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Popular Mechanics

SPECIAL ISSUE

HOME IMPROVEMENT

Essential Fixups And Great Upgrades That Will Add Value And Comfort To Your Home

Plus The Joy Of Doing It Yourself
By Tim Allen

WHICH SOUNDS BETTER, MINIDISC OR DIGITAL COMPACT CASSETTE?

We Sound-Test The Newest Audio Formats

BASEBALL GEAR GOES HIGH TECH

The Equipment Revolution In America's Favorite Pastime

'I LOVE MY CHRYSLER MINIVAN'
Why Owners Rave About The Dodge Caravan, Plymouth Voyager And Chrysler Town & Country



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A CAR LIKE TAURUS.**

SWEET DREAMS.



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While others spend their time dreaming about making a car like Taurus, we've spent ours making America's best-selling car even better.* We've continued to improve everything



Standard driver's and optional right-front passenger air bag supplemental restraint system. Always wear your safety belts.



from Taurus' suspension and handling to its ergonomically designed controls. We even added the security of available anti-lock brakes.

You can wait until the other

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*Based on 1992 calendar year manufacturer's reported retail deliveries.

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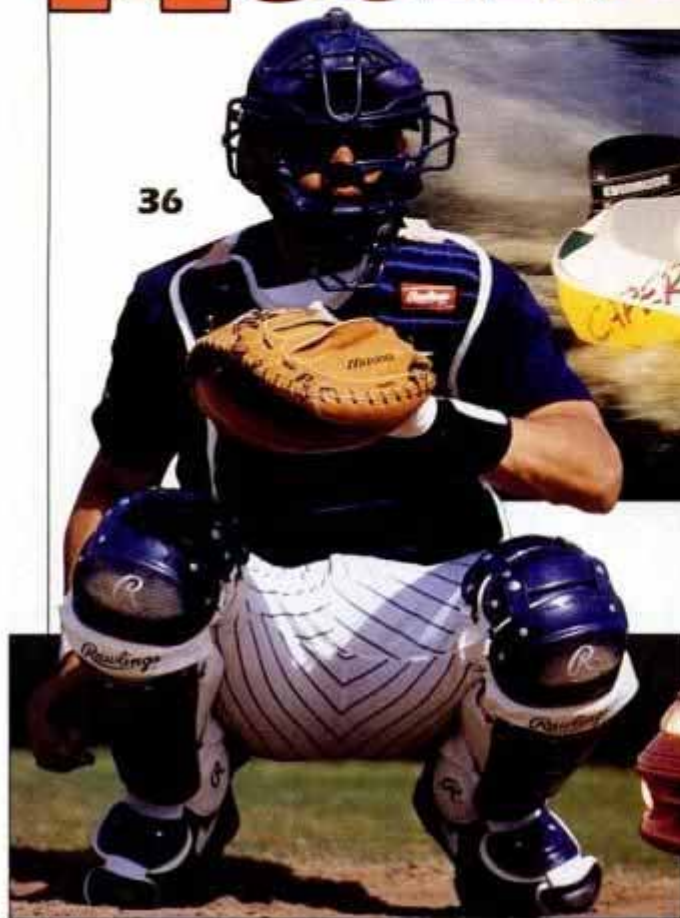


This One



85FP-1LC-BHKJ

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is not to offend."**

Chuck Norris



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EDITOR'S NOTES

• Okay, that's it. You've been putting off those household projects long enough. All winter, in fact. So now it's time. Time to get those tools in shape, build that deck, paint those rooms, repair those windows and waterproof that basement. To help you get motivated, turn to the annual Home Improvement Guide in this issue. It has all the information you need to tackle those jobs and others around your home. And while Home Improvement Editor Steve Willson and his staff were putting the articles together, Graphics Director Bryan Canniff was in Los Angeles to shoot our cover with the greatest do-it-yourselfer of all time, Tim Allen. "Home Improvement" TV-star Allen gives you



