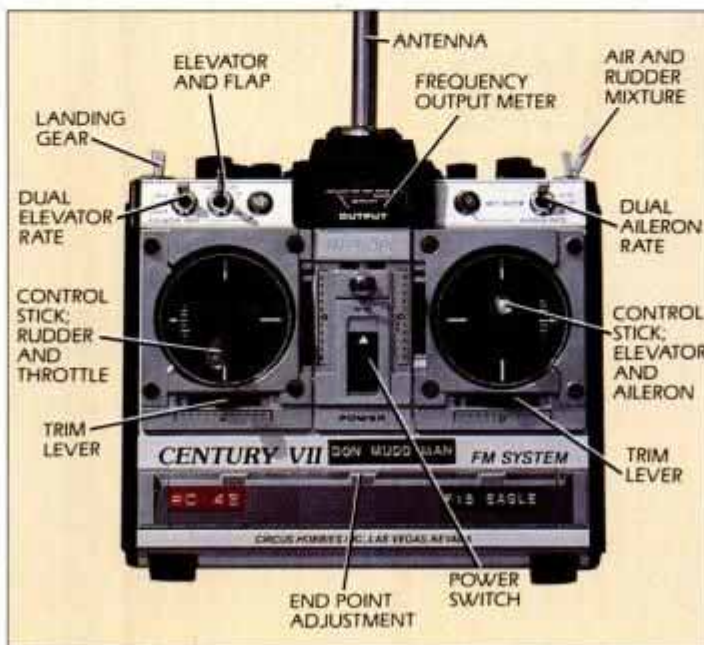
Most model aircraft are powered by a 2-stroke engine. Four-stroke engines are popular with some modelers because they can swing a bigger prop

in popularity as aeromodelers seek new thrills. While there is no true gas turbine jet engine for R/C use (although one will be available soon), a ducted fan engine offers an alternative. It consists of a standard model engine mounted to a long, tapering tube. The engine powers a multibladed fan that drives air through the tube. The fan unit houses several stators which are aerodynamically shaped blades that straighten and direct the airflow in a thrust line. As air is blown through the tube and exhausted out the back, thrust is produced.

Final word

R/C model aviation is a hobby that can be enjoyed by young and old alike. It's a great way to bridge the generation gap—share modeling with your kids or grandkids.

You don't have to be an aeronautical engineer and no special aircraft-building skills are required. Model plane manufacturers offer thousands of kits to satisfy all levels of interests and budgets. You're sure to find a plane that's right for you. Happy flying! **FM**



Here's the heart of an R/C system—the transmitter—with its main controls identified. The unit sends signals to a receiver mounted in plane.

and they sound more like a full-scale plane—they rumble and roar instead of whine. However, a 2-stroke engine works best at higher rpm and delivers more power than a 4-stroker of the same displacement. Plus, they're less expensive and have fewer parts. The displacement of the tiny 2-stroke powerplants range from about .015 cu. in. to .61 cu. in. The most popular engines are in the .40 range.

Two-strokes burn a glow fuel that's a mixture of nitromethane, methanol and lubricant. The percentage of nitro can be adjusted, but most modelers use a mixture that's 5-percent to 10-percent nitro.

The 2-stroke engines used in most giant-scale aircraft range from 1.38 cu. in. to 3.78 cu. in. A popular size is the 2.28 cu. in. that weighs nearly 4½ pounds. It costs around \$160 and can be used in planes weighing as much as 26 pounds. Most of these 2-stroke monsters burn either glow fuel or a gasoline/oil mixture. In fact, many of the engines used in large-scale planes are modified chain saw engines. Running a gas/oil mixture is popular because it's cheap and readily available. However, it's also more dangerous than glow fuel.

Ducted fanjet engines are growing

Source List

Here's a nationwide list of manufacturers and suppliers of radio-controlled kits, systems and accessories. Write for information regarding their line of R/C model aviation equipment.

- Ace RC, Box 511, Higginsville, MO 64037
- Airtronics, 11 Autry, Irvine, CA 92718
- Astro Flight, 13311 Beach Ave., Marina Del Rey, CA 90291
- Byron Originals, Box 279, Ida Grove, IA 51445
- Carl Goldberg Models, 4734 W. Chicago Ave., Chicago, IL 60651
- Cox Hobbies, 1525 E. Warner, Santa Ana, CA 92705
- Dura-Craft, 1007 Orchard Grove Dr., Royal Oak, MI 48067
- Fox Manufacturing, 5305 Towson Ave., Fort Smith, AR 72901
- Futaba, 555 W. Victoria, Compton, CA 90220
- Great Planes Manufacturing, Box 788, Urbana, IL 61801
- Hobby Lobby, 5614 Franklin Pike Circle, Brentwood, TN 37027
- Indy RC, 10620 N. College Ave., Indianapolis, IN 46280
- Kraft Midwest, 115 E. Main St., Northville, MI 48167
- Midwest Products, Box 564, Hobart, IN 46342
- Paul K. Guillow, Inc., Box 229, Wakefield, MA 01880
- Peck-Polymers, Box 2498, La Mesa, CA 92044
- Royal Products, Box 5026, Terminal Annex, Denver, CO 80217
- SIG Manufacturing, 401 S. Front St., Montezuma, IA 50171
- Top Flite Models, 2635 S. Wabash Ave., Chicago, IL 60616
- Tower Hobbies, Box 778, Champaign, IL 61820
- World Engines, 8960 Rossash Ave., Cincinnati, OH 45236



CHEVROLET LUMINA

A study in contrasts.

BY MICHAEL LAMM,
Contributing Editor

CHEVROLET SET its sights high when designing the Lumina as a 1990 model. The objective was to create a world-class vehicle in terms of customer features—things the owner comes in contact with in the car, things he can touch, see and smell. Chevy's idea was to take the collective features



gleaned from other cars and integrate them into a new car with a character all its own.

That's a tall order by any standards. And all too often, a car that seems destined for perfection on the drawing board has taken its lumps from corporate bean counters looking to trim production costs. Then again, design visionaries have little control over what actually happens to the car as it rolls down the assembly line.



So it's interesting to note how actual owners see the Lumina in light of Chevrolet's professed lofty world-class standards for the automobile.

Chevrolet appears to have done its homework in designing a car that's relatively trouble-free, if our survey of owners is any indication. Over 70 percent of Lumina owners indicated that the car gave them no mechanical problems. Chevy continues to shine in the dealer service area. Of those who drove back (or were towed back) to the dealership because they experienced mechanical difficulty, 77 percent indicated that the dealer was able to correct the problem on the first try.

The Lumina also gets high grades



Dash layout is clean, but gauges are small. The speedometer is especially difficult to read. Fuel-injected 3.1-liter V6 pulls strongly, but is noisy when pressed hard.



from owners in workmanship. Here, more Lumina owners rated the car as "good" (50.5 percent) than "excellent" (45.6 percent). But when you combine the ratings for a composite excellent/good score, the picture gets much rosier with the Lumina chalking up a 96.1

percent average. Lumina is a big car with room enough for six passengers. Riding on a 107.5-in. wheelbase, Chevy's version of the GM-10 platform is the largest front-wheel-drive Chevy ever produced. Big cars provide more interior room and usually

SUMMARY OF 1990 CHEVROLET LUMINA OWNERS REPORTS*

Total miles driven	1,507,837	Good handling	12.7	Average	3.9	No	23.0
Average miles per gallon:		Specific overall likes:		Poor	0.0	Dealer service opinion:	
With 2.5-liter Four		Exterior styling	53.0%	Comfort opinion:		Excellent	39.9%
In town	23.0	Handling	43.3	Front seats:		Good	44.4
On the highway	29.6	Riding qualities	34.7	Excellent	62.8%	Average	11.2
With 3.1-liter V6		Comfort	33.2	Good	32.2	Poor	4.5
In town	21.3	Power	22.0	Average	4.0	Number of vehicles owned:	
On the highway	28.2	Roominess	19.0	Poor	1.0	This car only	33.6%
Series chosen:		Specific dislikes:		Rear seats:		Two cars	36.8
Standard Lumina	58.4%	Rattles and noises	14.0%	Excellent	52.8%	Three cars	19.1
Lumina Euro	41.6	Glovebox too small	12.8	Good	40.6	Four or more cars	10.5
Body styles chosen:		No complaints	12.8	Average	5.6	Would you buy a Lumina again?	
4-door sedan	97.7%	Shoulder harness rubs neck	7.4	Poor	1.0	Yes	59.0%
2-door coupe	0.3	Front bench seat	6.2	Had any mechanical trouble?		Maybe	35.2
Engine selection:		Upholstery hard to clean	6.2	No	71.6%	No	5.8
3.1-liter V6	83.7%	What changes would you like?		Yes	28.4	Would you buy a Chevrolet product again next time?	
2.5-liter Four	16.3	No changes	26.2%	What type of trouble?		Maybe	64.2%
Major options chosen:		Bigger glovebox	15.2	Electrical system	23.5%	No	22.3
Air conditioning	99.3%	Greater silence	9.0	Rough shifts	14.1	Yes	13.6
Premium sound system	78.9	Reposition shoulder harness	6.6	Brakes	10.6	Principal driver:	
Power door locks	74.9	Make power seat available	5.3	Fuel injection	7.1	Female	49.0%
16-in. wheels	50.0	Buckets instead of bench seat	5.3	Power steering	7.1	Male	41.8
Why did you choose the Chevrolet Lumina?		How much did you pay?		Cold starts, balkiness	7.1	Equal	9.2
Styling	59.8%	Average	\$14,448	Did you repair it yourself?		Age distribution of owners:	
Roominess	19.2	Range	\$11,500-\$18,000	No	95.2%	Under 29 years	5.0%
Size	17.8	Workmanship opinion:		Yes	4.8	30-49	34.5
Price is right	13.0	Excellent	45.6%	Dealer repairs satisfactory?		50-plus	60.6
		Good	50.5	Yes	77.0%		

*Percentages might not equal 100 percent due to rounding or an insufficient amount of data.

are heavier—all the ingredients it seems that are needed for a very comfortable automobile.

Far from being an econo-stripper, Lumina comes with a host of standard features including 4-wheel power disc brakes, basecoat/clear-coat paint, 2-side galvanized body panels, full stainless-steel exhaust, wet-arm wipers and Scotchgard fabric protector on the upholstery.

But many Lumina owners felt that Chevy didn't go far enough with its comfort engineering, specifically when it came to the front seats. Only 62.8 percent of those surveyed gave the front seat an "excellent" rating. Some owners felt that the Lumina seats were too firm. Related complaints included criticism of the small glovebox and a problem with the shoulder harness rubbing on necks—a common complaint with many 1990 cars. Government safety regulations changed and so did shoulder harness pivot points.

As in most surveys we take, styling was still the primary reason for buying the car. Some owners noted that the Lumina came out late in the game in the area of aerostyling. As one owner put it, "Chevy has another winner, but why did they wait so long?"

Handling also came in for considerable praise, especially on snow and ice, where drivers agreed that front-wheel drive really comes into its own. And several owners volunteered that the Euro version corners as if mounted "on rails." Another area of solid satisfaction had to do with the Lumina's riding qualities.

Power and performance, especially with the 3.1-liter V6, pleased most purchasers, 22.0 percent citing that aspect of the Lumina as a specific like. Owners generally characterized the car as "economical and snappy."

Chevrolet reaped the benefits of a stronger Iron Duke 2.5-liter, fuel-injected 4-banger for the 1990 model year. Cylinder head and camshaft changes punched up horsepower an additional 12 percent to 110 at 5200 rpm. But the Lumina really wakes up when fitted with the new 3.1-liter V6 with multiport fuel injection. This engine delivers 135 horsepower at 4400 rpm, and comes standard in the Euro model and is optional in standard Lumina's.

The big question, the one that really asks owners to lay out their overall opinion on a car, remains: Would you buy this car again next time? A positive response by only 59.0 percent of the owners indicates that all is not well in Luminaland, despite high satisfaction with most of the specific areas we survey. **FM**



Styling strongly influenced Lumina buyers. Car has a pleasing aero shape and is more angular than its Taurus rival. Fit and finish received high marks.

EDITORS REPORT

Spice In Lumina's Life

BREAD-AND-BUTTER family transportation usually means boring cars with boring styling and boring performance. But Chevy's Lumina, with the Euro option (the car we evaluated), may not be perfect, but it's far from boring.

Take styling, for instance. The Euro version, with its optional 16-in. wheels, fat tires and full-deck rear spoiler reminiscent of those on earlier Pontiac Firebird models, gives the Lumina a real muscle look.

The muscle image is backed up by the car's 3.1-liter V6. While lacking some of the tire-shredding torque of a big-cube V8, the Lumina does feel its Wheaties when the stoplight turns green. But there's also a downside to the plucky engine, and that is noise. Punch the loud pedal into the carpeting and you really hear it. The volume of sound entering the passenger compartment might be acceptable for a sporty car, but may be inappropriate for a family hauler.

Handling is one area where the Lumina Euro excels. There is minimal body roll when pressed in the corners. The big rubber puts a serious footprint on the ground and it's used to good advantage. But the price of the Euro's strong handling is stiff ride qualities. We felt it to be too stiff. Suspension technology has come a long way since the days when the accepted wisdom was to use super stiff springs to nail the car to the pavement. We felt that Chevy engineers

could have done a better job in their damping and bushing calibrations. Of course, a base Lumina without the Euro option would have a whole different ride and handling profile.

Steering, compared to the Lumina Euro's good handling characteristics, comes up lacking. The ratio is quick and there's no slop in the rack or linkage. But the feel is stiff and not spot-on precise. There is not enough power assist at low speeds, and not enough road feedback comes through to the driver. Still, overall performance of the Euro is excellent. Its lack of torque steer, balanced handling and ability to perform aggressive maneuvers would make a Camaro IROC-Z pilot feel at home.

Inside, the ergonomics, for the most part, are very good. There's plenty of room, and entry and egress in our 2-door coupe was especially comfortable. Our biggest complaint here is the positioning of the climate control panel—square in the middle of the upper dash. Unless you've got long arms or like to drive with your seat so far forward that your nose leaves vapor marks on the inside of the windshield, you won't like it.

All the gauges are laid out very neatly, but are on the small side. The speedo with its crowded dial is especially difficult to read.

In spite of some shortcomings and details, the Lumina still will haul the family to its destination with alacrity and in style. —Cliff Gromer

TECHNOLOGY

REMINTED

Elvis is sounding better than ever. So are all the oldies but goodies whose music is being remastered for compact discs.

The Beatles, Dion, Elvis Presley and Louis Armstrong are just some of the artists benefiting from a digital remastering process that makes old music sound like it was recorded today. Clicks and pops are edited out of old recordings for clean-sounding compact disc releases. Digital remastering, although technically precise, is a very subjective art under the control of studio engineers.

BIX BEIDERBECKE, Fats Waller, Eddie Condon, Louis Armstrong and Cab Calloway are just some of the musicians whose names were on the tips of everyone's tongues during the 1920s and 1930s. Elvis Presley, Dion, James Brown, Ted Nugent and Miles Davis are more contemporary names, but they too have already carved out a place in music history.

All of these musicians shared a problem in that much of their work was deemed unlistenable by today's standards. The old records and tapes produced by these artists couldn't

stand the ravages of time. Old 78-rpm records are a bygone medium and recording tape is subject to a 20-year lifespan. Loud clicks and pops were accompanied by background noise on these recordings that made you feel like you were in a snake pit. So while these artists were still loved, their music wasn't recorded using today's technical wizardry.

Digital technology, fortunately, is exhuming the work of past masters for transfer to compact disc. The transfer process is anything but simple, however. If you've ever dubbed a record onto a cassette, you know that proper recording levels and equalization must be set and the type of noise reduction to be used must be considered as well. These types of decisions—but on a more complex level involving many more electronic components—must also be made when music is transferred from old records and tapes to compact discs. The big problem is that the small imperfections on these old recordings become enor-

mously magnified on compact disc due to the expanded dynamic range of CDs. Complicating matters further is the fact that portions of the music are often missing. The pops and clicks on 78-rpm records effectively mask the music affected, while on tape, the magnetic particles holding the musical information may have literally fallen off. The good news, of course, is that once the music has been put on CD, any deterioration process has been halted.

Modern audio restoration owes much to the pioneer work of a small band of like-minded individuals who began working with old classical and jazz 78-rpm recordings. The techniques employed by these early experimenters bordered on the primitive. England's John R.T. Davies and his American colleague, Jack Towers, worked on jazz restoration projects for the Smithsonian Institute and other institutions using a hand-built device that amplified the imperfections of a 78-rpm record. The record would

GOLD

BY FRANK VIZARD,
Electronics Editor



REMINTED GOLD

first be recorded on tape. The tape would be slowly fed through a hand-built device whose key component was a tape playback head connected to a microphone. The microphone's output was fed into a speaker. When a click was heard, a pin would automatically mark the location on the tape. Davies or Towers would then use a degaussed razor blade or knife to literally etch out the offending passage.

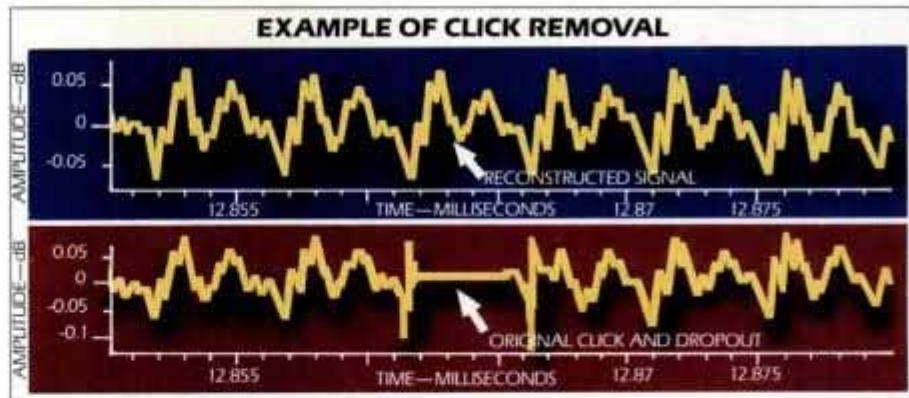
While the work of many early audio restorers like Davies and Towers were in the academic interests of historical accuracy, Australian Robert Parker's efforts have a more distinctly commercial approach. Mobile Fidelity Sound Labs is releasing much of Parker's work in a series of compact discs labeled *Jazz Classics In Digital Stereo*. The series includes three compilations of New York, Chicago and New Orleans jazz, as well as entire discs devoted to artists like Fats Waller and Louis Armstrong.

Parker's source material is a collection of over 8000 78-rpm records accumulated during the course of a lifetime as a jazz fan, engineer and broadcaster. A friend of both Davies and Towers, Parker knew that in the days of 78-rpm recording, the studio walls were treated as nonreflective surfaces and that the 3-dimensional spread of the instruments was squeezed into a single point. Dynamics were routinely crushed to minimize the perception of the surface noise inherent in the 78-rpm record.

Hidden music

Parker also knew that recording and playback technology was out of kilter in the sense that more information was being recorded than could be played back with the existing hardware. Modern styli are able to play back this "lost" information. By extracting and remixing this information from 78-rpm records, Parker was able to make the old masters sound acceptable to modern ears. The process of audio restoration, though, was still laborious and time-consuming.

Things changed in 1978. An experimental digital editing technique was developed by Thomas G. Stockham Jr. and used by RCA in an LP release of



The lower waveform shows a musical gap in a 1968 song caused by a faulty microphone cable. The upper waveform shows the music as reconstructed by a Sonic Solutions computer system.

The Complete Caruso. Electronic manufacturers soon developed their own digital editing systems and Parker quickly married his existing equipment to a Sony digital editing system. Analog musical information could now be converted to a series of zeros and ones that could be easily and precisely manipulated. The introduction of the compact disc provided the medium onto which the dynamic range present on 78-rpm records could be restored.

While Parker and others concerned themselves with old 78-rpm recordings, the major record labels realized that digital editing techniques could be applied to tape as well. Engineers like Rick Rowe at RCA, Dennis Drake at Polygram, Toby Mountain at Rounder and Bill Inglot at Arista began to take an interest in the audio restoration of tape recordings made decades ago. Within the past few years, the work of these engineers and others has come to read like a hit list for a generation. Releases include a James Brown collection, *The CD Of JB*; The Velvet Underground's *White Light/Heat*; two albums by The Monkees; a greatest hits collection by Ted Nugent and the Amboy Dukes; and another greatest hits collection by Elvis Presley, as well as Presley's early *Sun Sessions* and later, *The Memphis Record*.

The Beatles, of course, have benefited from digital remastering, as the digital editing process is often called, on the CD reissues of their albums. Columbia, meanwhile, has created the *Columbia Jazz Masterpieces* series to reissue the work of artists like Miles Davis, Thelonious Monk, Billie Holiday and many others. Time-Life is ambitiously releasing 27 remastered CDs chronicling the rock-and-roll era from 1954 to 1964.