Graphics Director Bryan Canniff and "Home Improvement" star Tim Allen on the set.

his personal insights into D-I-Y in a special essay on page 68. So I hope you find this year's Guide not only helpful and informative, but also an interesting read. . . . Seems like all you read about lately is how Chrysler is on a roll. Its minivans have been a smash hit since day one. The Jeep Grand Cherokee has been selling off the chart since it was introduced last spring. And now the LH family of sedans is the latest home run out of Highland Park. We even climbed on the bandwagon and awarded Chrysler's LH cars a PM Design & Engineering Award this year. So now comes the final test. We took one Dodge Intrepid and pitted it on road and track against the best of the family sedan class. Our auto editors tell you how it fared starting on page 27. . . . And owners of Dodge Caravans, Plymouth Voyagers and Chrysler Town & Countrys tell you how they fared after actually putting up cold cash to buy a Chrysler minivan in the Owners Report that starts on page 55. Hint on the outcome: Go back and look at the cover blurb. . . . Hey, we finally finished our '67 Camaro restoration. We've been getting lots of mail from other Camaro owners, which is great. Let me know how you like ours, pictured on page 52. . . . There is no position in baseball that is tougher than catcher. It's also the most dangerous and, therefore, the most protective-equipment intensive. In case you haven't noticed, the stuff strapped on every inning by Benito Santiago is a far cry from what Roy Campanella used to wear in 1953. The fascinating evolution is chronicled, beginning on page 36. Till next time.


Joe Oldham

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Don't lose another hair without getting the medical facts:

Take 2 minutes to learn about your best chance to regrow hair.

ROGAINE® Topical Solution (minoxidil 2%) is the only product ever proven to regrow hair. So isn't it worth your time to find out about it — even if it gets a little technical?

How hair grows:

Hair grows in cycles. There's a growth phase, then a resting and shedding phase. Usually, everyone loses some hair during the shedding phase. But male pattern baldness (androgenetic alopecia), the most common form of hair loss in men, is different. It shortens the hair's growth phase. So hair grows less and rests longer, resulting in thin hairs that are barely visible. Eventually there is no growth at all.

How Rogaine regrows hair:

ROGAINE works in part by prolonging the growth phase. With more hairs growing longer and thicker at the same time, you may see improved scalp coverage.

No one can predict how well ROGAINE will work for you. But research suggests that patients having a large number of growing hairs (at least $\frac{3}{8}$ inch or longer) seem to have a better response.

Dermatologists conducted 12-month clinical tests. After 4 months, 26% of patients using ROGAINE reported moderate to dense hair regrowth,

compared with 11% of those using a placebo (a similar solution without minoxidil — the active ingredient in ROGAINE). After 1 year, 48% of the men who continued in the study using ROGAINE rated their regrowth as moderate to dense. Thirty-six percent reported minimal regrowth. The rest (16%) had no regrowth.

Side effects were minimal: 7% of those who used ROGAINE had itching of the scalp. ROGAINE should only be applied to a normal, healthy scalp (not sunburned or irritated).

Make a 4 to 6 month commitment to see results:

Studies indicate that *at least 4 months of twice-daily treatment* with ROGAINE are usually necessary before there is evidence of regrowth.

As you'd expect, if you are older, balding longer, or have a larger area of baldness, you may do less well.

ROGAINE is a treatment, not a cure. So further progress is possible only by using it continuously. Some anecdotal reports indicate that if you stop using ROGAINE, you will probably shed the newly regrown hair within a few months.

Here's what you should do:

Individual results vary widely. So discuss your hair loss with your doctor to understand what you can realistically expect. Only a doctor can prescribe ROGAINE. So see a *dermatologist or another doctor experienced in treating hair loss* today. Why just accept what nature has handed you when you can fight back?

For more information, a list of doctors near you, and a \$10 certificate as an incentive to visit your doctor, call this toll-free number: 1-800-759-4073.

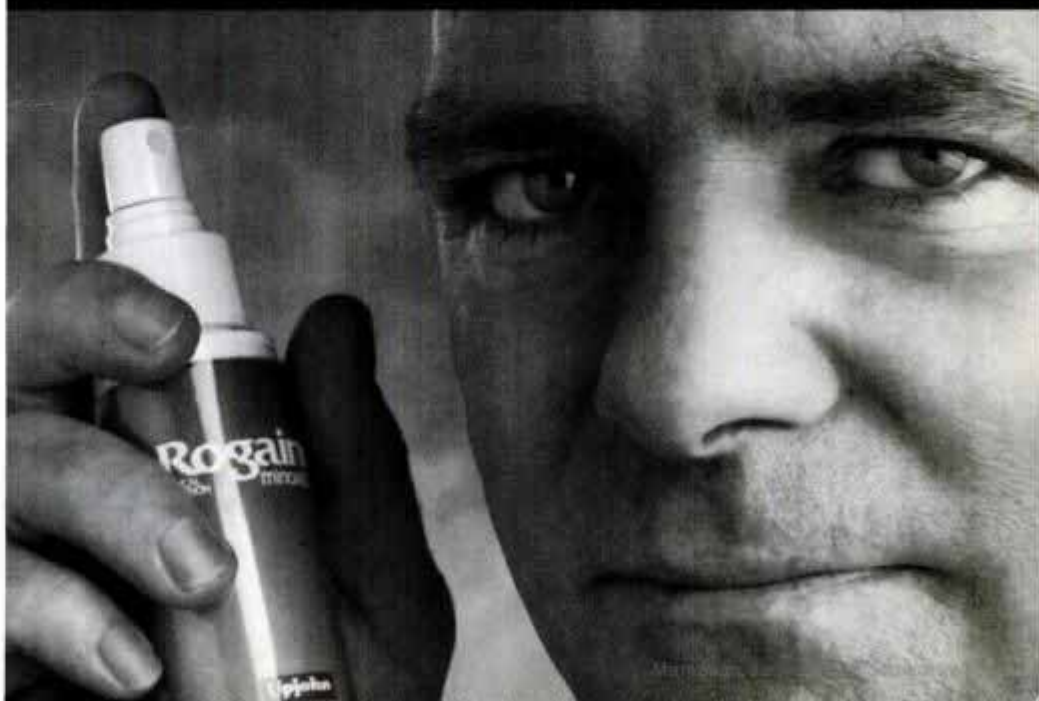
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Fight back with Rogaine®

TOPICAL SOLUTION minoxidil 2%





The only product ever proven to regrow hair.

What is ROGAINE?

ROGAINE Topical Solution is a prescription medicine for use on the scalp that is used to treat a type of hair loss in men and women known as androgenetic alopecia: hair loss of the scalp vertex (top or crown of the head) in men and diffuse hair loss or thinning of the front and top of the scalp in women. ROGAINE is a topical form of minoxidil, for use on the scalp.

How effective is ROGAINE?

In men: Clinical studies with ROGAINE of over 2,300 men with male pattern baldness involving the top (vertex) of the head were conducted by physicians in 27 US medical centers. Based on patient evaluations of regrowth at the end of 4 months, 26% of the patients using ROGAINE had moderate to dense hair regrowth compared with 11% who used a placebo treatment (no active ingredient). No regrowth was reported by 41% of those using ROGAINE and 60% of those using a placebo. By the end of 1 year, 48% of those who continued to use ROGAINE rated their hair growth as moderate or better.

In women: Clinical studies with ROGAINE were conducted by physicians in 11 US medical centers involving 256 women with hair loss. Based on patient evaluations of regrowth after 32 weeks (8 months), 19% of the women using ROGAINE had at least moderate regrowth compared with 7% of those using a placebo. No regrowth was reported by 41% of the group using ROGAINE and 60% of the group using placebo.