Other releases include the work of Ella Fitzgerald, Duke Ellington and the remastered soundtrack to "Hair." Most of the work being done in audio restoration at this point involves pop-

ular and jazz music. Fewer classical titles have been remastered up to this point since the initial recordings were likely to be more technically pristine and because popular and jazz releases are considered more commercially viable.

The engineers at the large record companies often have access to musical material stored within their companies' vaults. At times, this material can include the original copper master plates used to produce 78-rpm records. Playback of these old masters is done using a 2-tip stylus shaped like an inverted V that straddles a ridge instead of a record groove.

Many old metal masters were donated to the war effort during World War II so engineers more often than not find themselves working with actual records, as far as older material is concerned. Tape, however, is the medium most worked with by record company engineers.

The search for Elvis

Tape, while seemingly a more convenient and modern format to work with than 78-rpm records, often presents unimagined difficulties. While master tapes generally exist, the earliest source is not always the cleanest. Tape begins to deteriorate after 20 years and the process can be accelerated by poor storage—therefore, a later copy of the master may sound better. The master tape may also have been overused, particularly in the days when LP records were assembled from the masters of singles. Engineers often try to assemble as many copies and outtakes as possible in the hope that any problems can be solved by editing in an identical passage from the copy or outtake.

Record companies and studios occasionally err in their record keeping as well. RCA's Rick Rowe, who is developing a reputation as a witch doctor able to sonically resurrect what's long been given up for dead, discov-

(Please turn to page 126)



Kitchen Remodeling

A wealth of tips and techniques for improving any kitchen without completely disrupting your life.



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PM PHOTOS BY JOHN GREBSCH



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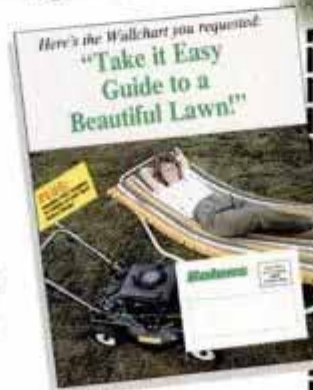
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Kitchen Remodeling

How to do it yourself on a sensible schedule.

BY NEAL BARRETT



THERE'S NO QUESTION that a new kitchen is a compelling dream for most of us. And with good reason. It's the room where we all spend a great deal of quality time, whether preparing meals or socializing with family and friends. And, it's one of the few rooms in the house that

actually has to *work*. An inefficient kitchen can drive even the most patient to distraction.

But wanting a new kitchen and getting one are two different things. These days even a modest kitchen remodeling can eat up \$8000 and a full-blown approach with a bumped-out

addition, new designer cabinets and countertops, high-end appliances and other costly amenities can run into the neighborhood of \$40,000. And that's a pretty expensive neighborhood to be in no matter how much you get back at resale.

Of course the cost—no matter what it is—can be budgeted sensibly. But the inconvenience is another matter altogether. Doing without a properly functioning kitchen for any length of time could discourage anyone from tackling the job. This is especially true if you want to do most or all of the work yourself. A couple of weeks can easily lead to a couple of months and beyond until you reach the point you wonder if you'll ever be done.

A better idea

In the finished kitchen you see here, and in the stories that follow, we have tried to make some headway through the troubled waters of kitchen remodeling. Our goal was not simply to create a spectacular room. You can see great-looking kitchens in any number of showrooms, books and other magazines. Instead, we wanted to create something dramatic while still being sensitive to the very real problems of cost and inconvenience.

In this guide, you'll find a host of kitchen remodeling ideas. Some are major and will require a good deal of effort, time and money to accomplish. Other ideas are smaller in scope and could be put to good use in any kitchen, even if you don't want to undertake the major work we did here. But all these ideas have two things in common. First, we were trying to get the biggest bang for our remodeling buck. For instance, instead of replacing our cabinets, we gave them an extensive facelift at a fraction of the cost. Of course, this work *is* labor intensive. But being willing to put out the effort

Source List

Floor Tile:

■ Quest 6 × 6 Juniper Blue and 2 × 2 Almond unglazed quarry tile from American Olean Tile Co., 1000 Cannon Ave., Lansdale, PA 19446

Appliances:

■ Wall oven (No. W130W), cooktop (No. CCS446W), microwave oven (No. M436W), dishwasher (No. DU588W), disposer (No. GC430), and refrigerator (No. JRS202W) from Jenn-Air Co., 3035 Shadeland, Indianapolis, IN 46226

Cabinet Storage Systems:

■ Keije Cabinet Organizers from Clairson International, 720 S.W. 17th St., Ocala, FL 32674

Sink And Faucet:

■ Sculptura sink (No. DCGR-3322-R-W) and Calais faucet (No. LK-4200-F-WH) from Elkay Manufacturing Co., 2222 Camden Court, Oak Brook, IL 60521

Countertop Appliances:

■ Cordless mixer (No. 9210), stand mixer (No. SM100), blender (No. HB15), combination can opener and knife sharpener (No. PEC90), and coffee maker (No. PDC403A) from Black & Decker, Inc., Household Products Group, 6 Armstrong Rd., Shelton, CT 06284



is, and always has been, the essence of sweat equity.

The other thing these ideas have in common is that they were designed so that each could be completed in a minimum amount of time, in most cases within a single weekend. And we scheduled them in such a way so that you could continue to use your kitchen throughout the entire remodeling job. When each is completed, it's a simple matter to return your kitchen to work until you are prepared to move onto the next project. This way, you can enjoy the full benefits of your sweat equity without totally disrupting your life. And you can extend the length of the entire project more comfortably, if that suits your purposes.

A different approach

Because of the way we organized this job, some of the projects will be handled in a different order than would normally be the case. If you hired contractors, they would begin by dismantling the room. Then they would make any electrical improvements that were necessary and follow this up by installing the new cabinets, countertops, appliances and flooring.



The starting point for our projects was a typical suburban kitchen (circa 1970) that we built just for these stories. It featured dark cabinets and flooring, dated appliances and made no allowance for a microwave or recycling chores without sacrificing existing space.

We, of course, omitted the demolition stage and began with a general discussion of the new electrical improvements you should consider on any kitchen remodeling job. If you are confident of your electrical abilities, then this should give you a good road map to follow. If not, this story will help you explain to your electrician what you want done. Then we explain how to give your cabinets the facelift that was mentioned before. These stories include how to install clever storage systems to get the most out of the space you have and how to add plenty of undercabinet lighting to

make your kitchen work more enjoyable. We also show you how to easily build a kitchen island from stock cabinet parts. It's even outfitted with two pull-out trash bins to make recycling chores much easier.

We also explore how to remove old appliances, install new ones, and how to finish up the room by adding a beautiful quarry tile floor. And, we rounded out the guide with two straightforward consumer pieces. The first discusses buying strategies for major kitchen appliances, and the second offers tips on where to find the money for all the work that you are doing.

If you want to proceed along the same lines we did, then make sure to read the entire guide first. This will help you understand clearly how to undertake such an extensive project and still be able to use your kitchen throughout the job. And, you may find that you can change the project order to suit your purposes better and still have a warm meal just about every night.

At any rate, we do hope that what we've shown here will help you take a few giant steps toward the kitchen of your dreams. **PM**



Even though we didn't replace our cabinets, we did give them quite a facelift. First the interiors were all painted, then modular storage systems were installed, new doors and drawer fronts were attached, and the latest countertop material was added throughout. We also updated the room with an easy-to-build island (left), made of stock base cabinets and standard raised panel doors. And, we outfitted the island with two pull-out trash bins to make recycling more convenient.

PM PHOTO BY NEAL BARRETT

PM PHOTO BY JOHN GREBSCH

Electrical Update

How to meet the electrical needs of a new kitchen.

BY MERLE HENKENIUS

ONE OF THE serious limitations of most older kitchens is their shortage of electrical outlets and, ultimately, electrical circuitry. The builders of these homes could not have anticipated the proliferation of electrical appliances and gadgets that are standard in today's kitchens. Nor could they have ever guessed that such staple appliances as refrigerators would grow to demand so great a share of existing electrical service. Furthermore, building codes have changed in recent years, making electrical access safer and more convenient. All of this points in an obvious direction. If you're contemplating a kitchen upgrade, electrical improvements should be high on your list of priorities.

Meeting codes and needs

To begin, let's differentiate between code requirements and use requirements. All electrical codes are locally specific, but each is based on the National Electrical Code. We'll use the NEC guidelines here, but keep in mind that local codes may be more demanding. Remember, too, that codes establish minimum standards. In some cases, you'll want to exceed those standards and tailor an electrical system to your particular needs.

As for minimum requirements, every kitchen needs at least two 20-amp, 120-volt appliance circuits. These circuits must be separate from overhead lighting circuits. As for placement of receptacles, you can apply two standards in a kitchen—one for the cabinet space and another for the remaining walls.

The NEC stipulates that every counter space of 12 in. or more must have a receptacle. Typically, this regulation applies to the narrow cabinets commonly placed between a range and refrigerator.

Additionally, you'll need a receptacle every 4 ft. along a counter wall, beginning not more than 24 in. from either end of the countertop. All receptacles within 6 ft. of a kitchen sink must also be ground-fault protected. Ground-fault circuit interrupters



PHOTO BY JOHN GREBSCH

(GFCIs) will protect you from the hazards of electricity around water. Should a small appliance fall into a sink full of water, the flow of current would be interrupted instantly.

GFCI protection can be obtained in one of two ways. You can install a GFCI breaker in the panel, giving protection to every receptacle connected to that breaker. Or, you can install a GFCI receptacle in the first outlet on the circuit approaching the sink. In that case, all outlets following the GFCI receptacle are protected.

As for the remaining walls, you'll need one receptacle behind the refrigerator and at least one within each 12-ft. span of uninterrupted wall space. In addition, you'll need one receptacle within 6 ft. of each door and one on any wall 2 ft. long, or longer. If you'll have an appliance cabinet, such as a rolltop mixing station, you'll need a receptacle within the cabinet, even if there is already one nearby.

With the growing number of small appliances available to us, it's probably a good idea to underrate your kitchen circuits. For example, because refrigerators now require greater amperage, a separate circuit dedicated to the refrigerator is a good idea. Likewise, if you see yourself doing most of your food preparation at a

specific location, additional outlets in that area will be a good investment, one every 2 ft., for example. And don't forget about specialty outlets. If you would like a 120-volt kitchen clock, have a recessed outlet installed on one of the kitchen walls. In that way, the cord can be concealed.

Keep in mind that one 20-amp circuit, using 12/2 with ground cable, will safely support 11 receptacles elsewhere in the kitchen, but only eight along the countertop. More may be allowed in some areas, but don't push the limit.

This will also be a good opportunity to install nonappliance-related wiring. If you like to watch the evening news while cooking dinner, have a cable-TV line and recessed box installed. Likewise, new telephone wiring is best run within the walls.

Lighting options

As mentioned earlier, lighting circuits must be separate from appliance circuits. In most cases, they'll be part of a general lighting circuit, serving other areas of your home. When planning for new kitchen lights, keep in mind that lighting circuits generally have less capacity than appliance circuits. They are typically wired with 14-gauge cable and 15-amp breakers,

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giving you only nine outlets per circuit. Count the existing lights in your home, relative to the number of existing circuits (one is common), and plan for a new circuit, from the service panel, if existing circuits are already near capacity.

Choosing fixtures

If choosing recessed lighting fixtures, insist on zero-clearance lamp canisters, to avoid excess heat, and more complicated wiring within the ceiling joists. Flush-mounted fluorescent fixtures, which are also recessed, produce much less heat, but you'll still need to keep attic insulation away from the lamp cabinets.

Aside from these precautions, the rest is a matter of stylistic preference. Just remember, most kitchens are used for more than cooking and eating. Kitchen tables, for example, host everything from board games to bookkeeping. It's probably the light that draws us, so plan for plenty of it.

How it's installed

Unless you are very confident in your electrical abilities, it's a good idea to leave major work to a licensed electrician. He or she will determine the best approach to your wiring needs. But it does help to have some idea how the work will proceed to make your job scheduling easier.

Typically, new circuit cables will be brought into kitchen walls from below. This will be done by drilling up into a stud space from the basement. The cable will then be pulled through a new box opening in the wall and a cut-in box will be installed in the opening. If cables need to be run overhead, as for a ceiling light, another hole will be drilled in the top plate of the wall, providing access from the attic.

If more than one outlet is to be added in horizontal sequence along a wall, your electrician will likely cut out a section of drywall and drill through each stud to the location of the final outlet. Then, as many boxes as are needed will be mounted.

While cutting out drywall may seem a radical move, it's not. Wall repair is easy and inexpensive, while the labor costs for an electrician to enter each stud space from the basement—one at a time—can be substantial. The same is true of ceiling repair, if the kitchen supports a second story. There are methods and materials available for damage-free retrofits, but in a major kitchen remodel, it will almost always be better and cheaper to cut the drywall. The outlet boxes will be more secure, and you'll have them just where you want them. **PM**

Room Preparation

How to get off on the right foot.

BY NEAL BARRETT

IN JUST ABOUT every kitchen, the cabinets are the focus of your remodeling efforts. And many times, the first thing people think of is replacing the existing cabinets with new ones. But before pulling out your checkbook and investing a sum that may be staggering, it's worthwhile to investigate other possibilities—namely, painting or resurfacing your existing cabinets.

In the past few years, cabinet resurfacing has become a popular option for achieving a new look. Whether the job is hired out or done by the homeowner, the results can be dramatic and come at a fraction of the cost of new cabinets. Resurfacing materials can be either plastic laminate or wood veneer, both of which give you an extremely broad range of color and texture choices.

But by far, the easiest and least expensive option is to paint the cabinets. Combining a good color choice with the use of a premium quality paint can result in a transformation that is dazzling. An additional option is to replace the cabinet doors and drawer fronts. This is the route we chose, and we show you how to do it in the story that begins on page 111.

Of course, our room preparations were organized with the complete scope of the project in mind. If you undertake only selected improvements, omit any steps which are irrelevant to your plan. The total amount of working time for our cabinet preparation



1 Empty all the cabinet contents and temporarily store them. Then remove drawers and take off doors and hinges together.



2 To remove existing drawer front, either unscrew the front from the drawer box or pry it off if it's stapled to the box.



3 If drawer front was attached with staples, clip off staples as close to drawer box as possible. Then file them flush to surface.



4 If you want to install wire storage racks, existing shelves may be in the way. To remove, just cut with sabre saw and pull out.



5 If you plan to remove countertop, take advantage of empty cabinet to remove screws that hold counter to corner blocks.

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



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was about 15 hours, excluding drying time for the paint. So, you should be able to get it done in a couple of days.

Where to begin

Before beginning work, carefully lay out a complete plan on paper. By thoughtful organization, you can avoid inconvenient and wasteful duplication of procedures, and make the work run as smoothly as possible.

If you need to update the electrical service—including room lighting and supply lines for undercabinet lighting—now is the time to have that work done. (See our preceding story, "Electrical Update," page 89.) If you don't feel comfortable doing the work yourself, hire a licensed electrician to do the job. Try to anticipate any changes in appliances which would require new electrical service so that the work can be completed in just one visit.

Cleaning out

Empty all cabinets of stored items. Remove any shelf paper or cabinet lining and clean the cabinets thoroughly. Remove the doors by unscrewing hinges at the face frame (Photo 1), and if you intend to reuse either the doors or the hinges, remove the hinges from the doors and set them aside.

Remove the drawers from cabinets and, if you plan to replace faces, detach the existing face from drawer box. If the face is screwed onto the box, merely remove the screws and drawer pull, if present, to free the face. If the face is stapled to the box, you'll have to pry the face free. Use a flat pry bar to carefully loosen the face, working gradually from all sides (Photo 2). When the face is removed, clip the protruding staple ends (Photo 3), and file them flush to the drawer box front. To permit use of the drawers while the work continues in the kitchen, install temporary drawer pulls—made from screw-in eyelets—to the drawer box front.

If you plan to outfit the cabinets with storage systems like we did, you may have to remove some existing built-in shelves. Cut through the shelves with a sabre saw (Photo 4), and pull the halves from the dados in both case sides. If you plan to replace the countertops, take advantage of empty base cabinets, and remove the screws that hold the countertop to the cabinets (Photo 5). The weight of the counters will hold them in place for short-term use.

Fill any holes or scratches in the cabinet face frames and exposed sides with wood filler (Photo 6). When the

filler has dried, sand the cabinets thoroughly with 120- and 220-grit sandpaper to smooth the surfaces and promote good adhesion between the old and new finishes (Photo 7).

Painting

It has, in the past, been assumed that for the best results only oil-based paints should be used. However, developments in latex technology over recent years have resulted in products with excellent appearance and durability. When you consider this, along with the current concerns over exposure to the toxic solvents commonly found in oil-based paints, and latex's ease of application and clean-up, you almost have to conclude that latex is the paint to use.

Start by applying primer to all cabinet surfaces, as well as any walls, ceilings and other surfaces you want to be painted. Let the primer dry thoroughly, then lightly sand the cabinet surfaces with 220-grit sandpaper to ensure a smooth finish. Apply at least two coats of a high-quality semigloss enamel to the walls and ceiling, and either a semigloss or full-gloss enamel to the cabinets. Carefully follow the manufacturer's directions for the best results. **PM**



6 If you plan to paint the cabinets, fill all holes, nicks and scratches with wood filler. Push filler in place with putty knife.



7 Thoroughly sand cabinets with 120-grit followed by 220-grit sandpaper for a smooth surface and good paint adhesion.

Wire Storage Racks

How to install these great space savers.

BY NEAL BARRETT

IT SEEMS THAT storage space is always in short supply around the kitchen. And even the space that does exist is often poorly organized or difficult to use. Canned goods are stacked in pyramids. Pots and pans are piled in the furthest reaches of base cabinets. And corner cabinets often become repositories for things that are never used, if only because they are so hard to reach. Fortunately, there is a good solution to many of these storage problems.

Within recent years, cabinet organizing hardware has become available in any number of retail outlets. Before, these cleverly designed items were supplied only to cabinet manufacturers. This provided a strong motivation for replacing your existing cabinets with new ones that featured these well-designed storage systems. For our project, we used Keije Cabinet organizers, made by the same people who build Closet-Maid storage hardware.

The catalog of Keije items is extremely comprehensive, providing solutions for almost any storage problem. Some of the units for wall cabinets include rotating spice shelves, slide-out dry food storage bins and wire racks that mount on the cabinet doors.

The choices for base cabinets are even more varied: pull-out trash bag holders, trolleys (for cleaning supplies), cabinet organizers, lid racks, quarter-turn pull-out shelves for corner cabinets and lazy Susan shelves. Various sizes and configurations of each item are offered.

It's best to decide what units you want to use before beginning any cabinet-prep work. In this way, you can make allowance for the units, if necessary, by removing fixed cabinet shelves.

Once you've decided on the units, carefully comparison shop and then make your purchases. Be sure to check for any missing hardware and carefully read the manufacturer's instructions beforehand. By doing this,



1 To install slide-out trash bag holder, position manufacturer's template on cabinet floor and mark screw hole locations.



2 Prebore pilot holes, then mount trash holder roller brackets to cabinet floor using screws provided. Tighten screws securely.



3 Assemble trash holder basket according to instructions and then slide assembly onto brackets. Place bag inside basket.

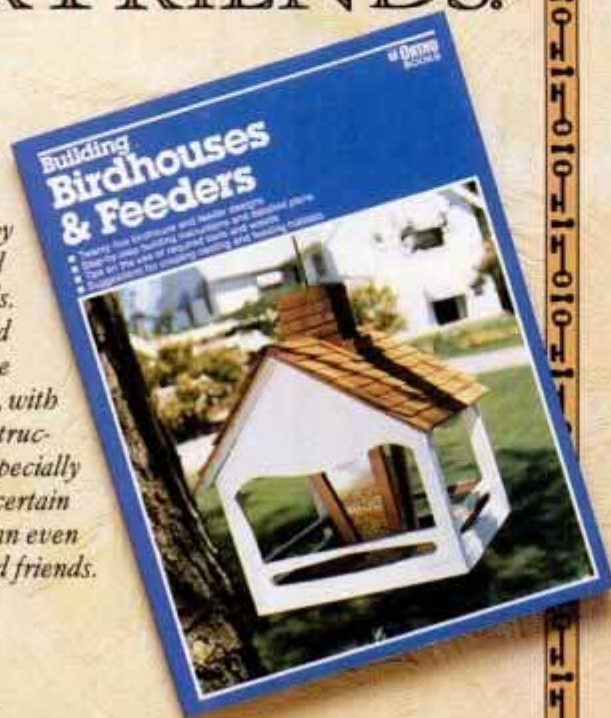


4 Quarter-turn shelves are great for corner cabinets. To install, prebore pilot holes, then screw brackets to edge of face frame.

Lead photo: John Griebusch
Step-by-step photos: Neal Barrett

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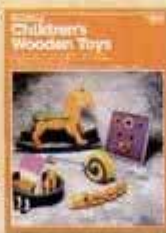
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you'll be as prepared as possible, with all the proper tools at hand.

If you work in an organized and determined manner, you should be able to remove all the cabinet contents, remove the doors and drawer fronts, prime and paint the cabinet interiors, and install the storage systems in one weekend. Once you're done, just replace the cabinet contents so the kitchen can function, and wait until later to install your new doors and drawer fronts.

Basic installation procedures for wire storage racks are shown in the photos. Installation time ranges anywhere from 5 minutes to 30 minutes, depending on the unit. **PM**



5 Lift bottom shelf over bracket, lower pivots into bracket holes and repeat for upper shelf. Shelves will pivot and slide out.



6 To install pull-out trolley hardware, mark screw locations with template. Then prebore pilot holes and attach roller track.



7 Assemble pull-out trolley, then slide it into track. Trolley can simply be pulled out to carry cleaning supplies around house.

Easy Kitchen Island

How to build an island from stock cabinet parts.

BY NEAL BARRETT

ADEQUATE kitchen counter space always seems to be in short supply, whether you need a spot for newly purchased groceries, a place to roll out the pastry dough or an empty space to hold the dirty dishes from a dinner party. In many homes, the only solution to this problem is to expand the kitchen area, which is certainly a major project. However, in some cases there is adequate floor space to add a work island to your kitchen layout which will provide not only new counter space, but added storage space as well.

As a general rule of thumb, you'll want at least 3 ft. of floor space around the entire perimeter of the island. In most cases, less than 3 ft. of clearance will make working in the kitchen too awkward. Also, it's a good idea to use our size (2 x 3 ft.) as a minimum island requirement. Anything smaller won't add that much storage or counter space to the kitchen and could easily look foolish.

To determine if an island makes sense in your kitchen, you should draw up a scaled floor plan. Include on this plan the proper swing direction of all appliance and cabinet doors. And note how far each projects into the room when open. Then draw a 2 x 3-ft. rectangle in the middle of the room and check for clearance all the way around. If you have extra room, you can enlarge the island if you want. Once you are satisfied with your plan, double-check your layout by transferring it to your kitchen floor using



masking tape to indicate the island's position.

We had enough room in our kitchen to build a small island. And we decided to outfit it with two roll-out trash bins. By doing so, the island became a recycling center of sorts, allowing for convenient separation of disposable and recyclable waste.

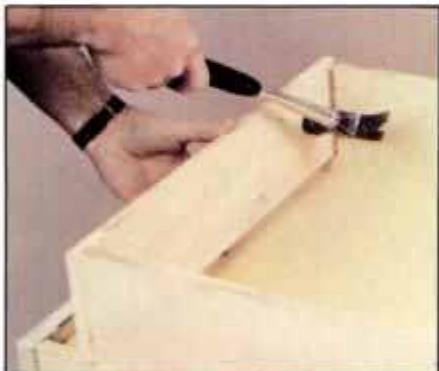
Island options

One option for building an island is to start from scratch, with plywood and lumber, which is a considerable task.

A second option is to make use of stock cabinets, available from a lumberyard, home center or cabinet dealer. This choice was the one we picked, and since we were repainting the existing cabinets, we chose inexpensive, unfinished cabinets for our island.

In general, readily available base cabinets range in size from 12 in. to 36 in. wide x 24 in. deep. Wider units,

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



1 Remove door and drawer from stock cabinet, then turn over cabinet. Using a hammer, drive toe kickboard off cabinet.



2 To create toe kick on sides of cabinet, lay cabinet on its side and mark toe kick line on side. Cut off waste with sabre saw.



3 To join two cabinets, clamp front face frames together, prebore and countersink pilot holes. Then attach with screws.

most often used as sink base cabinets, are sometimes available as stock items, and could be adapted for use as an island. These sink base cabinets, however, come with false drawer fronts instead of functional drawers, thereby eliminating valuable storage space from your finished island.

We decided to build our 36-in.-wide \times 24-in.-deep island by joining two 18-in.-wide cases. Since we were ordering new doors and drawer fronts for the kitchen, we added enough door and drawer panels for the island as well. In addition, we chose to finish the sides and back of the island with panels which would match the cabinet doors.

If you want to do the same thing as we did, be sure to purchase the island cabinets before placing your door order to establish the exact panel sizes you'll need.

You should construct the island entirely in your basement or garage, and install it only when appropriate in the remodeling schedule. By doing so, you'll avoid any kitchen down time. This island can be completed in about 10 hours of working time, excluding the countertop.

Construction

To create an island from stock cabinets, you must create a toe-kick space around the entire island, instead of on only one side which is how your stock cabinets will come. Begin by removing the doors, drawers and existing toe-kick facing panels from cabinets. The toe-kick panels are usually held on with staples or nails and should come off easily (Photo 1). Mark a line on case sides indicating the top of the toe-kick, and cut case sides to this mark with a sabre saw (Photo 2). Remove the waste.

To join cases, temporarily clamp the cabinets together at their face frames, making sure that you have them perfectly aligned. Bore pilot holes through the face frames (Photo 3), and screw them together. Screw the cabinets together through the case sides as well (Photo 4), adding spacer blocks between the sides to keep the island assembly square if the face frames overhang the sides, which is usually the case.

Attach a $\frac{3}{4}$ -in. plywood panel to the back side of the island, by screwing through the case backs (Photo 5). This panel should be exactly the same dimension as the newly combined face frame on the island front side. In positioning the panel, make sure that it overhangs the case sides the same amount as the front face frames.

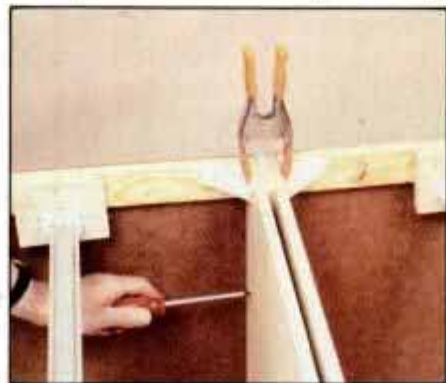
Then, attach strips at the top and bottom edges of both of the island sides to furr out the sides flush to the edges of the front face frame and rear panel (Photo 6). These will provide a firm attachment for facing panels that will come later.

Construct a new toe-kick for the island using $\frac{1}{2}$ -in.- or $\frac{3}{4}$ -in.-thick plywood. Miter the corners, and fasten them together with glue and 4d finishing nails (Photo 7). Then take this toe-kick assembly and center it on the bottom of the island. Cut and install corner gussets along top edge of toe-kick using glue and 4d finishing nails. Then, attach the toe-kick by screwing

through gussets into island bottom (Photo 8). Set and fill any nail holes in toe-kick.

Attach facing panels to sides and back of island by screwing through the case (Photo 9). Also, install the new doors and drawer fronts at this time, using the instructions starting on page 111 as a guide.

Finally, prime and paint the island to match the rest of the kitchen cabinets, and leave the island in the garage or basement until time comes for installation. You should build the island countertop at the same time you build the other countertops. (See our story that begins on page 102.) **PM**



4 Join sides with screws driven through rear cabinet corners. Use spacer block between cabinets to keep assembly square.



5 Cut $\frac{3}{4}$ -in. plywood back to same size as front face frame. Clamp in place and attach with screws driven through cabinet back.



6 If back panel and face frame extend beyond sides, nail strips—cut to same thickness as space—to top and bottom of sides.



7 Construct new toe-kick assembly using $\frac{1}{2}$ -in. or $\frac{3}{4}$ -in. plywood. Miter corners, apply glue and join with finishing nails.



8 Cut corner gussets to size and glue to toe-kick assembly. Then center assembly on island bottom and attach with screws.



9 Order back and side panels from door and drawer front company. Then, attach by driving screws from inside the cabinet.

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Undercabinet Lighting

How to put more light where you need it.

BY NEAL BARRETT

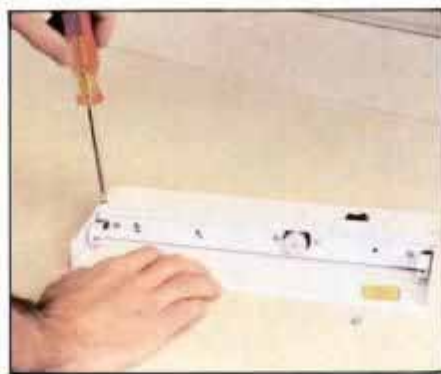
ONE OF THE great pleasures of a well-designed kitchen, or any work area for that matter, is adequate lighting. There are few things more frustrating than working where the lighting isn't up to the task being done. Even when the general kitchen lighting is adequate, too often a person working at a counter is forced to proceed in his or her own shadow. There is a relatively simple solution, namely mounting lighting fixtures underneath the wall cabinets to directly illuminate the countertops.

There are specialized fixtures designed for just this application. For our project, we chose low-profile fluorescent fixtures by Alkco (11500 W. Mellrose Ave., Box 1389, Franklin Park, IL 60131). These lights use miniature tubes (F8T5 and F13T5) and give excellent illumination. And, each fixture comes with its own built-in switch, so you have the option of controlling the light from the fixture or from a wall switch. The lights are available in various lengths to fit standard cabinet widths.

Discuss with your electrician the location of fixtures, wiring requirements and details of any switches you may desire. You should have the feed lines run at the time other electrical work for the room is being done. Just make sure that the circuit is not tied into the main service panel until you have the fixtures wired.

Installation

Assuming that the feed lines are already in place, installing these fixtures should take about 30 minutes each. Begin by removing the plastic diffuser and wireway cover from each unit (Photo 1). Then, install the cable connector (supplied with the fixture) in the knock-out opening (Photo 2). Then, feed the supply lines into the fixture, and mount the housing under



1 Remove plastic diffuser cover from fixture. Remove screws at both ends that hold wireway in place and set wireway aside.



2 Determine most convenient location for entry of cables and remove knock-out plate. Install cable connector in hole.



3 Strip off sheathing from cables and feed wires through connector. Locate fixture on cabinet, bore pilot holes and attach.



4 Cut and strip 6-in. pigtail wires, and join white wires together and black wires together using proper size Wire-Nuts.

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett

a cabinet with two screws (Photo 3). Connect 6-in. pigtail wires to the lead wires (Photo 4). Then, join the black fixture lead to the black pigtail and the white fixture lead to the white pigtail (Photo 5).

Connect the ground wire to the housing ground lug. Be sure that all Wire-Nuts are secure and that no loose strands of wire are left exposed. Tuck the wires neatly into the housing and replace the wireway with the screws provided (Photo 6). Install the fluorescent tube (Photo 7), and replace the plastic diffuser.

When all fixtures have been installed, have the circuit connected at the main panel box. **PM**



5 Locate leads in wireway. Then attach black lead to black pigtail and white lead to white pigtail using Wire-Nuts.



6 Carefully fold wires into wireway, then slide wireway into fixture. Align mounting holes and drive screws securely in place.



7 Push fluorescent tube into fixture brackets. Then replace plastic light diffuser. Turn on power and check for proper operation.

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Old Fixtures

How to remove the old to make way for the new.

TEXT AND PHOTOS
BY NEAL BARRETT

IF YOU HAVE included the replacement of your appliances and countertop in your kitchen plans, careful planning can limit the inconvenience caused by changing these major components. Of course, the amount of time your kitchen will remain tied-up depends on the specific choices you've made. If, for example, you are replacing a slide-in stove with one of a similar design and size, you can make the transition in less than an hour. However, if you are replacing a slide-in unit with a built-in or drop-in configuration, the cabinet and countertop modifications will require a longer period of disruption.

In any case, if you are replacing the countertops, the sink will have to be temporarily disconnected and removed, leaving the kitchen without water and counters for a time.

The best strategy is to be completely prepared for the new installations before you remove the old items. Be sure to have all new appliances either on hand or scheduled for delivery at the appropriate time.

If you are having a new countertop fabricated by a contractor, or if you plan to build it yourself, be sure that it's ready to install before you demolish the existing one. If you're going the contractor route, confirm the scheduling of their installation as the date approaches, and try, as well, to determine the length of time they'll need to complete the work. Also, make sure to establish the entire



1 To remove range hood, first shut off circuit power. Then, using a screwdriver, remove the hood's junction box cover.



2 Disconnect all electrical connections and loosen cable connector. Support hood, then remove screws that hold it in place.



3 To remove dishwasher, begin by loosening clamp that holds drain hose to sink tailpiece or to disposer. Pull off drain hose.



4 Remove screws that hold access panel in place. They were accessible from inside of our unit, once the door was opened.



5 Remove access panel and lower trim panel (shown) to get to the electrical and plumbing connections underneath unit.

scope of the contractor's responsibility on the job, for instance, are sink and cooktop cutouts included in the price, and will the old counters be removed from the job site?

Removing appliances

Begin by moving the refrigerator to an adjacent room, where it can be plugged in and remain reasonably accessible for a few days. Most refrigerators have casters built into the unit base for easy movement. Even so, it's a good idea to protect floors and carpets by rolling the appliance over some heavy cardboard.

Next, pull out and disconnect the old stove. If the unit is electric, mere-

ly unplug it. If the stove is a gas model, there should be a shutoff valve directly behind the stove. Turn off the gas supply to the stove, and check for complete shutoff by trying to ignite the burners. Then, disconnect the gas line and remove the unit.

In our kitchen, we replaced the exhaust hood over the stove with a combination microwave oven and exhaust hood unit. To remove the existing hood, begin by shutting off the circuit power to the unit. Then, open the junction box on the underside of the hood (Photo 1), and disconnect the supply lines and ground connection (Photo 2).

Loosen the screws that hold the

hood to the cabinet above, and lower the unit far enough to gain access to the cable connector. Loosen the screw which anchors the connector, and pull the cable out of the hood. (Since our new appliance was a plug-in model, we had the old supply line rewired into an outlet box inside the cabinet above.)

Before beginning to remove the dishwasher, shut off the water supply to the unit. Then loosen the hose clamp that holds the drain line to the sink drain tailpiece (Photo 3), and pull off the drain hose from the fitting. Next, loosen the screws that hold the dishwasher access panel in place (Photo 4), and remove the panel and trim piece (Photo 5).

Shut off the circuit power to the unit, and disconnect the electrical supply lines at dishwasher junction box (Photo 6). Then pull the supply cable out of the box. Use an adjustable wrench to disconnect the water supply line from the dishwasher, and remove the screws that attach the dishwasher to the countertop (Photo 7). You can now pull the dishwasher out of its opening. Keep in mind that you must feed the drain hose through the adjoining cabinet side as you remove the unit.

Removing the sink

To remove the sink, use a pipe wrench to loosen the compression fitting between the sink tailpiece and the trap (Photo 8). Then, disconnect the slip-joint fitting between the trap and drain, and remove the trap. Loosen the compression fittings between the water lines and sink supply lines (Photo 9). Unscrew the sink hold-down clamps from the underside of the countertop (Photo 10), then run a thin putty knife around the sink rim to free it from the countertop. Lift out the sink and set it aside.

In our cabinet preparation story (page 91), we showed how to remove the screws that hold the countertops to the cabinets. If you haven't removed these screws, do so now. At this point, the countertop can be removed. Often, however, kitchen counters are so large that taking them out in one piece is either impossible, or extremely unwieldy. If this is the case on your job, you can simply cut the top into smaller, more manageable pieces. Slide scrap blocks of 2x2 lumber between the counter and cabinets, and use a circular saw with carbide-tipped blade to cut across the counter (Photo 11). Be sure that the counter is adequately supported so that the saw blade does not bind in the cut.



6 Shut off circuit power to unit and disconnect all electrical leads. Then shut off water supply and disconnect supply line.



7 Remove screws that hold dishwasher to underside of countertop. Then pull unit—with drain hose—away from cabinet.



8 To remove sink, loosen nut between tailpiece and trap using pipe wrench or pliers. Pull trap away from tailpiece.



9 Shut off water at meter if necessary, and loosen compression fittings between water feed lines and sink supply lines.



10 Using a wrench, remove sink hold-down clamps that bear on countertop. Run putty knife under sink rim to free up sink.



11 If countertop is too large to remove in one piece, support it on scrap blocks, then cut into pieces with carbide blade.

High-Tech Countertop

How to build a new countertop with the latest material.

BY NEAL BARRETT

IN ITS MOST basic form, the kitchen is a workroom. And as such, the countertop is the workbench—the primary component on which all other operations depend. But the countertop functions on another level as well. Because of its scale and position in the room, it defines one of the primary decorative elements in any kitchen design.

The choice of materials available for countertops is vast. The time-honored selections of plastic laminate, wooden butcher-block, ceramic tile and stone have been joined in recent years by the new solid surfacing materials. These new products, made from either an acrylic or polyester base, have a stone-like appearance and are easily machinable.

When properly joined, using the methods outlined by the manufacturers, these materials give a virtually seamless appearance, creating a very dramatic effect. And, these countertops wear extremely well. These materials are resistant to stains, and any scratches or nicks which might occur can be removed easily with fine sandpaper.

Keep in mind that such innovations are not available at bargain prices. Solid surfacing materials are definitely a premium product, and they command a premium price. The material cost for our project was almost \$2000. If we hired a contractor, the installed



price would have been at least \$3000. Despite the high cost, we chose to use one of these materials, Avonite's Green Mist, for our counters, because the results can be so spectacular.

While you may find these materials available in unfabricated form, the manufacturer's general marketing strategy is to make them available only through fabricators trained in proper construction techniques by factory representatives. Having been instructed in the Avonite program, we did build the counters in our own

shop. But as it stands now, if you want to work with this material, you'll have to contact a local Avonite dealer, take his or her course and proceed in the manner shown here. Or, you'll have to hire a fabricator.

Working with this material is a rather messy process, generating a lot of dust and toxic fumes from the seaming substance. So, if you hire a fabricator, arrange to have as much

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



1 Begin countertop by laying out and cutting substrate material to fit. Leave 1/8-in. space around perimeter of each sheet.



2 Lay out counter openings on substrate according to manufacturer's specifications. Carefully make cutouts with sabre saw.



3 Once satisfied with fit of substrate, remove it and nail 1x4 support strips to top of cabinets. Then screw substrate to strips.

work as possible completed in the shop. Also, discuss precise schedule deadlines to determine the amount of disruption you can reasonably expect.

The Avonite most commonly used for countertops is 1/2 in. thick and comes in 3 x 10-ft. sheets. The material is heavy, having about the same weight per square foot as industrial grade particleboard.

Techniques

The first step in constructing the countertops is to lay out and fit a solid 3/4-in.-thick particleboard substrate over the entire counter area (Photo 1). When fitting these panels, a 1/8-in. space must be left at the walls and at the front edge of cabinets, for expansion and air circulation. Next, the cut-out areas for sink and cooktop are located and cut in the substrate material (Photo 2). These cutouts act as a template for making the final cutouts in the countertop material later.

Since the edge treatment we wanted was going to raise the countertop 1 1/2 in. above the cabinets, allowance was made for this thickness by removing the substrate and applying a series of 1x4 spacer strips along the tops of the cabinets (Photo 3).

The manufacturer says that seams should not be located at the corners of the countertop. Since the sheets come

in a 36 in. width, and our counter was only 26 in. deep, we cut the corner sheets to an L-shape and offset the seams 10 in. from the corners (Photo 4). To make cuts, you'll need a router and a 1/2-in. carbide-tipped bit. The router is guided with a straightedge guide, clamped firmly to the workpiece.

The seams are also machined by running a router along a straightedge guide. And, registration at the seams is achieved by one of two methods. The first is clear plastic joining plates, available from Avonite suppliers, that are used along the seams in the same manner as wood plates are used in biscuit joinery.

A second method, and the one we used (Photo 5), is a router and bit system from Porter-Cable called the Tru-Match System, model No. 692, that was specifically designed for joining solid surfacing materials. This system consists of a router with an oversized base and a special router bit that machines an interlocking wavy profile on each of the adjoining edges. The system is generally available for about \$200.

When the seams are all machined and fitted properly, the pieces are brought into the kitchen and checked for fit in place (Photo 6). Any adjustments are easier to accomplish before

the seams are permanently joined. Once satisfied with the fit, the pieces are returned to the workshop to fabricate the edge buildup.

The substance used for bonding Avonite is called *fusion material*, and is activated by the addition of a catalyst. The pieces that create the edge buildup are cut, sanded smooth, dusted off and wiped with alcohol just prior to joining. The catalyzed fusion material is spread on the mating parts, and then spring clamps are placed approximately every 2 in. along the joint until the bond sets, which takes at least 2 hours (Photo 7). Because of the complexity of the edge buildup on our counter, the process took place in a series of steps—bonding, routing and more bonding. We used a 1/2-in.-radius rounding-over bit to machine the counter edge, both top and bottom. This yielded a 1-in.-bullnose profile. A stepped buildup was added behind the bullnose to create a more classical feel to the design.

When the buildup was complete, the counters were returned to the kitchen for seaming. Each piece was attached to the substrate with dabs of clear silicone (Photo 8). Wax paper was placed underneath each seam to prevent the Avonite from bonding—at these points—to the substrate.

(Please turn to page 126)



4 For a U-shaped counter, do not make joints at corners. Instead, clamp L-shaped guide to surface and cut returns on ends.



5 Cut seams with Tru-Match routing system. System produces wavy cut that is self-aligning and nearly invisible.



6 Once seam is cut, slide mating sheets onto cabinets and check for fit. If fit is tight, then cut other end of sheet to length.



7 Underedge of countertop can be built-up to create different designs. Just join strips to top with fusion material.



8 Join counters to substrate with dabs of silicone adhesive. Place wax paper under seams to keep seam area from bonding.



9 Temporarily attach clamping blocks to mating surfaces. Then apply fusion material and draw seam closed. Let dry for 2 hours.

New Appliances

How to buy major kitchen appliances.

BY MERLE HENKENIUS

WHEN REMODELING a kitchen, the finishing touch is all-new appliances. You'll find, however, that the selection process is not as simple as it once was. Competition is stiff, and is played out in tit-for-tat announcements of *new-and-improved* features. The appliance industry has endured a dizzying shell game of buy outs and takeovers, resulting in extreme consolidation. In fact, all the domestic brand names you'll encounter are now owned by just five companies.

So how to proceed? As always, ignore the boardroom maneuvering and concentrate on the product. It's still a matter of matching features to life-style and, of course, budget. Here are a few considerations to keep in mind as you stroll down the appliance isle, commissioned salesperson in tow.

Kitchen Ranges

If you have a choice of gas or electric, but no clear preference, here are some differences you may wish to consider in making a decision.

The primary advantage of gas is its immediate response and visual confirmation of heat levels. Gas ranges also work in power outages. Tests indicate more uniform oven temperatures, which will be important to those who do a lot of baking. Many newer gas ranges also feature convenient waist-level broilers.

In addition, fickle gas pilots have been largely replaced by electric spark igniters, which offer further energy savings. Some also feature electronic controls and digital temperature readouts. And finally, a gas range is usually less expensive to operate than a comparable electric model. Operating costs will vary widely with regional energy prices, of course, but a gas range could easily be 20-30 percent less expensive to use.

Electric ranges offer a cleaner cooking method and are generally more reliable, requiring less routine maintenance. More electric models are available with self-cleaning ovens, as well. While available in both electric and gas, self-cleaning ovens are generally more effective in elec-



PHOTO BY JOHN GREBSCH

tric models. While electric ranges fall behind slightly in oven performance, they excel in broiler performance, with a uniform distribution of heat.

Electric ranges lend themselves more easily to design variations, hence, you'll find a greater variety of options on electric models. Chief among these is a rapidly expanding choice in burner styles and sizes. Resistance coils are still the most popular, with ceramic- or metallic-coated cast-iron burners gaining somewhat. Cast-iron burners are slower, however, and require flat-bottomed pans for best results.

Also available are cooktops without visible burners. These smooth-top glass or ceramic surfaces contain heating elements just below the surface. Their real value, of course, is that they are very easy to clean. The disadvantage is that they offer no visual confirmation of when a burner is on. This, combined with the fact that they are slow to cool, makes it much easier to accidentally burn yourself. Smooth-tops are also slower in response time than surface coils.

Convenience factors

The key to convenience in ranges is ease of cleaning. This may include lift-up or removable cooktops, removable oven doors, coated oven racks, easy-to-clean burner drip bowls or elements, and self-cleaning or continuous cleaning ovens.

The advantages of lift-up cooktops, removable doors and nonstick coatings are obvious. Of course, self-cleaning ovens have an automatic appeal. No one wants that job. Still, the process is not perfect, and it will add \$50-\$100 to the price of a range. In simplest terms, self-cleaning is accomplished by extreme heat. With temperatures reaching 900°, spills and splatters are literally vaporized and vented through the back of the stove. In most cases, you'll still need to clean the door frame manually. Ranges with self-cleaning ovens are also slightly less reliable.

Continuous cleaning ovens do not use extreme heat, but rely on baking temperatures and a textured surface to loosen oven grime. This method is less effective.

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Model	Sensitivity, dBm/μm ²	
	X-band	K-band
BEL Vector 3	117.2	115.6
Audison RM 4	104.1	93.9
Cincinnati Microwave Escort	112.9	106.8
Cincinnati Microwave Passport	114.1	107.8
Coobra Translocator RD 3170	113.4	110.9
Fulton IS-9000		
Snooper G-4000	109.4	106.8
Kraaco KRD 16	102.7	104.7
Mascof PR-022	101.5	94.6
Maxon RD 25	109.3	106.8
Radio Shack Minimax		
Road Patrol MK	107.6	106.0
Uniden HD90AL	113.1	108.8
Welder Spectrum 2	115.6	110.4
Average unit	110.1	106.3

Source: Road & Track, Nov. 1988
BEL VECTOR 3 is the only unit in this test that also detects Ka band radar.

The Technology Leader In 3 Band Radar Detection.



BEL-TRONICS LIMITED
The Intelligent Choice



(Continued from page 104)

Little things, like an oven handle that runs the full length of the door, a bright control-panel light, oven door windows, control knobs that are not concealed by tall stock pots on a rear burner, are all small comforts that make a big difference to some, and none at all to others.

A few upscale ranges also feature down-draft grills and modular, plug-in griddles. Others include overhead microwave ovens. The grill and griddle are clearly lifestyle choices. The disadvantage of grills that are drafted outdoors is that they also pull air from your home. If you've just heated or cooled that air, a grill can harbor a hidden expense. As for integral microwaves, they can save valuable counter space, and can be perfect for kitchen remodeling projects.

Refrigerators

Refrigerators too have grown in capacity, features, and, yes, in price. In fact, you'll find the sticker prices of the new *super-fridges* to be quite chilling. The upside of this evolution is that today's models use 40 percent less energy than early 1970's models.

Even if you were to opt for a much larger size, your new refrigerator is likely to use less energy than your old avocado-colored clunker.

Deciding on the right size refrigerator and a style that suits you and your kitchen is the most important part of the selection process. The most popular model is still the top freezer, bottom refrigerator model. It requires only slight stooping to reach the most often used items, while frozen foods are handy at eye level.

Single door units do not have true freezers and are generally not adequate for families. Side-by-side models work well in narrow, galley kitchens where a full-size door swing will obstruct traffic. Side-by-sides are generally less efficient, owing to less insulation between fridge and freezer, but they do put more food, both frozen and unfrozen, at eye-level.

What size will you need? The best indicator will be your experience with your old unit. If you don't have enough space, upsize. Otherwise, buy a similar or smaller size. If your household is increasing or decreasing in number, or appetite, that too

should be factored in. Keep in mind that smaller units of comparable quality will use less energy.

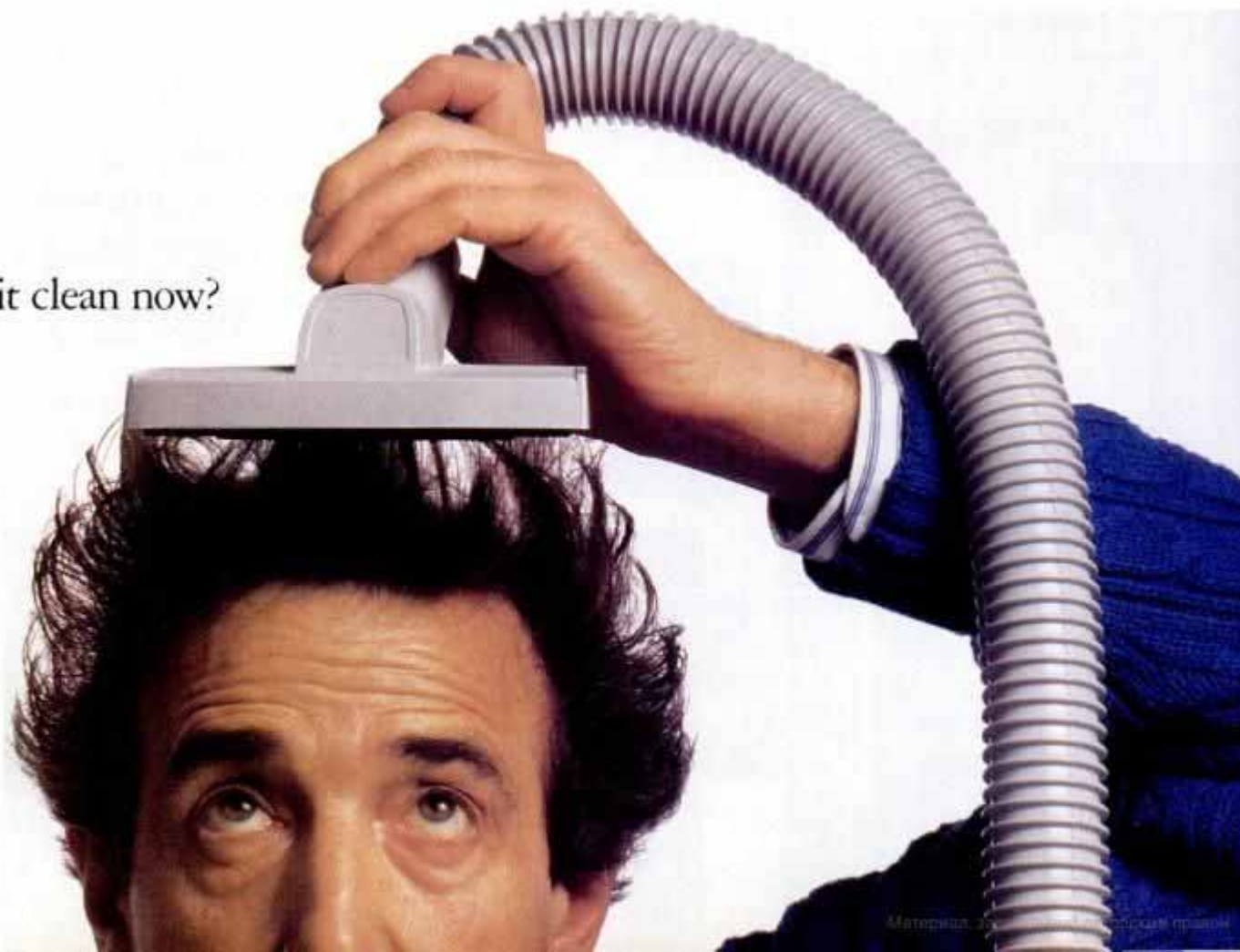
Generally speaking, a family of two will need 8 cu. ft. of refrigerator storage, with one extra foot for each additional family member. Lifestyle factors should also come into play. If you buy groceries in large quantities or freeze your own garden vegetables, then a larger unit is in order.

Structural considerations

If you look at enough refrigerators in a row, your eyes will sort of glaze over and you'll fall prey to the sales pitch. A better method is to look for specifics and rate each offering accordingly.

To begin, note the compressor capacity. As the compressor is the heart of every refrigerator, it should be efficient, big enough and, ideally, quiet. Your best indicator will be found on the unit's yellow energy label. The more efficient the compressor, the more excess capacity it will likely have. Also, have the unit plugged in. Compressor noise levels vary. A noisy compressor does not necessarily signal poor quality, but you'll need

Is it clean now?



to decide if the noise level is too high to ignore on a daily basis.

Another important feature will be the inner lining. Will it stand up to 15-20 years of use and abuse? While ABS and PVC plastic were once the norm, some new models feature polystyrene plastic. Polystyrene is superior in its resistance to staining and cracking.

Insulation is another sure-fire signature of quality and efficiency. While polyurethane has replaced fiberglass batt insulation in refrigerator walls, fiberglass or slab-foam insulation can still be found in doors. Polyurethane-filled doors are far superior, offering not only better insulation but a more rigid door. This helps make for a better seal when the door is closed. As a perfect door seal is critical, also check for solid plate-steel or die-cast hinges. These will offer the best durability through thousands of swings. The door seal material should also be fastened in place with metal strips.

Aside from these considerations, notice how easily the meat keeper and crisper drawers slide. Keep in mind that sticky operation on the showroom floor will worsen with time,

weight and cold temperatures. Avoid, if you can, plastic door glides. Opt for those with rollers that allow little side-to-side movement.

Warranties are generally better on refrigerators than on ranges. Some components, such as the compressor, may be warranted for five years. Of course, extended warranties are also available at the retail level.

Dishwashers

When it comes to selecting an automatic dishwasher, you'll encounter far fewer options and much less confusion. Performance is everything in a dishwasher, however, so buy the best your budget will allow.

The most important factor is the number of wash levels. Single-level units often leave spots and do little to wash stubborn food particles from dishes and utensils. These are often builder's-grade models and should probably be avoided.

Look for a unit that has at least two levels of spray action, one at the bottom and another near the top. These will give reasonably good results at a fair price. For the best results, how-

ever, choose a 3-level spray-action model. These shoot water from several directions and, as a result, require less rinsing of dishes before loading.

Another useful feature is a booster heater that raises water temperature. This will improve washing results and save money by allowing you to turn down your water heater.

And, you might opt for an energy cycle on the control panel. This allows you to wash a lightly soiled load with less hot water. It also offers a rinse-and-hold cycle, so that a few dishes at a time can be added to the machine, rinsed and held, until a full load can be run. A pots-and-pans cycle and no-heat drying are also available.

Finally, you'll find quite a range in dishwasher warranties. One-year parts and labor is standard, but some top-of-the-line models come with a 3-year parts warranty and five years on the pump motor.

Disposers

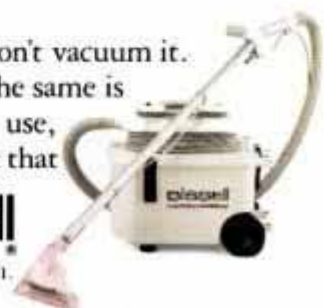
When shopping for a disposer, try for a unit with at least a ½-hp motor. Beyond that, upscale models will feature

(Please turn to page 125)

Of course not. When your hair needs cleaning you don't vacuum it. Because to really get it clean you need soap and water. The same is true for carpets and upholstery. The compact, easy to use, Bissell Power Steamer cleans deep down. So it gets at dirt that vacuums can't. And makes all the things you live on, a lot easier to live with.

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Sink, Disposer And Dishwasher

How to install the cleanup equipment.

BY NEAL BARRETT

ONCE YOUR countertops are installed, move as quickly as possible to restore the kitchen to a functional status. To provide water once again, install the sink, dishwasher and garbage disposer unit first. Assuming all necessary parts are on hand, it is reasonable to expect that these units can be installed completely in less than 8 hours.

Sink And Disposer

Regardless of what sink you choose to install, it greatly simplifies the task to mount as much hardware as possible on the sink before locating it in the countertop (Photos 1-5). If you are using your old sink, much of this will already be in place. If you choose a new one, like we did, be sure to follow carefully the instructions included with the hardware.

Once all the hardware is in place, run a bead of plumber's putty around the sink rim and lower the sink into the cutout in the countertop. Use the bolts provided with the sink to fasten it firmly to the countertop, then clean up any excess putty which squeezes from under the rim.

Connect the electrical leads from the disposer to the wires in the power cable (Photo 6). Then, position the disposer on its mounting ring and rotate the clamp to hold the unit in place (Photo 7). Wait until the drain lines are connected before locking the clamp tightly.

In our installation, it was most convenient to connect the disposer drain line to a tee just above the sink trap. Once this was in place, we installed the trap and reconnected the sink drain line (Photo 8).

You can also design your waste plumbing so that each separate sink compartment has its own trap. If you go this route, then just connect the disposer drain line to the closest sink



1 If you want a disposer, attach its mounting ring to sink before installing sink. Follow manufacturer's specific instructions.



2 To install strainer basket, apply putty to basket flange, then slide flange into sink hole. Place washer and cup over basket.



3 Thread retaining nut onto basket and tighten securely against cup. Turn over sink and wipe away putty squeeze-out.



4 Attach sink tailpiece to basket with nut tightened securely in place. Tailpiece can be cut to length for drain alignment.

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett

tailpiece. Once the waste line assembly is together, be sure to completely tighten the disposer mounting clamp. Then, finish your sink installation by attaching your faucet supply lines to the compression fittings on the feed line shutoff valves (Photo 9).

Dishwasher

Because of the location of our dishwasher, we had to install its trim kit before we could slide the dishwasher in place. In most situations, however, you can do this later. (See "Appliance Trim Kits," page 116.)

Begin installation by removing the dishwasher access panel and sliding the dishwasher into position. Be sure

to feed the drain hose through an appropriate hole in the adjoining cabinet side. Ultimately, the drain hose will be connected to a drain port on the side of the disposer.

Adjust the unit to proper height—following manufacturer's instructions—then level it using the adjusting screws that are accessible from the front of the unit. Feed the electrical supply line into the junction box, fasten with a cable connector (Photo 10), and make the electrical connections (Photo 11). Be sure to properly ground the unit by attaching ground wire to the lug that's provided inside the box.

Connect the water supply line to

the dishwasher using the fittings stipulated by the manufacturer (Photo 12). Then, install the screws that fasten the dishwasher to the underside edge of the countertop (Photo 13). Keep in mind that with solid surfacing countertops, the screws should be placed into the substrate and not into the counter material.

Connect the dishwasher drain hose to the disposer unit. If you're installing a new disposer, you'll have to clear the plug in the disposer port first. Once everything is installed, turn on the circuit power to the disposer and dishwasher. Then, turn on the water supply, and check for proper performance of all components. **PM**



5 Install faucet by sliding through sink opening and tightening with retaining nut. Follow manufacturer's directions.



6 Remove disposer access panel and knockout plate. Install connector and power cable. Join wires with Wire-Nuts.



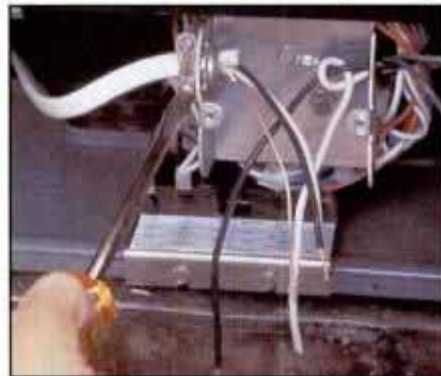
7 Lift disposer onto sink mounting ring, then rotate ring to clamp unit in place. Align drain connections before tightening.



8 Join disposer to waste line with proper tee. Then add trap to waste line and tail-piece. Tighten disposer ring securely.



9 Cut faucet supply lines to proper length and slide ends into compression fittings on water supply shutoff valves. Tighten nuts.



10 Slide dishwasher into cabinet opening and level in place. Remove junction box cover, install cable and cable connector.



11 Connect ground wire to lug provided, then connect unit leads to feed wires. Whites together, blacks together.



12 Connect water supply line to inlet valve with fittings recommended by manufacturer. Attach drain hose to disposer.



13 Attach upper corners of dishwasher to underside of counter with screws driven up into substrate, not countertop material.

Oven, Cooktop And Microwave

How to install the cooking equipment.

BY NEAL BARRETT

BY THIS TIME, you've probably spent longer than you'd like without having a hot, home-cooked meal. Now is the time to return full function to your kitchen. On this job, we replaced all of the cooking appliances. By combining a built-in, under-the-counter oven with a drop-in cooktop, we achieved a truly custom-designed look. And, by adding a combination microwave oven and exhaust hood to our cooking center, we provided the latest in convenience options. If you have all the required wiring in place for these units, installation can be expected to take approximately 4 to 6 hours.

Since we replaced a slide-in stove with a built-in oven, some modifications had to be made to the cabinetry. To support the oven, 3-in.-wide cleats were attached to the adjacent cabinet sides (Photo 1). And, a bottom face rail was added by nailing it into these cleats (Photo 2). A new toe kick facing panel was installed to finish enclosing the area (Photo 3). We also had to provide a new junction box—for cooktop and oven hookup—to replace our existing stove outlet. If you plan to do what we did, have your electrician supply this box when the rest of the electrical system is being updated.

Lead photo: John Griesch
Step-by-step photos: Neal Barrett



1 To modify cabinet space to receive built-in oven, glue and screw 3-in.-wide wood cleats to cabinet sides to support oven.



Installation

To install the oven, slide it part way into the cabinet and make the electrical connections in the new junction box (Photo 4). Then, push it all the way into the case and fasten it to the face frame on both sides with the screws provided (Photo 5).

To install the cooktop, line its cutout with nonconductive aluminum

tape (Photo 6). And, apply the foam tape provided with the unit to the bottom edge of the cooktop. Position the cooktop next to the cutout, and make the electrical connections in the junction box. Then, gently lower the unit into the cutout.

Attach the microwave oven mounting plate to the wall above the cooktop

(Please turn to page 125)



2 Cut bottom rail to match size of existing cabinet rails. Then, attach to oven support cleats with glue and finishing nails.



3 Install toe kickboard—made of 1/4-in.-thick plywood—on adjacent cabinets to span oven cabinet opening. Nail in place.

New Doors And Drawer Fronts

How to update old cabinets instead of buying new ones.

BY NEAL BARRETT

AS MENTIONED earlier, we decided to replace our existing cabinet doors and drawer fronts with new ones of a different style. This job is extremely straightforward, if the new components are ordered from one of the many companies that specialize in these cabinet parts. One such company that we recommend is the Porta-Door Co., Inc., 65 Cogwheel Lane, Seymour, CT 06483. On request, they will forward a catalog and ordering information. The selection of styles includes over 30 different designs. But before placing an order, be sure to thoroughly read their instructions so you will receive the proper sizes.

When the doors and drawer fronts arrive, check that the sizes are correct. Then, prime and paint these components to match the cabinets. Take the time to do a high-quality job, because the doors and drawer fronts are the most visible aspect of your cabinetry.

Lay out the hinge position on each door, then prebore pilot holes and install the hinges (Photo 1). You can use a spacer block to help locate the hinge position on the cabinet face frames (Photo 2). Again, bore pilot holes (Photo 3), then install the doors.

(Please turn to page 132)

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



3 Remove door and bore pilot holes into cabinet stile. Lift door back into place and attach by driving screws into stile.



4 Glass panel doors come without glass. Buy glass panes and install with stops provided. Attach stops with 1/2-in. brads.



5 To install new drawer fronts, temporarily clamp front to drawer box. Carefully bore pilot holes and attach with screws.

Tip-Out Compartments

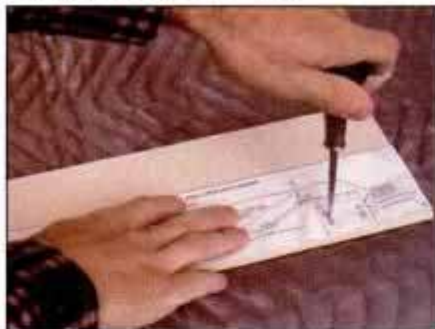
How to get sponges and cleaning pads out of view.

BY NEAL BARRETT

IT IS ALWAYS a pleasure to find a simple solution to a small, but irritating, problem. In this case, the problem was finding a place to store unsightly sponges and scrub-pads, and the solution came from an easily installed set of tip-out trays. We put one behind both false drawer fronts in our sink cabinet. There are several manufacturers of this type of hardware. We chose Amerock's version, which is readily available through retail hardware outlets.

Most false fronts are lightly glued in place and can be easily removed by running a putty knife around them. Complete directions are included with the units, and installation for each takes less than 1 hour. **PM**

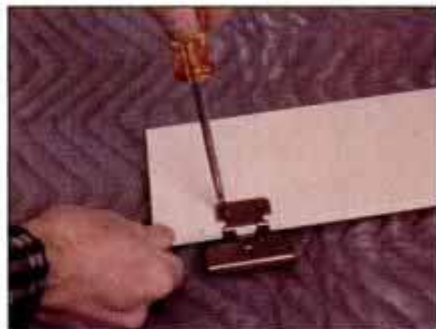
Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



1 Remove false drawer front and paint if necessary. Align template provided by manufacturer and locate hinge screwholes.



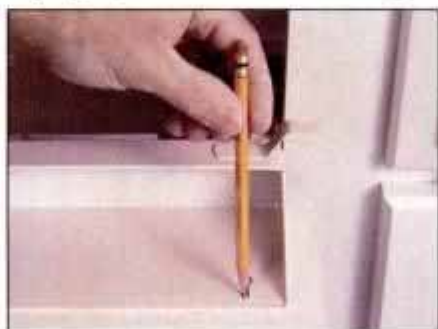
2 Bore pilot holes in back of false front. Wrap masking tape around bit, to act as depth gauge, so bit won't break through.



3 Hinges are surface mounted and require no mortise. Just position on false front so holes align. Then attach with screws.



4 Hook hinge rail leaves over top edge of cabinet rail. Then center false front on face frame opening and bore screw pilot holes.



5 Attach front with screws. Center compartment on back side. Mark position of retaining screws. Remove and bore holes.



6 Install retaining screws, then slide compartment in place so side wings fall behind face frame. Push over screwheads.

Floor Preparation

How to pave the way for floor tile.

BY NEAL BARRETT

REGARDLESS OF the material selected for a new floor, it must rest on a properly prepared underlayment. The amount and nature of the preparation will depend on the condition of the existing floor. A new vinyl tile floor, for example, requires only a 1/8-in.- or 1/4-in.-thick underlayment. A ceramic tile floor, however, may require up to a 3/4-in.-thick underlayment, if the existing floor is not adequate. Be sure to check specific requirements with your flooring dealer.

Because our subfloor was extremely heavy, we used 1/4-in.-thick exterior grade underlayment for our tile floor. Install the underlayment with 4d ring-shanked nails driven in a 4- to 6-in.-square pattern across each sheet. Leave 1/8-in.-wide expansion joints between the sheets.

Once the underlayment is in place, mark the position of the newly constructed island on the floor. Trace a second line inside and parallel to the first, a distance equal to the thickness of the toekick material. Then, nail cleats along this inside line and lower the island over the cleats to anchor its position. The weight of the island should keep it from moving once it's in place. If you have young children who'll be playing in the kitchen, you can attach the island to the cleats by driving finishing nails through the toekick. Installing the underlayment should take less than 1 hour per sheet.

PM

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett.



3 Once all panels are in place, mark outline of island. Then subtract thickness of island toekick and mark second set of lines.



1 To install underlayment, remove shoe molding from cabinets and baseboards. Undamaged molding can be reused.



4 Cut 2 x 2 stock to size and nail to floor along inside edge of second set of lines. Cleats will keep island from moving.



2 Cut underlayment panels to size and install with 4d ring-shank nails. Leave 1/8-in.-wide expansion joints between panels.



5 Lower assembled island over cleats. Island weight should keep it from moving, or if you prefer, attach it with finishing nails.

Tile Floor

How to put down a premium product.

BY NEAL BARRETT

IF YOU ARE thinking about installing a new floor to complete your kitchen remodeling, you'll be confronted with a long list of choices. Beginning with vinyl sheet goods or vinyl tile, the field expands to include both cork and rubber tiles, glazed and unglazed ceramic tiles, hardwood strips and parquet, slate, marble and even granite. Each choice has its advantages and disadvantages. So, shop carefully before you make your decision.

In our kitchen, we used a new unglazed quarry tile from American Olean Tile's Quest line. While quarry tile has long been the floor of choice in restaurant kitchens, with the addition of new color choices, they can add a wonderful decorative touch to residential kitchens as well.

We chose 6 × 6-in. Juniper Blue tile, with an accent strip of 2 × 2-in. Almond tiles running around the perimeter of the room. We also decided to use gray-colored grout for all the joint lines.

But these days, about the only thing that limits your choice in tile is your own imagination. So many different colors, textures and patterns are available. And different colored grouts give you even more design choices. For this job, we opted for a fairly straightforward floor pattern. But it's an easy matter to create a much more involved border and the field tiles can be broken up into many different mosaics.

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



3 Mix tile adhesive or cement according to manufacturer's directions. Our product had to stand for 10 minutes before being used.



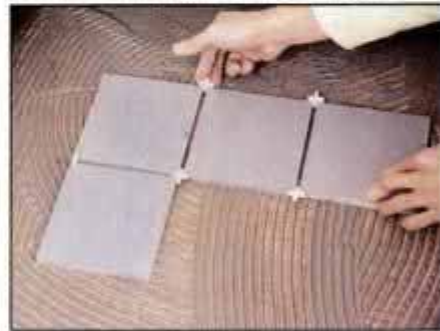
1 Determine tile layout by placing tiles across both length and width of room. Balance size of perimeter tiles that must be cut.



2 Mark position of first tile, then snap chalklines through marks in both directions. Chalklines must form 90° angle.



4 Apply adhesive to underlayment using notched trowel. Hold trowel at 45° angle and fill expansion joints as you go.



5 Lay first course of tile along chalkline, which will be visible through adhesive. Use plastic spacers for consistent alignment.

Layout

In order to establish the tile layout lines, set out tiles across both the length and width of the room, allowing for proper joint spacing (Photo 1). Then, balance the layout, so that there will be equal size tiles along opposing walls. Mark the floor at the edges of a tile, one or two courses in from the perimeter.

Snap a chalkline, parallel to one wall, through one mark. Then snap another chalkline perpendicular to the first, through the second mark, to indicate the edges of the first course of tile (Photo 2).



6 Once the main field of tile is laid, you can add border tiles of different size or color to create interest. We used 2 x 2-in. tile.



7 Cut tiles to size on tile cutter. Just score surface with arm and snap off. Tool works best when cutline is near center of tile.



10 Remove excess grout as you work by holding trowel at 45° angle. Less grout left on surface makes cleaning up easier.

Next, mix the tile adhesive according to directions on the container (Photo 3). The cement we used needed to rest or slake for 10 minutes, then it's remixed before using. Apply the cement to the floor using a $\frac{1}{4} \times \frac{1}{4}$ -in. notched trowel, holding the tool at a 45° angle to the floor (Photo 4). Fill any expansion joints in the underlayment with cement as you come to them. Then, lay the first course of tiles along the chalkline (Photo 5). Inexpensive plastic spacers are available from your tile suppliers, to help you align the tiles with uniform joints. Then add the border tiles (Photo 6), and finish laying full tiles that will fit beyond the border.

Most tile supply houses will either loan or rent tile-cutting equipment when you purchase tile. Straight cuts near the center of the tile are easily made by scoring with the tile cutter, and snapping on the score-line (Photo 7). Irregular cuts, or straight cuts near an edge, must be made with a tile nibbler (Photo 8).

Grouting

After the tile has set for at least 24 hours, you can grout the joints. Mix the grout with water, according to the package instructions, and let it set for 10 minutes before using.



8 For irregular-shaped cuts—or straight cuts near edge—use tile nibblers. Remove small chunks until line is reached.



11 Once grout has set up, clean surface with damp cloth. Rinse cloth frequently in clean water to get best results.

Be sure that all plastic spacers are removed from the joints. Then, work the grout into the joints using a rubber squeegee (Photo 9), also available at tile supply houses. Hold the squeegee at a 45° angle to the floor to remove excess grout from the tile surface (Photo 10).

When the grout has set for approximately 2 hours, use a damp cloth to wipe away any grout left on the tiles (Photo 11). Rinse the cloth frequently in clean water, for the quickest and best results.

Because the grout is actually a cement-based product, it requires a slow curing to achieve full strength. So, cover the floor with kraft paper for several days, to retard the drying process (Photo 12). You can use the floor after the grout has cured for at least 24 hours.

Keep in mind that actual drying times for the adhesive and grout will vary depending on the products chosen. So, be sure to carefully read and follow the directions for each product, to ensure the best results. And, while the actual time spent working on the floor may be only 8 to 10 hours, when you add in the time required for both the adhesive and grout to set, plan on the room being unusable for at least 3 days. **PM**



9 Once all tile is laid, let adhesive cure, then remove spacer blocks. Spread grout onto floor using rubber-faced trowel.



12 Because grout needs to cure slowly for best strength, cover floor with kraft paper to slow down drying process.

Appliance Trim Kits

How to create the custom built-in look.

BY NEAL BARRETT

A NICE OPTION, which is available on most new dishwashers and many refrigerators, is a simple trim kit. This feature allows you to install various custom panels on the front of these appliances and, in the process, better integrate them into your overall kitchen design.

Unfortunately, trim kits are a relatively recent improvement and, therefore, are not available for most older appliances. Still, if you want to update your old appliances in this way, it pays to check with the local dealer of the brand you own. Because the exteriors of some appliances haven't changed much over the years, a trim kit that will work on a new unit may work on an older one.

In our kitchen, we chose to reflect the styling of our new cabinet doors in the appliance panels. All we did was order the appliance panels from the same supplier we used for our doors and drawer fronts. Most of these suppliers are well versed in the requirements of appliance trim kits, and have pricing guidelines for them included in their catalogs. Just be sure to have the exact size specifications from the appliance manufacturer before you place your order. (If inspired, you can also make the panels yourself.)

Once you receive your appliance
(Please turn to page 119)

Lead photo: John Griebisch
Step-by-step photos: Neal Barrett



1 To install trim kit on refrigerator doors, first remove chrome trim strips on sides of doors. Strips are held in place with screws.



2 Loosen, but don't remove, trim strips at top and bottom of doors. Then slide in panels, replace strips and tighten screws.



3 To install trim on dishwasher, remove door panel by taking out retaining screws. Our screws were accessible from inside.



4 Remove front decorative panel and backing material, by removing one side trim strip. Loosen other trim strips as well.



5 Slide new wood panel into place, making sure it's centered in the opening. Then replace removed strip and tighten screws.

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The Cost

How to finance home improvements.

BY MARY RETLAW

FINDING A LOAN to finance a remodeling project is a cinch today. Most banks, savings and loan associations and credit unions are willing—make that eager—to lend anywhere from \$30,000 to \$50,000 for a gut rehab of your kitchen, or to pass out just a few thousand dollars to put a “thirtysomething” face on your Ozzie and Harriet cabinets.

What’s hard, however, is sifting through a lender’s ever-growing menu of options—home equity lines of credit, home improvement loans, second mortgages and personal loans—to find what works best for you.

You can start narrowing down your choices by examining the tax status of different loans. Under the new tax laws, only 10 percent of the interest on consumer debt, such as personal loans and credit-card borrowings, is deductible this year. And starting in 1991, none of that can be deducted.

You can save that valuable tax deduction, though, by sticking to loans such as home equity lines, second mortgages and home improvement loans that are secured by your home. Interest on such loans remains fully deductible provided the total amount of debt on your house doesn’t exceed \$1 million—not likely to be a problem unless you are Leona Helmsley.

This tax-deductible feature can save you substantial bucks on a large project. During the first year of a \$20,000 loan at 12 percent, for example, you will pay \$2400 in interest. But if those payments are tax-deductible and you’re in the 28-percent tax bracket, the *after-tax* cost of that loan is \$1728—a savings of \$672, or \$56 a month. Your actual savings will probably be greater since tax-advantaged loans typically have lower interest rates than other loans even before taking tax deductions into account.

Of course, you will also want to factor in other considerations, such as ease of getting the loan—does the lender require a detailed financial history from you, how long does it take from application to advancing the funds—and the length of time you have to pay it back. The longer the repayment term, the lower your month-



ly payments will be.

Even if you have enough money stashed away in savings, you may still want to finance an improvement rather than ante up cash. One reason is that you should always have enough readily available money in savings accounts, certificates of deposit or money-market accounts to carry you through an emergency, such as unexpected medical bills or an episode of unemployment. Once you spend savings on a home improvement, you can only get that money back by selling your home or borrowing against it.

Here’s a quick rundown on the best options for financing home remodeling projects, large and small.

Home Equity Line Of Credit

This type of loan has become increasingly popular in recent years for all kinds of borrowing because it offers the best combination of low interest rates, flexible repayment schedules and tax-advantaged status. Though there are an unnerving number of variations, once you cut through the flash and dash, the underlying principle is the same: The lender establishes a line of credit against the equity in your home, and you borrow against it as you need it. To figure out how large a line you qualify for, the lender appraises your house to establish its market value, takes up to 80 percent

of that amount and then subtracts your home mortgage. Thus, if your house is worth \$200,000, and you have a \$60,000 first mortgage, you could qualify for a \$100,000 line.

You can usually draw on the loan by writing a check or, in some cases, by using a credit card linked to your home equity loan account. The ease of tapping into the line makes it ideal for improvement projects that may involve many payments to suppliers and contractors over a period of several months. Many lenders offer the option of paying interest only for the first five years of the loan. After that, you pay off the remaining balance over a period of 10 to 15 years. If you choose, you can pay off the entire balance at any time.

Most home equity lines carry an adjustable interest rate, usually pegged one or two percentage points above the prime rate. With prime recently at 10 percent, the going rate on these loans is currently 11 percent to 12 percent. You’ve got to look beyond the interest rate, though, to figure the true cost of your line. Since a home equity line is actually a second mortgage on your home, you must also pay many of the closing costs associated with first mortgages. Such charges—loan origination points, appraisal and application fees, a title search—can add anywhere from several hundred to several thousand dollars to the cost of

your loan. Some lenders offer home equity lines with either no or low closing costs—\$150 to \$300—but they may charge a higher rate—prime plus 2 percent or 3 percent. If you plan on using your home equity line sparingly, however, you may be better off opting for a line with low initial costs and a slightly higher rate than one where you shell out thousands upfront and save one percentage point a year on the rate.

Second Mortgage

Like a home equity line, a second mortgage loan is made against the equity in your home—that is, the market value of your house minus your first mortgage. But instead of allowing you to borrow against a line of credit, a second mortgage gives you all your money at once. This means you will be paying interest on the full amount of the loan even if you aren't actually ready to put all the money to work in your remodeling project. Second mortgages come with either a fixed rate or an adjustable rate. Whichever you choose, you will probably pay two to four percentage points or more above the going rate on a first mortgage—more if you get a second from a consumer finance company rather than a bank. You should expect to pay roughly 13 to 16 percent for a second mortgage. You will also incur the regular closing costs associated with a first mortgage, which can add a few hundred to a few thousand dollars to the cost of the loan. Lenders are less likely to drop or reduce the closing costs with a second mortgage. Repayment terms vary widely, but typically lenders give you 10 to 20 years to pay back a second mortgage.

Home Improvement Loan

Since the advent of home equity lines, home improvement loans are relegated to small improvement projects—usually under \$25,000. But they do have one big advantage: speed. Most lenders can approve them within two days and have the money available for you within two weeks. Since home equity lines and second mortgages involve title searches and other red tape, it may be four to six weeks before you can actually tap your loan. Some lenders might want to take a look at the plans for your project before they okay the loan; others will approve the loan with the stipulation that the funds are used only for home improvement. Generally, the rate on a home improvement loan is about the same as that for a second mortgage, but the repayment term is usually

shorter, five to 10 years—which means the monthly payments are higher. You can borrow up to \$15,000 and comfortably spread the payments over 15 years, however, by dealing with a lender who offers home improvement loans insured by the Federal Housing Administration's Title I program. Since these loans are guaranteed by the U.S. government, lenders consider them less risky and, therefore, you stand a chance of getting a better rate than with a regular home improvement loan. One caveat: Not all home improvement loans are actually secured by your home. The interest payments are fully tax deductible only if the lender has actually recorded a lien against your house.

Personal Loans

Like home improvement loans, personal loans offered by banks, savings and loan associations and credit unions are a quick way to drum up cash. With sufficient income and a solid credit rating, you can get a loan of \$5000 to \$25,000 within a week or so. But personal loans have several disadvantages. Starting next year, none of the interest is tax deductible. Repayment terms are a short three years or so, which makes for high monthly payments. Also, unless you have a savings account or certificate of deposit to offer as collateral, you will usually pay a much higher rate than for home improvement loans, second mortgages and home equity lines. Today, lenders often charge 16 percent or more for unsecured personal loans. Given these shortcomings, you should only turn to this option if you need the money at once, plan to pay it off very quickly or you need cash not just for home improvements, but other purposes as well.

Credit Cards

For low-cost projects—say, \$2000 or less—you can opt for the sheer convenience of plastic. By charging building materials to your credit card, or paying for them with a cash advance against your card, you get instant cash without the hassle of loan applications. And you have the option of paying the balance off all at once—or stringing it out over several years by making the minimum monthly payment. Convenience does have its price. Beginning in 1991, none of the interest you pay on credit-card debt is tax deductible and the average interest rate on credit cards is a near-usurious 19 percent. Unless you enjoy fattening lenders' coffers, avoid this expensive option for all but the smallest of projects. **PM**

HOME IMPROVEMENT GUIDE

(Continued from page 116)

panels, prime and paint them the same color as the rest of the kitchen. Of course, you can stain these panels as well or give them a natural finish. But if you do this, be sure to let the panel manufacturer know in advance. Generally, they have different grades available and if you plan on a stained or clear finish, order the better grade. We ordered the poorer grade because we were painting them. Full instructions are included in the owner's manual for each appliance, and the job should take an hour for each unit. **PM**



6 Reinstall front panel on dishwasher door, then remove lower access panel. Check owner's manual for proper method.



7 Remove trim strips from around access panel. Then remove decorative panel and any existing backing material behind it.



8 Install new panel so it's centered in opening and then attach trim strips by replacing screws. Reinstall access panel.

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payload, it's powerful enough to haul your favorite insurmountable load of peat moss, storm windows or sacks of cement.

In fact, we think the mid-size Dakota should solve just about any serious trucking dilemma that arises. Except what to do with that red bandana you used to tie to the end of your two-by-fours.

The tough new spirit of Dodge.



You'll have to get the plywood yourself, though anti-lock rear brakes come standard. But, buckle up for safety, anyway. You, not the plywood.



PASSING YOUR STATE INSPECTION

BY PAUL STENOQUIST; PM Illustrations by Fred Wolff

THE ANNUAL RITUAL of state motor vehicle inspection can fill any car owner with anxiety. For the enthusiast who has modified his car, there's the question of compliance. Even the suburban commuter with a factory-spec family sedan may have some concern. Will the exhaust emissions meet regulation? Will I have to wait through long lines again because of a misaimed headlight that I could have adjusted at home in a few minutes?

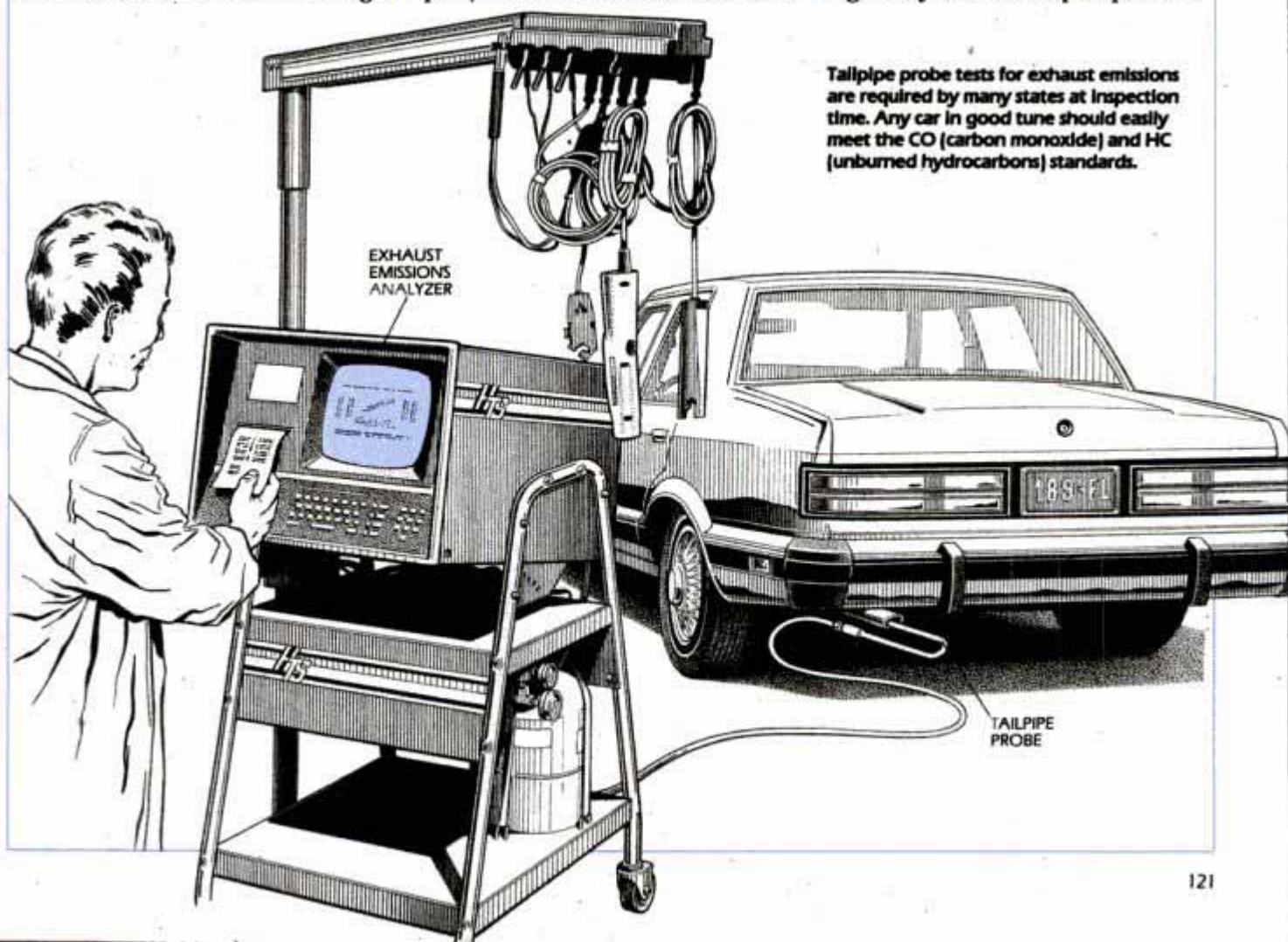
Those worries are not without some justification. Fact is, in some states with periodic motor vehicle inspection programs nearly one-third of all cars fail to meet safety or emissions standards their first time through.

Presently, nearly half of all states require regular inspections, and another 10 stipulate that the car's condition must be checked whenever ownership changes. And it's certain that stricter exhaust emissions standards in the years to come mean that virtually all car owners will be subject to at least a tailpipe sniffer test on a regular basis.

The good news is that with regular engine maintenance and a straightforward check of safety items you can catch nearly all of the potential failures which might turn up in a state inspection. The exact procedures and standards of inspections vary greatly from state to state, of course. In the past, state-run facilities were com-

monplace but private repair shops are increasingly assigned this task. These shops are generally licensed by the state's Department of Motor Vehicles and continually audited by that agency. Certified mechanics follow guidelines in the regulations handbook when making their inspection.

Preparing your car to pass state inspection can save you more than just time, too. In general, the inspection fees charged by private garages are regulated by the state, and they're often far less than the shop's normal hourly labor rate. Taking New York as an example, the maximum fee runs to \$17 and the procedure takes a half hour to do properly. To avoid losing money on the time spent perform-



Tailpipe probe tests for exhaust emissions are required by many states at inspection time. Any car in good tune should easily meet the CO (carbon monoxide) and HC (unburned hydrocarbons) standards.

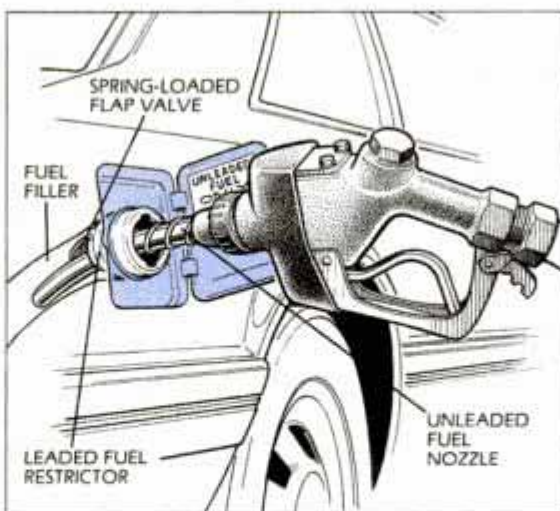
ing inspection service, the mechanic has an understandable incentive to fail items which may be on the borderline of compliance. The car owner isn't obligated to have his car repaired at the inspecting shop, but the mechanic hopes he will, to avoid the inconvenience of moving the car to a second repair shop. You'll have to decide how much you trust the inspecting mechanic's ethics.

Tailpipe sniffers

As more American cities become concerned with air-quality standards, requirements for checking the performance of each car's emissions control system are adopted. In some cases, a visual check to ensure that all the emissions control devices are present may be performed. Other states use an exhaust-gas analyzer to determine carbon monoxide (CO) and hydrocarbon (HC) levels. This requires that a probe be placed in the tailpipe with engine running at normal idle speed (see lead illustration on page 121).

The tester prints out a tape of the CO and HC readings, usually making one copy for the car owner and one for inspection station records. Each time the tailpipe test is performed, the equipment should check the validity of its own calibration against reference gases.

Any car with a good-running, properly equipped engine should be able to pass the emissions segment of a state inspection. If it hasn't been tuned up recently, this is the time to do it. Make sure that the idle speed and ignition timing are at the manufacturer's spec. Experienced Saturday mechanics will



1 A missing or modified leaded fuel restrictor in the fuel filler will cause a catalytic converter-equipped car to fail state inspection.

immediately recognize the important areas requiring attention. A dirty air filter could cause an overly rich condition, raising the CO level beyond allowable tolerances. A sticking choke on carbureted engines would have the same effect. Bad sparkplugs or ignition wires will create a misfire, raising HC levels and probably causing a failure.

An illuminated CHECK ENGINE light is a sure tipoff that the engine's fuel management system has detected a problem.

Use the procedures outlined in your factory shop manual to check for trouble codes in the memory of the engine control computer. An O₂ sensor failure, for example, could certainly make for high emissions levels. In general, the relatively low cost of these sensors makes it smarter to replace them rather than to attempt a

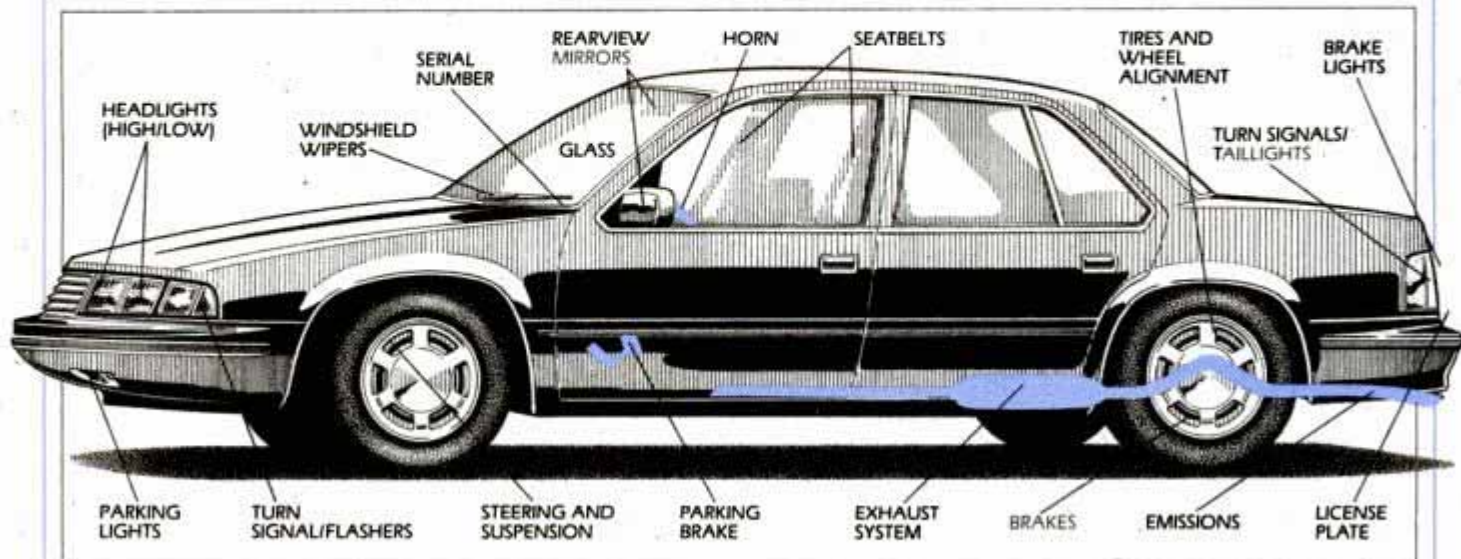
cleanup of the fouled sensor.

Even portions of the emissions control equipment designed to lower oxides of nitrogen levels, which are not measured by the test equipment, can affect the other pollutants which are checked. For example, a leaking EGR valve or a vacuum leak might well cause a lean misfire condition, raising HC readings high enough to provoke a test failure.

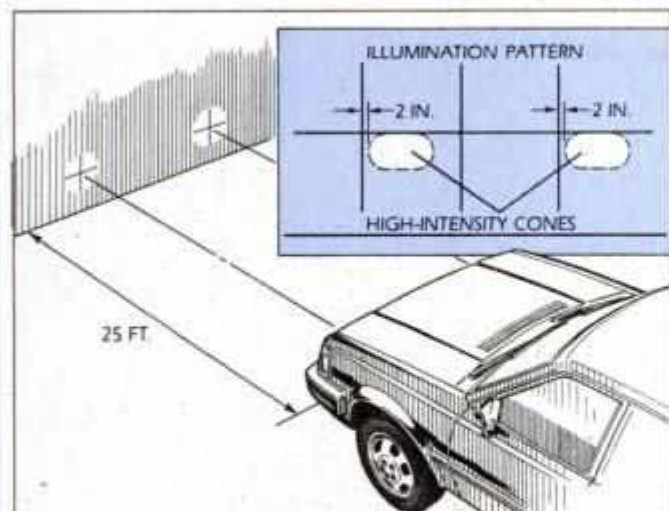
Ideally, an engine should be thoroughly warmed up to operating temperature before the emissions test is performed so that the catalytic converter will be operating and the choke will have opened.

Inspections for the presence and operation of emissions control devices are generally limited to the most common systems in use. Obviously, the catalytic converter must be present and its air supply line (if originally equipped) should be properly connected. On converter-equipped cars, the fuel inlet restrictor (Fig. 1) must be in place to prevent the use of leaded gas which would poison the catalyst.

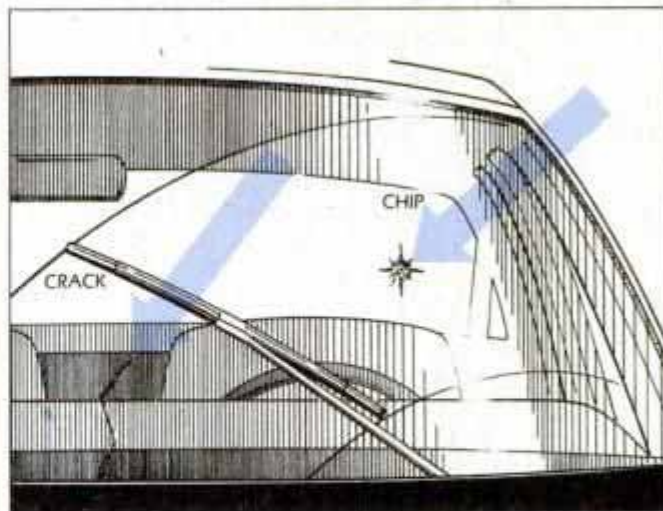
In the engine compartment, visual checks are performed to determine that all control devices are still in working order, provided the car was equipped with these devices when it was built. The PCV system has to be in working order. The EGR valve must be installed to factory specs and all vacuum hoses connected. A thermostatic air cleaner must have its manifold heat pipe in place, and any holes drilled or punched in the housing will result in a failure. The air in-



2 Safety check points you should look over before inspection time include all lights, glass and mirrors, as well as mechanical components.



3 Headlight aim requires parking the car 25 ft. from a wall and adjusting the beams to fall below the line between the lights' centers and slightly toward the right side of the road.



4 Any large star-shaped stone chip or long crack in the wiped area of the windshield glass will cause a rejection. Minor chips or cracks out of the driver's line of sight are usually okay.

jection pump, along with its drive belt, diverter valves and plumbing, must be present. The evaporative canister must be properly located and connected.

If your car has all of the proper equipment in place and still fails the state sniffer test it may be eligible for repairs under the factory warranty. Many components are covered by federal law requiring up to 5-year/50,000-mile coverage of emissions control devices.

There are also a number of chemical compounds sold at auto parts stores which are designed to help cars pass the inspection tests. The trouble is, these gas tank additives will only mask the symptoms, not cure the condition causing the high pollutant levels. It's better to fix the problem properly to assure optimum gas mileage and prevent any further damage to the engine.

Exceptions to the rule

Realizing that the high costs of bringing some older or high-mileage cars into emissions compliance might not be economically feasible, most states have provisions for exemptions. After failing the initial test, the owner must follow set repair procedures and submit to a second test. He can then get a waiver of emissions inspection provided the inspector certifies that control devices are in place and the second test shows an improvement in pollutant levels. Some states place a cost limit on the amount of money an owner must spend trying to bring the vehicle into compliance, but there is no limit for the cost of repairs to correct previous tampering with the control devices.

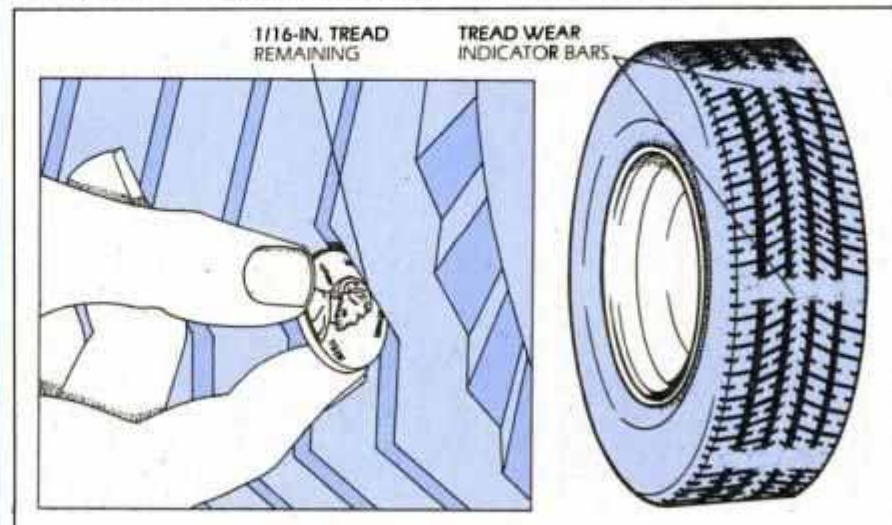
Safety checks

The traditional periodic safety inspection covers many easily checked items such as operation of the horn and turn signals, as well as some tougher points like the brake performance and headlight aim (Fig. 2). Start your checks with the lighting system, making certain that all headlamps, tail lamps, stop lamps, turn signals, side marker lights, license plate lights and reverse lights will illuminate and that all lenses are in good condition. Four-way flashers must work as well. If you have added auxiliary spot or fog lamps they must be wired to a switch separate from the headlamps.

Several methods are in use for verifying proper headlight aim, but you can pass the test in most states by adjusting them yourself (Fig. 3). Park the car on a flat, level surface with the headlights 25 ft. from a vertical wall.

Draw a line on the wall parallel to the ground at the height of the headlight centers. Make a mark where the car's centerline intersects this parallel line. Using the diagram, turn the headlight's adjusting screws to aim their brightest spots below the line marking the headlight centers and slightly toward the right side of the road. If you have single headlights, this will bring your high beams in as well. If you've got quads, adjust the high beams so the center of the bright spot is straight ahead.

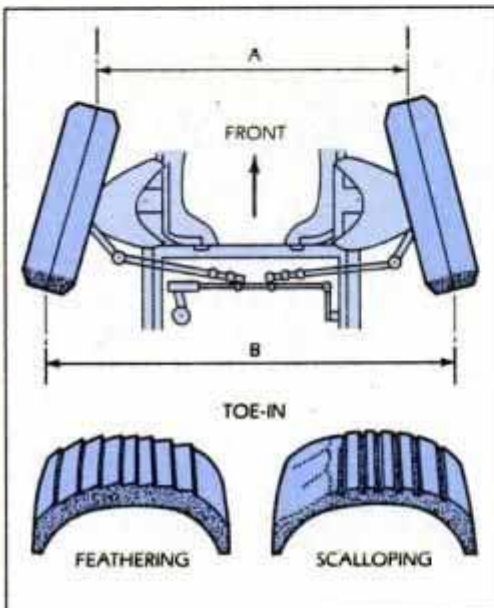
All windows must be made of approved safety glass and free of exposed sharp edges (Fig. 4). In general, any star-shaped stone chip larger than 3 in. dia., or any crack longer than 11 in. in the area covered by the windshield wipers, will be a cause for rejection. All mirrors must have unbroken glass.



5 It's exactly $\frac{1}{16}$ in. from Lincoln's head to the rim. Tread wear indicators will also show when the tire is worn beyond safe use.

Underneath the car

The safe control of a vehicle is directly related to the condition of its tires and suspension. Tires must not have any visible cuts, bulges or exposed cord. The minimum acceptable tread depth is $\frac{1}{16}$ in., measured at four points. Note that in many states the readings are taken in two adjacent tread grooves showing the most wear and at a similar point at least 15 in. away on the circumference. You can use a coin



6 Difference between measurement A and B is toe-in. Wear patterns of the tire will show the need for an alignment.

to gauge the tread depth and transfer your measurement to a ruler, or you can look for the tread wear indicators which are molded into the tread pattern (Fig. 5).

The condition of the tire tread area will also give you some indication as to the wheel alignment. Look for feathering and scalloping patterns which indicate that the toe-in is out of adjustment (Fig. 6). In most cases, state inspection procedures don't use the standard toe-in measurements in fractions of an inch. Instead, a scuff gauge is used, driving the car over a pad to determine the amount of sideways slippage of the front tires. A reading of more than 30 ft. per mile will result in rejection.

Brake checking

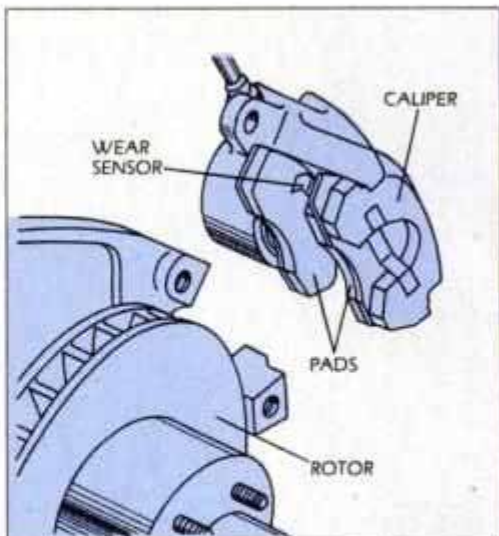
Braking systems are the largest category of state inspection failures. For the most part, it isn't the outright stopping performance of the brakes that's tested but the equal braking power at all four wheels and the physical condition of the components.

Testing the brakes for equalization

in state-run facilities can be done on sensitive, calibrated equipment, but all you need to do in preparation is assure that the car will stop straight, without pulling left or right. The private repair shop will also perform a visual inspection to look for leaks at the wheel cylinders, calipers or brake fluid hoses. Disc brakes will be failed if a pad's friction material is cracked or if the wear sensor is in contact with the rotor (Fig. 7). Drum brake linings must be at least $\frac{1}{16}$ in. thick, or at least $\frac{1}{32}$ in. above any rivet head. Cracks in the rotors or drums will also cause rejection.

Several tests of overall brake system condition are also used. These can be performed by the car owner before taking the car in for inspection. The pedal must have a reserve of at least one-third of its possible travel when depressed under normal foot pressure and the engine is running (on cars fitted with power brakes). The pedal must also hold its position without sinking for at least 60 seconds. Then, the vacuum is depleted from a power brake-equipped car by pumping the pedal several times with the engine off and holding foot pressure against the pedal. When the engine is started, the pedal should fall slightly.

Operation of the parking brake is checked by setting the brake and running the engine slightly above idle speed with the automatic transmission in DRIVE or a manual transmis-

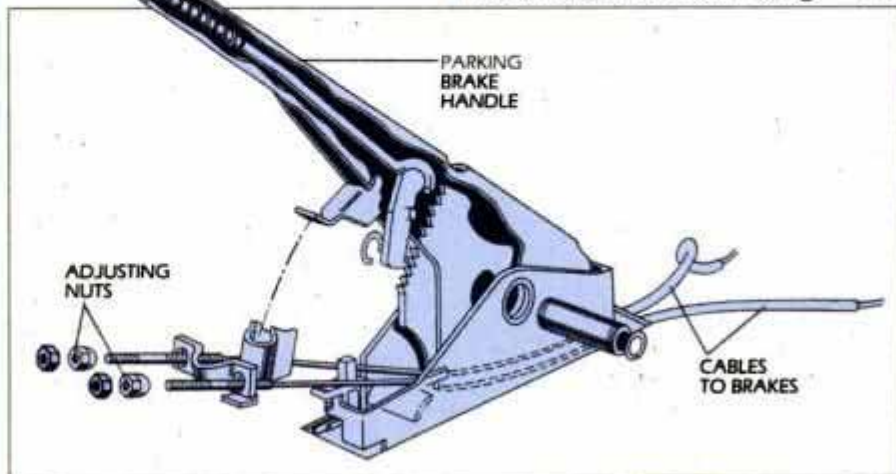


7 If the wear sensor is contacting the brake rotor, the brakes will be rejected in state inspection. Replacing the pads is called for.

sion in LOW gear and the clutch lightly engaged. To avoid failing inspection, the car can't move forward. If it does, adjust the cables controlling the parking brakes by tightening (Fig. 8).

Suspension system checks vary greatly from state to state. Some actually require an inspection of ball joints and tie rods for looseness, while others accept a measurement of steering wheel freeplay as a guide to front-end condition. In those cases, a maximum of 2 in. of freeplay with power steering (or 3 in. with manual steering) is allowed before rocking the steering wheel can be detected at the front wheels.

There should also be no binding or excessive tightness anywhere in the steering system. Additionally, all springs and torsion bars should be mechanically sound and the shock absorbers or struts and their mounts must not be broken or missing. **FM**



8 Adjustment of the parking brake can be done by tightening the cables attached to the brake lever. Turn both adjusting nuts the same amount.

(Continued from page 107)

a reversing motor, which rotates in a different direction each time you turn it on. This will greatly reduce the number of times hard or stringy foods will stop the motor, tripping its reset button. In addition, better quality disposers will include stainless-steel food wells and upper-body parts. Stainless steel is much easier to keep clean and won't rust, as occasionally happens in low-end models. These features come with a substantial price tag, however. The high-end models cost roughly four times more.

Disposer warranties do not differ greatly among manufacturers, but their service procedures may. With some models, the disposer must be sent in for repair, while other manufacturers contract with local repair companies for on-site service. The practical difference is substantial, so check out the warranty policy along with the warranty coverage.

Microwave Ovens

Your choice in a microwave oven will have a great deal to do with how you plan to use it. If you primarily use a microwave to defrost meat and warm leftovers, most any model will do. If you would like to prepare real meals in a microwave, however, then consider these features.

To begin, most microwave cookbooks are written for units of at least 700 watts. Make that your cutoff point. Oven size will also be a factor, ranging between .8 and 1.2 cu. ft. If you have the space, choose at least a 1.1-cu.-ft. model, or you'll have trouble fitting larger dishes inside.

As microwave heat is uneven, you'll almost certainly need to interrupt the cooking cycle to stir the food and rotate the dish. To reduce the number of times you'll need to interrupt the process, choose a model with a turntable, preferably one that can be turned off when a dish is too large to be rotated. A convection fan will also reduce the amount of participation required of you. For browning meat, a browning element at the top of some cabinets is also convenient, but cannot be used with plastic bowls and dishes. And because cooking times are fairly precise in microwaves, a heat-sensing probe can be useful. Most are integrated with the oven's circuitry and will shut off the oven when the desired internal temperature is achieved.

Microwave ovens generally come with 1-year coverage on parts and labor, except for the heating (magnetron) tube, which will vary with manufacturer. Expect a 5-, 7- or 10-year warranty on the tube. **PM**

(Continued from page 110)

(Photo 7). Because these ovens are quite heavy, be sure to anchor this plate firmly into the wall studs. The unit is also attached to the wall cabinet above. It may be necessary to screw spacer blocks to the underside of this cabinet to provide solid attachments. Following the manufacturer's directions, lay out and bore the appropriate holes for mounting bolts in the cabinet floor, and bore a hole for the power cord to enter the cabinet. Make sure that existing ductwork from your old range hood lines up properly with the new oven.

If it doesn't, you'll have to make some ductwork modifications. Fortu-



4 Slide oven part way into opening, then install cable connector and oven cable in box. Make connections with Wire-Nuts.



6 Check cooktop for fit in counter cutout, then remove and apply aluminum tape to counter edge to reflect heat. Install unit.



8 Hang microwave on mounting plate and temporarily support unit. Attach to plate by tightening screws at front of unit.

nately, there's usually plenty of room in the cabinets above the microwave to install the proper combination of fittings and flexible duct to make the proper connection. Be sure to consult your owner's manual for all the correct clearances. If the solution to the misalignment isn't obvious, seek help at your appliance dealer.

Remove the access grille panel from the front of the microwave and hang the oven on the mounting plate. Use the screws provided to attach the oven to the plate (Photo 8). Then, complete the installation by tightening the bolts through the cabinet above into the oven (Photo 9). **PM**



5 Slide oven completely into opening and check for level and plumb. Attach sides to cabinets with screws through oven flange.



7 To install microwave, first attach mounting plate to wall. Drive mounting screws into wall studs for proper support.



9 Attach microwave to cabinets above by sliding support bolts through prebored clearance holes and tightening securely.

ered this when remastering Presley's *The Memphis Record*.

"We thought we had the original tapes. Everybody thought so," says Rowe. "Then one day I go down to the vaults and see this paisley box with 'Elvis' written on it. I start opening other crates and I find this psychedelic stuff all over the boxes. I knew then I had the actual masters."

Why had the tapes remained undiscovered? Perhaps because most people couldn't read the notes taken at the session. "The session notes are far-out," says Rowe. "The engineer wrote the session notes in a spiral because he thought it was groovy."

Modern audio restorers use a variety of signal processing equipment arranged in a variety of ways in the signal chain, depending upon their personal preferences or the effect desired. Rowe, for example, uses an Aphex aural exciter and a Barcus-Berry processor to enhance certain frequencies and compress others; two parametric equalizers to zero in on malevolent frequencies that need taming; a digital equalizer for even more precise frequency adjustment with the added benefit of no noise being added to the recording (analog equalizers add a bit of noise of their own); and a dbx expander/compressor device which can expand or contract an audio signal very quickly. Other engineers may use different brands of equipment and may add a component to the chain if they think it will achieve a desired result.

The heart of the component chain is the same whether your name is Parker or Rowe, whether you operate alone or work for a large record label. Digital editing systems are made by a variety of manufacturers including Sony, Mitsubishi, Soundstream and JVC. Actual editing is done on 3/4-in. videotape in order to utilize a time code system called SMPTE developed for film editing by the Society of Motion Picture and Television Engineers. The SMPTE time code system essentially throws out little markers every 1/30 of a second as the tape speeds by. Once you know where the markers are, you can speed up and down the tape highway as often as you please. Editing is much like dubbing from one tape deck to another, except that playback is interrupted for the removal or addition of various passages of varying length. With digital editing, the interruptions are seamless and precise to a level impossible to achieve with a razor blade.

Digital editing involves more removal of material than addition. What is removed is unwanted ticks, clicks and other noises that have nothing to

do with the music. Much of this work now starts with Sonic Solutions, a new San Francisco concern specializing in audio noise reduction. Sonic Solutions has developed a computer which learns what the unwanted sounds are on a recording and then simultaneously reproduces the exact opposite of that sound, thereby canceling both.

While recordings treated by Sonic Solutions are far from consumer-ready, it does speed the remastering process by removing the glaringly obvious flaws. More precise editing still has to be done by studio engineers.

Recreating Elvis

While most audio restoration is a taking-away or substitution process, sometimes material must be added from scratch. Perhaps the most publicized instance of this type involved RCA's remastering of Presley's *Young & Beautiful*. Much of the first 4 seconds of the song were missing and no acceptable copy or outtake was available. Rowe, the engineer on the project, was able to reconstruct the missing 4 seconds from similar but not exact phrasing and bits of words appearing near the end of the song. Within the first 4 seconds of the song, Rowe made 36 electronic edits, a feat that would have been impossible to do any other way but digitally.

Adding or reconstructing material is just one part of the tinkering process that often involves reemphasizing certain instruments and re-adjusting our perception of where certain musical elements are coming from. Rowe confesses that Presley's *The Memphis Record* is "so different from the way it was when it originally came out. It's cleaner, has more dynamic range, and is musically truer to what the musicians intended."

Rowe maintains that the initial recordings were toned down at the time to make Elvis more acceptable to the public. Presley's intentions are unknown. "There's no way for me to know what Elvis wanted, the watered-down version or the full-meat of what he had done," says Rowe. "I did know that the full-meat version hadn't been out."

Audio restoration, a.k.a. digital remastering, as practiced by today's engineers is a subjective process utilizing very precise technology. The music is better, say our ears, but our minds wonder: Are the remastered CDs true to the original artist?

There may be no knowing for sure but perhaps Rowe's answer is the most accurate. "It's what the studios would have done then if they had the technological tricks available." **PM**

The seams were made using the same joining techniques used for the edge buildup, except that to draw the seam tight, wood blocks were hot-glued to the surface to create a place to attach the clamps (Photo 9). After the seam set, the blocks were knocked off easily and the glue was scraped from the surface.

To make the cutouts for cooktop and sink, we used a self-piloting router bit that followed the cutouts in the substrate (Photo 10). Then, our backsplash was cut to size and attached to the wall and counter with clear silicone. Special plywood clamping jigs were made to hold the backsplash in place until the adhesive set (Photo 11).

One of the more interesting features of Avonite is its ability to be polished to a high gloss. This type of polish can work well for vertical surfaces, but would scratch easily on a countertop. So, we opted for a satin polish. This finish was achieved by sanding first with 60-, then 30-micron finishing film, available from automobile finishing suppliers. The last step is to buff the entire surface with a fine Scotchbrite pad. We also used Avonite for our island countertop, and it was fabricated in the same way as the other tops. **PM**



10 To make counter cutouts, use a router and straight bit with a ball-bearing pilot. Pilot follows cutout in substrate exactly.



11 Join backsplashes to counter and walls with silicone adhesive. Clamping jig holds pieces until adhesive sets.

HOME VIDEO

Have Camcorder, Will Travel

A machine for around the world.

BY FRANK VIZARD, Electronics Editor



YOUR BAGS are packed and your passport is in your breast pocket. You're all prepared for an overseas trip. Now comes the big question for video lovers: Do you bring the camcorder?

Many times I've answered this question with a definitive "No." For some trips, particularly those with multiple destinations, a camcorder was too much gear to carry. In these instances, I'd opt for a small point-and-shoot 35mm camera.

No more. Thanks to Sony, size and weight are no longer considerations when it comes to deciding whether or not to bring a camcorder on a trip. The camcorder of choice for travel is the Sony CCD-TR5.

As you can see from this photo, the CCD-TR5 is tiny. The CCD-TR5 measures only $4\frac{1}{4} \times 4\frac{1}{4} \times 6\frac{3}{8}$ in., which means it fits easily into a coat pocket or small bag. The CCD-TR5 is also light, weighing 1 pound 12 ounces

without battery or cassette.

The small size of the CCD-TR5 can be attributed to two facts. First, the CCD-TR5 uses 8mm videotape, the smallest of the videotape standards available. Of course, other camcorders use 8mm videotape, but these are larger and bulkier than the CCD-TR5. The CCD-TR5, however, uses a tape transport called the FL mechanism that is half the thickness of those used in most other 8mm camcorders. It also uses a new 4-layer circuit board, a miniaturized integrated circuit and new surface mount technology—all of which contribute to the camcorder's small size.

Noteworthy views

Field testing of the CCD-TR5 was done in the Austrian Alps near Salzburg as well as in Munich, West Germany. After two weeks with this product, some impressions are worth noting.

First, the CCD-TR5 is wonderfully portable. I carried the CCD-TR5 with me more often than I carried my passport, and it was never a burden. Also, recharging batteries abroad was not a problem. The TR designation in the model number means travel, so the CCD-TR5 is equipped for all contingencies. The adapter normally used to recharge the camcorder's batteries also serves as voltage converter when necessary.

The CCD-TR5's small size allowed me to do some very discreet recording. For instance, I was able to shoot the inside of a cathedral in Salzburg while sitting virtually motionless in a pew. The viewfinder of the CCD-TR5 rotates up to 90°. To record the interior, all I had to do was move the camcorder body while I kept the eyepiece rigid. I was able to record the beautiful interior without disturbing those

around me and without drawing the wrath of church authorities who generally frown upon picture-taking of any sort. The viewfinder, it should be noted, extends and retracts like a telescope.

I monitored the results of my cathedral recording on a tiny battery-operated Magnavox color LCD television. While it is possible to playback your recording on the CCD-TR5 and watch it through the viewfinder, the image you'll see is black and white. A small color LCD television—the one I used was smaller than the CCD-TR5—provides you with a truer sense of the colors you've recorded.

How did the inside of the cathedral look on videotape? Very good, even though the lighting was very low. The stained glass windows provided enough light for the CCD-TR5. Sony recommends a minimum of 4-lux illumination for recording. The CCD-TR5 uses a $\frac{1}{2}$ -in. CCD image sensor with 270,000-pixel rating by Sony.

Good listener

Another impressive aspect of the CCD-TR5 is the sound quality. I already knew from past experience with other 8mm camcorders that the Audio Frequency Modulation (AFM) system would yield good audio playback. What impressed me was the range of the rather diminutive looking microphone. The CCD-TR5 microphone is set into the body of the camcorder for the sake of compactness. Surrounding the microphone is a noise-canceling structure that prevents the slight noise made by the camcorder's operation from being recorded by the microphone. This noise-cancellation structure works well.

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considering the sensitivity of the microphone. On a country road south of Salzburg, the sound of cowbells is clearly heard on the tape even though the cows themselves are grazing halfway up a distant mountainside.

The small size of the CCD-TR5 doesn't mean it lacks features. Like many other camcorders, there's autofocus, automatic white balance for continuous adjustment to changing light conditions and an auto iris to control the amount of light entering the lens. Among the other additional features, there's also a variable-speed shutter to record fast-moving objects without blurring. A flying erase head provides smooth transitions between scenes.

The CCD-TR5 also contains some handy editing features. An edit search feature allows you to play back material while in the camera mode. Insert editing lets you add scenes to existing footage without rainbow noise or glitches. Tape dubbing or editing is done with a minimum loss of quality by engaging the edit switch, a feature that intensifies color and edges.

If there is any drawback to the CCD-TR5, it's in the 6x zoom lens. Fully extended to record distant objects, the lens sometimes had trouble focusing on the desired object. The CCD-TR5 isn't really designed for long-range shooting, though. It's really a kind of video snapshot. But with its wide variety of features, it is a far better tool than it first appears.

List price for the Sony CCD-TR5 is \$1500. A camcorder virtually identical to the CCD-TR5 is sold by Ricoh. The Ricoh camcorder is called the R-680.

Widescreen TV

Four major players in the television world are combining their technological resources to develop a new widescreen, high-resolution TV system by 1993.

The new Advanced Television Research Consortium comprises NBC, the Philips Consumer Electronics Co., Thomson Consumer Electronics, Inc. and the David Sarnoff Research Center with a standing offer for other interested participants to join. Thomson manufactures televisions under the RCA and GE brands, while Philips makes TVs under its own name as well as Magnavox and Sylvania. The two television producers combined account for about 35 percent to 40 percent of televisions sold.

The David Sarnoff Research Center in Princeton, New Jersey, and the Philips Laboratories in Briarcliff Manor, New York, are perhaps the two leading television research centers in the U.S. The Sarnoff Center has already invested \$70 million, while the Philips Labs has devoted \$30 million thus far in researching widescreen television.

Under the timetable proposed by the consortium, the widescreen television projected for 1993 would not be High-Definition Television (HDTV) as such. The consortium calls the 1993 product Advanced Compatible Television (ACTV). According to the consortium, ACTV would have a 16:9 aspect ratio which translates into a much wider screen than the 4:3 ratio of current televisions. Horizontal resolution, a common measure of TV performance, would be 410 lines as compared to the 330 lines offered today.

The ACTV widescreen image is derived by breaking the camera signal into three encoded subsignals. One subsignal governs the center panel transmission compatible with current 6 megahertz TV signals. The second subsignal transmits two side panels which are joined to the center panel. The third subsignal carries luminance or brightness information.

Widescreen ACTV transmissions are compatible with existing 4:3 televisions largely due to a pan-and-scan technique that automatically shifts the focus of subjects to improve comprehension of a scene. For example, the TV image would shift from person to person in conversation so there's no confusion about who was speaking. ACTV, by contrast, could show all the speakers together in a single image.

ACTV would also include digital audio and a ghost cancellation circuit to get rid of reflected signals. The consortium is aiming at a list price of between \$500 and \$1000 for an ACTV set.

As for HDTV, which promises even greater resolution and thus greater picture clarity (see "21st Century TV," page 60, Dec. '89), the consortium believes implementation is a decade away. As the consortium sees it, HDTV would be basically a simulcast requiring the allocation of a second channel to each existing broadcaster. While this is the theory, no one is sure this approach actually works, so a lot of engineering work remains to be done. HDTV research, though, is likely to be stimulated by other video developments, like the anticipated launch of flat-screen televisions. The consortium already acknowledges that ACTV won't look good on flat-screen televisions. Flat-screen TV still appears years away, however.

Whether the Advanced Television Research Consortium gets the inside track on widescreen TV remains to be seen. Zenith, the only American-owned TV producer, is developing its own HDTV system. Various Japanese and European companies are interested as well. The Japanese companies are already far ahead in the research race, but the consortium should pose a formidable challenge. **PM**

(Continued from page 66)

and houses shoulder straps for front passengers. Unfortunately, the roll-bar look interrupts the open-air feel of the convertible. On the plus side, body stiffening offered by the fixed-position targa bar also allows a full-size rear seat in the Beretta, so accommodations are adult-sized.

Geo's tiny Metro is designed to be one of the most affordable open-top cars with prices coming in possibly below the \$10,000 level. But because of limited production, they'll be available in only 10 states during 1990—California, Florida, Illinois, Michigan, New York, Texas, Ohio, Pennsylvania, New Jersey and Hawaii. The top operates manually and has a rigid tonneau cover for a finished appearance. Only the standard Metro drivetrain (1-liter, 3-cylinder engine and automatic or manual transmission) is available in the 2-seater convertible. A pass-through provides access to the trunk from the front seat.

Chrysler

Call it a big brother to the Dodge Daytona, and you'll be right on the mark in describing the Dodge Stealth, a leap forward for the line in the sporty-car field. With the chassis and driveline designed by Mitsubishi and the body conceived by Chrysler, the Stealth is intended to be Dodge's lead image vehicle during the 1990s.

Four Stealth models will be available starting this fall, and will range in price from significantly under \$20,000 to a level in the high 20s. Top-of-the-line will be the R/T, 2-plus-2 cruise missile powered by a 24-valve, twin-turbo 3-liter V6 that pumps out 280 horsepower, according to Dodge. In addition to all-wheel drive, the R/T will have antilock braking and electronic suspension control. Top speed is estimated at 160 mph with 0-60-mph capability in the 5-second range.

Less muscular Stealth models will use other versions of Mitsubishi's 3.0-liter V6, including a 155-hp 12-valve type and a 205-hp double-overhead-cam 24 valver.

Newest in the Chrysler lineup is a 1990½ LeBaron 4-door, Chrysler's nameplate on the Plymouth Spirit/Dodge Acclaim chassis. This compact 4-door sedan carries traditional Chrysler styling cues in its grille and landau roof, plus a long list of luxury/convenience equipment that arrives under the umbrella price of \$15,995. One drivetrain is offered—the Chrysler 3-liter V6 with electronic automatic 4-speed transmission. **PM**

“I’ll never
buy another
Simplicity.
Ever.”



—— Oras Cress, Toledo, Ohio
Owner

Some people figure their Simplicity tractors will never wear out. When a machine works so good for so long, you do tend to get a little overconfident. Chances are, however, you won't get much more than twenty-five or thirty years out of a Simplicity. But remember. You can always buy a new one. And convince yourself all over again that it will never wear out.

Simplicity

There's just no substitute.



FIRSTHAND DRIVE REPORT

Toyota MR2

The new Mister-Two stretches the performance envelope.

BY TONY SWAN, Automotive Editor; PM Photos by Ron Hussey



LIKE SO MANY cars that Toyota has introduced over the years, the original MR2 seemed to offer little opportunity for improvement. Aside from its kit-car styling, this jaunty little mid-engined 2-seater was virtually above criticism—quick, balanced and thoroughly responsive. It struck us as a near-perfect recipe for small sports-car fun.

However, the introduction of the supercharged version of this car two years ago showed us there was room for improvement after all. Forgiven and predictable with 115 hp on tap, the MR2's handling qualities got to be tricky when 145 hp was applied to the rear wheels.

It was clear that making Mister-Two go faster was going to require something more than mere horsepower, which led to the car displayed here: bigger, faster, more capable and better looking.

The key to the MR2's improved handling and ride lies in its expanded chassis dimensions and increased rigidity. Wheelbase has been stretched 3.2 in., to 94.5 in.,

and front/rear track dimensions are up 1.2 and .4 in., respectively, to 57.9/57.1. There have been some subtle revisions in the suspension geometry to go with this, to reduce brake dive and squat during acceleration, but the componentry is basically the same as in the original—gas-pressurized MacPherson struts at all corners, ball-joint antiroll bars fore and aft and rear trailing links.

Bigger is better

Overall length has also been increased, by 8.7 in., to 164.2 in., and, as you'd expect, a bigger, stiffer MR2 is also a heavier MR2. The basic car weighs in at 2705 pounds, 355 more than the original, and this gain applies to upscale editions as well.

However, there's substantially more power to offset the weight increases. Toyota has replaced the dohc 1.6-liter 16-valve Four that powered the original MR2 with a dohc 2.2-liter 16-valve Four borrowed from the Celica line, good for 15 additional horsepower (130 at 5400 rpm) and, more important,

40 lb.-ft. of additional torque (140 at 4400 rpm).

And if you want boost, there's the MR2 Turbo, with a healthy 200 hp on tap. This engine, a dohc 2.0-liter inter-cooled 16-valve Four, is also borrowed from the Celica lineup, where it powers the Celica All-Trac Turbo.

The turbo engine has faster turbine spool-up due to a dual-exhaust-inlet system that feeds into the turbine housing. Splitting the exhaust stream eliminates sonic waves in the exhaust which can tend to slow the turbine down as it gets hit by the pulses. Turbine acceleration is uneven under these conditions. Eliminating or smoothing out the pulses results in a more even exhaust flow into the housing and quicker turbine acceleration.

Another feature of the turbo engine is Toyota's variable-induction system (TVIS). Basically each set of intake ports (2 per cylin-

der) has its own intake tube inside a common intake runner. At low speeds, a throttle-linkage-controlled butterfly valve closes off one intake tube per cylinder to increase vacuum and air velocity, which in turn eliminates bog—a problem that is commonly associated with 16-valve 4-cylinder engines. As soon as the engine speed picks up, the butterfly opens and both ports function for greater flow and better top end.

While the normally aspirated version of the new MR2 provides enough grunt to be entertaining, the boosted edition now rates as nothing less than an adrenaline pump. The speedometer needle touches 60 mph in about 6 seconds, and Toyota expects quarter-miles in the low 14-second range, numbers worthy of a Corvette.

Braking, which was a strong point on the original car, is excellent in the new one as well. The basic setup is ventilated discs all around, and Turbo models get dual-piston calipers up front. The Celica antilock system is available as an option, and, as always, we recommend this feature.

Another new option worth considering is the MR2's electrohydraulic power-assisted rack-and-pinion steering. The system eliminates the bulk and plumbing that

(Please turn to page 132)



2.0L 16-valve Turbo Four is good for 200 hp.

Never venture into uncharted waters.

FEATURES	BLUE DOLPHIN FIBERGLASS	CONCRETE	LINER	STEEL WALL
GUARANTEE	25 years	1 year	Seams Only	1 year
MAINTENANCE HOURS/WEEK	1 hour	8 hours	6 hours	6 hours
INSTALLATION TIME	1-2 weeks	6-8 weeks	2-3 weeks	3-4 weeks
POOL DRAINAGE	Never	Yearly	2 years	Yearly
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COPING TYPE	Fiberglass	Concrete	Aluminum	Aluminum



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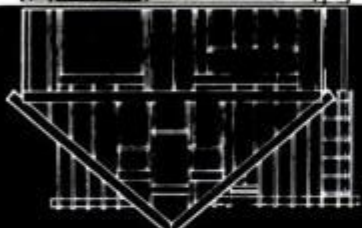
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FIRSTHAND DRIVE REPORT

(Continued from page 130)

go with traditional engine-driven pumps, reducing low-speed steering effort with no loss of road feel.

Inside, the new MR2 offers small but welcome gains in head, leg and shoulder room. The instrument panel has been redesigned to provide the cockpit look that characterizes most Toyota products today, with major gauges (all white-on-black analog) grouped under a curved cowling. The steering-wheel hub now contains an airbag, and the seating offers a range of adjustability that ought to fit just about any driver this side of the NBA, with leather upholstery available as an option. Opting for leather also nets you 7-way seat adjustability, in contrast to the standard 4-way seat.

Predictably, the sound-system offerings start at very good and range up to an optional 160-watt, 7-speaker setup with AM/FM/cassette and CD player. Other options include a pop-up and/or pop-out glass sunroof (it stows behind the driver's seat) and a T-top.

Transmission offerings include a very precise 5-speed manual gearbox (standard) or an electronically controlled 4-speed automatic (normally aspirated models only).

We think the new MR2's exterior speaks for itself. Although it obviously borrows from current Ferrari styling, this doesn't keep it from being a very appealing little package. And it's also more aerodynamically efficient, with a C_d rating of 0.31, compared to 0.36 for the original. The rear spoiler is a Turbo standard, optional on normally aspirated cars.

While we look forward to wringing these cars out under controlled circumstances at a test track, our initial impressions, based on a day of mountain driving near Ojai, California, could hardly be more enthusiastic. We think a little more footprint would help the Turbo version in really hard cornering—all editions wear 14-in. VR-rated tires, 195/60 front, 205/60 rear—though this is a shortcoming that can quickly be corrected in the aftermarket. But for most driving, the basic package is first rate. Whether you're exploring the limits in high-speed sweepers or just cruising down the freeway, this is an impressive piece of equipment.

It probably comes as no surprise that more MR2 means more money. The old MR2 started in the high \$13,000 range and topped out at about \$17,500. Although pricing wasn't final at press time, the new one is expected to start at about \$14,500 and progress beyond the \$20,000 barrier.

Prices like these are certainly well beyond the realm of entry-level sports cars. But then, so is the new MR2. **PM**

HOME IMPROVEMENT GUIDE

(Continued from page 111)

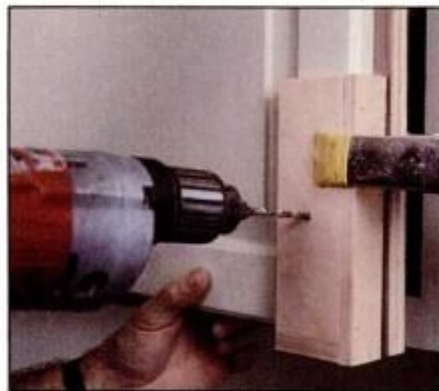
If you ordered doors that will have glass panels—like we did—you must buy the glass separately and install it yourself. Rip down the stops provided with the doors to the proper dimension for the thickness of the glass panel, then install the stops with brads (Photo 4).

Next, position the drawer fronts on the drawer boxes, and temporarily hold them in place with clamps. Bore pilot holes, then attach them from inside the box with screws (Photo 5). Locate and bore the holes for the drawer pulls, and install the pulls (Photo 6).

You can make a simple jig to aid in drilling the numerous holes required for mounting the door pulls. Just select the placement of the pulls, and cut a scrap wood block to match the corner of the doors. Locate the pull position and bore a hole through the block at this point. Then, simply clamp the block to the door—making sure that the corner edges are flush—and use the hole jig as a guide for boring the doors (Photo 7). The time the job takes, of course, will depend on the number of doors and drawer fronts. We completed ours in about 4 hours. **PM**



6 To install drawer pull, clamp alignment jig and backer block to drawer front and drawer box. Bore hole and install pull.



7 To install door pull, clamp jig—with pre-bored hole at proper place—and backer block to door. Bore hole and add pull.



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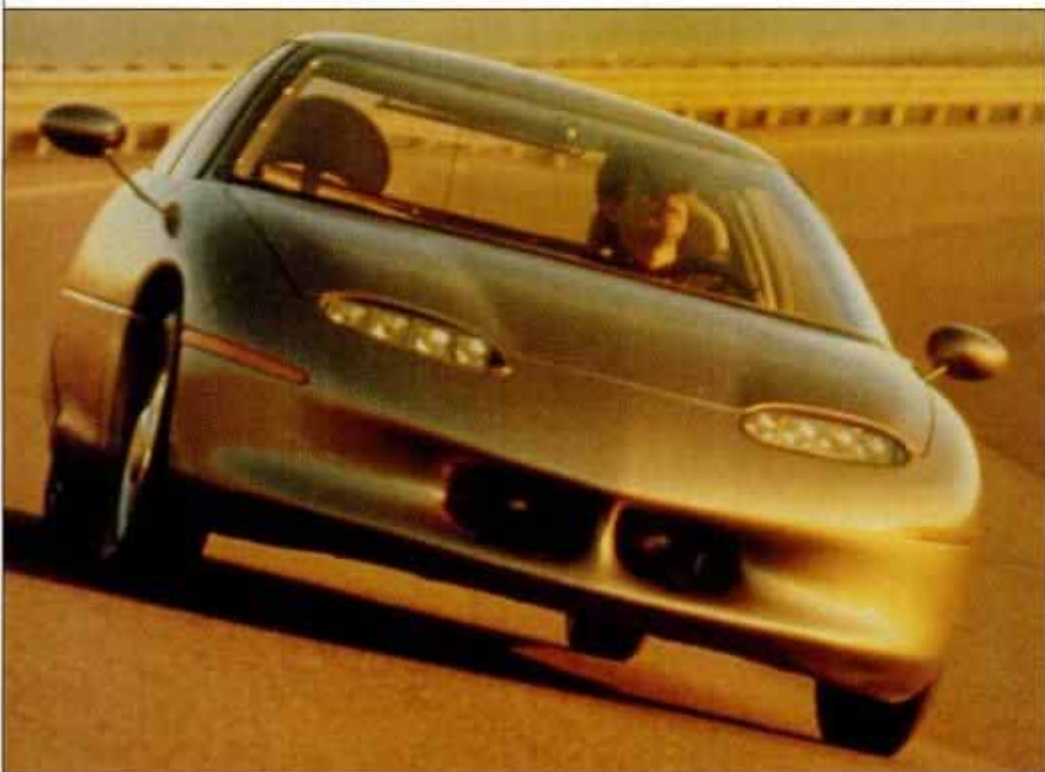
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TECHNOLOGY

Batteries Are Included

GM's Impact is a bright spot in the development of a practical electric car.

BY RICK TITUS, West Coast Editor



low drag coefficient is the shape of the backlight. It allows the air to flow smoothly and remain attached to the car all the way back where it separates cleanly. The Impact is powered by two AC induction-type motors, each driving a front wheel. Together they develop 114 horsepower at 6600 rpm and 94 lb.-ft. of torque from 0-6000 rpm. These deliver power instantly no matter how high or low the motors are revving.

Impact accelerates from 0-60 mph in 8 seconds, which is respectable even for gasoline-powered cars, and is capable of speeds of nearly 100 mph. The combination of Impact's slippery shape, light weight and efficiency of the motor and battery give the current test car a range of 120 miles between charges.

RUMORS OF promising electric-car developments have been leaking out of Detroit for years. But the practical electric car itself remains elusive at best. But now, it appears that there just may be some real potential for battery-powered vehicles in the near future.

As research continues on alternate internal combustion fuels, the backrooms of each of the three domestic auto manufacturers have been busy trying to develop a truly usable, purely electric-powered car.

The two single largest design challenges have been performance and range. Until recently, if a car was quick enough, it wouldn't go far enough, and vice versa. But major breakthroughs in electric motor, battery and aerodynamic efficiencies have permitted GM, Ford and Chrysler to make significant progress in developing a real-world electric car.

Electric cars have been going fast since 1968. In November of that year, Ford co-developed the Lead Wedge racer with Autolite, and they set a land speed record of 138.863 mph. Designed by Danny Eames, the Lead Wedge was powered by 20 Autolite High Performance lead-acid car batteries wired in series to a General Electric forklift motor. But what the car achieved in speed, it clearly lacked in range, the limiting factor being battery technology.

Here comes the Sun

In 1987, electric-car development received its next boost when General Motors unveiled its Sunraycer. Developed to compete in solar-powered vehicle races worldwide, the Sunraycer proved to be an enormous success on both the technological and public relations fronts, not to mention its hands-down victory in every

race it entered. Spurred by the engineering success of the Sunraycer and the resulting positive public opinion, GM dove headlong into its leading electric-car project, the Impact.

Based on a 2-place highly aerodynamic platform, the Impact may well be the first electric concept car with a shot at production reality. One of the keys to the car's

Packing the batteries

The power source is a specially designed Delco Remy lead-acid battery, which, to date, is still considered the most cost and production effective method for electric-vehicle power. Impact's battery is a long and narrow unit that simply slides on a rolling tray down the center of the Impact's backbone chassis.



Fill 'er up. Impact's appetite is satisfied by 870 pounds of batteries.

In order to accommodate the 870-pound battery pack, a tunnel had to be run through the center of the interior. This created a challenge to the design team which had to figure out a way to prevent the passengers from becoming claustrophobic. In the end, they used the forward section of the tunnel to mount controls, and the remaining section as an armrest. Recharging is just a matter of running an extension cord out to the side of the car and plugging it in—to a 110-volt socket. Long-term testing has shown that expected battery life should be 20,000 miles before complete unit replacement is necessary, which, in today's market, would cost about \$1200.

Another interesting technical highlight is that Impact's driving motors become generators on the deceleration cycle, and use no power at all when at standstill. In gridlocked traffic patterns, like Los Angeles and New York, these two features could be significant advantages. Accessory units like motor cooling fans, headlights, radio and air conditioning are powered by a separate battery so they won't effect range.

Electric van

Ford Motor Co.'s current feasibility study platform is a converted Aerostar van which features a transaxle that incorporates the electric motor, 2-speed

automatic transmission and drive axle into a single-axis unit. The result is a compact, easily maintained component with fewer parts. Ford's ETX-II Aerostar will maintain a 65-mph average with a 100-mile range. Acceleration to 60 mph is nearly 25 seconds, which puts the Ford entry in the less-than-brisk performance class. Ford's design intent, though, is good for load capacity.

However, despite all the progress in electric-vehicle development, a production electric car is still some time off. GNB, Inc., makers of Champion batteries, indicates that it might well be another five years before the problem of efficient, lead-acid battery recycling is fully solved. Engineering vice president for GNB, Tom Hatterschide, recently stated that: "Although we can currently retrieve 98 percent of the battery's original lead and metallics content, the acid itself is less than 25 percent of original strength and is thereby unusable, requiring expensive reducing and neutralizing to be safely disposed of." And there remains the issue of pollution transference. As GM president, Roger Smith, pointed out at Impact's introduction, "It would be irresponsible of us to expect the present power-generating services to accept the load that a full shift to electric-powered cars would require. This would only shift the pollu-

tion emphasis off of cars and onto power stations." Granted this form of air pollution is easier to control, as it is contained to a specific site, it draws attention to the need to thoroughly preplan the electric car's introduction.

Curbside service

Details like parking meters with electric outlets in them, like those used in Canada for heating engine fluids during subzero weather, would have to be designed and installed. Charging stations, with the ability to sell, service and exchange batteries would have to be set up as well as charging facilities installed at work centers and shopping malls. In short, there's still a sizable amount of homework to be done.

Ford, GM and Chrysler each have experimental electric vehicles in the field being tested by several governmental agencies. School buses, delivery vans and postal vehicles head the list of current test fleets. Their in-service results are being fed directly into the development of the production electric car that manufacturers feel certain is less than 10 years away. Given the current crop of development breakthroughs and some forethought on the part of cities across the country, the electric-powered vehicle is certain to become a reality in the 1990s.

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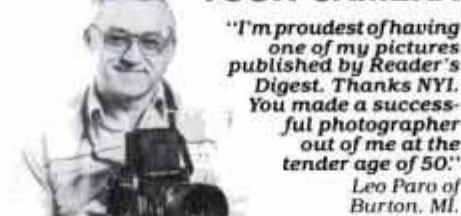
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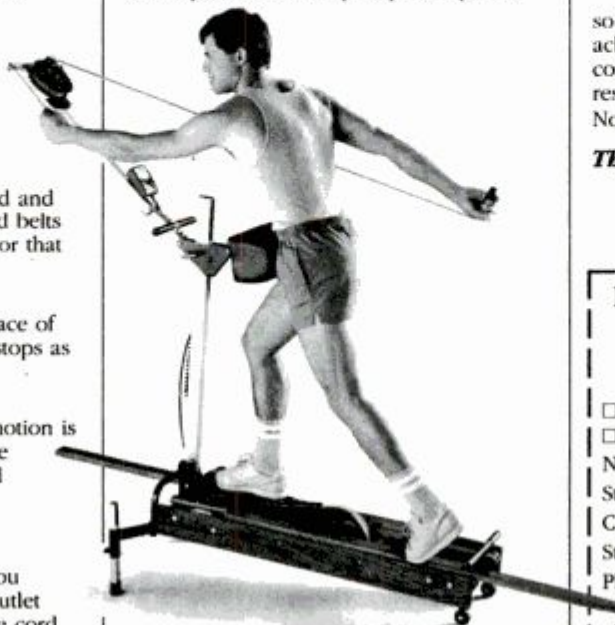
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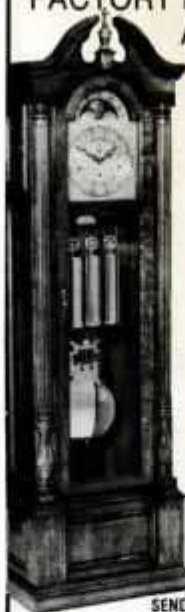
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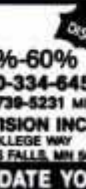
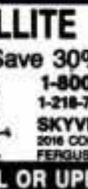
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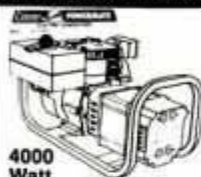
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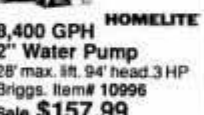
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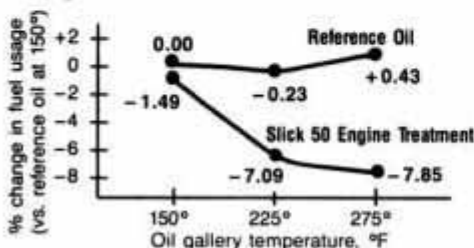
"Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicated that it will improve gas mileage by about two or three miles per gallon . . . Slick 50 does exactly what Petrolon claims it does." *Consumer Digest* (Mar/Apr 1982, p. 35)

In 1989, the premiere engine and lubricant testing lab in the U.S. tested Slick 50. This EPA recognized lab conducted a strictly controlled experiment using industry standard ASTM procedures. Results showed Slick 50, compared to a standard reference oil, reduces engine wear by more than 50%. Be cautious of those Poly treatments that cannot back up their claims with such solid evidence.

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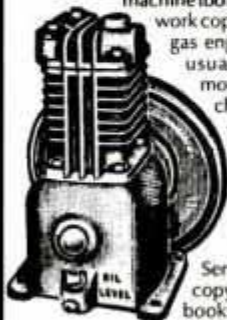
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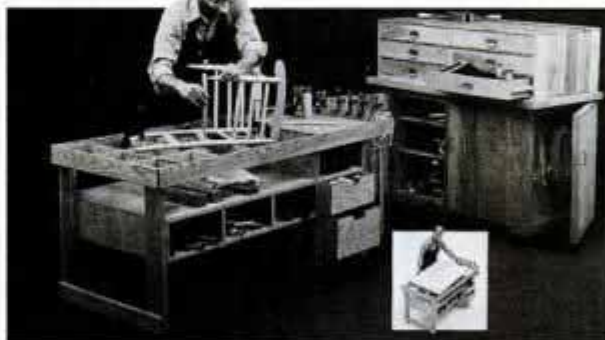
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