How soon can I expect results from using ROGAINE?

Studies show that the response time to ROGAINE may differ greatly from one person to another. Some people using ROGAINE may see results faster than others; others may respond with a slower rate of hair regrowth. You should not expect visible regrowth in less than 4 months.

How long do I need to use ROGAINE?

ROGAINE is a hair-loss treatment, not a cure. If you have new hair growth, you will need to continue using ROGAINE to keep or increase hair regrowth. If you do not begin to show new hair growth with ROGAINE after a reasonable period of time (at least 4 months), your doctor may advise you to discontinue using ROGAINE.

What happens if I stop using ROGAINE? Will I keep the new hair?

Probably not. People have reported that new hair growth was shed after they stopped using ROGAINE.

How much ROGAINE should I use?

You should apply a 1-ml dose of ROGAINE twice a day to your clean dry scalp, once in the morning and once at night before bedtime. Wash your hands after use if your fingers are used to apply ROGAINE. ROGAINE must remain on the scalp for at least 4 hours to ensure penetration into the scalp. Do not wash your hair for at least 4 hours after applying it. If you wash your hair before applying ROGAINE, be sure your scalp and hair are dry when you apply it. Please refer to the Instructions for Use in the package.

What if I miss a dose or forget to use ROGAINE?

Do not try to make up for missed applications of ROGAINE. You should restart your twice-daily doses and return to your usual schedule.

What are the most common side effects reported in clinical studies with ROGAINE?

Itching and other skin irritations of the treated scalp area were the most common side effects directly linked to ROGAINE in clinical studies. About 7 of every 100 people who used ROGAINE (7%) had these complaints.

Other side effects, including light-headedness, dizziness, and headaches, were reported both by people using ROGAINE and by those using the placebo solution with no minoxidil. You should ask your doctor to discuss side effects of ROGAINE with you.

People who are extra sensitive or allergic to minoxidil, propylene glycol, or ethanol should not use ROGAINE.

ROGAINE Topical Solution contains alcohol, which could cause burning or irritation of the eyes or sensitive skin areas. If ROGAINE accidentally gets into these areas, rinse the area with large amounts of cool tap water. Contact your doctor if the irritation does not go away. If the spray applicator is used, avoid inhaling the spray.

What are some of the side effects people have reported?

ROGAINE was used by 3,857 patients (347 females) in placebo-controlled clinical trials. Except for dermatologic events (involving the skin), no individual reaction or reactions grouped by body systems appeared to be more common in the minoxidil-treated patients than in placebo-treated patients.

Dermatologic: irritant or allergic contact dermatitis—7.36%; **Respiratory:** bronchitis, upper respiratory infection, sinusitis—7.16%; **Gastrointestinal:** diarrhea, nausea, vomiting—4.33%; **Neurologic:** headache, dizziness, faintness, light-headedness—3.42%; **Musculoskeletal:** fractures, back pain, tendonitis—2.59%; **Cardiovascular:** edema, chest pain, blood pressure increases/decreases, palpitations, pulse rate increases/decreases—1.53%; **Allergic:** nonspecific allergic reactions, hives, allergic rhinitis, facial swelling, and sensitivity—1.27%; **Metabolic-Nutritional:** edema, weight gain—1.24%; **Special Senses:** conjunctivitis, ear infections, vertigo—1.17%; **Genital Tract:** prostaticitis, epididymitis, vaginitis, vulvitis, vaginal discharge/itching—0.91%; **Urinary Tract:** urinary tract infections, renal calculi, urethritis—0.93%; **Endocrine:** 0.47%; **Psychiatric:** anxiety, depression, fatigue—0.36%; **Hematologic:** lymphadenopathy, thrombocytopenia—0.31%.

ROGAINE has been monitored for up to 5 years, and there has been no change in incidence or severity of reported adverse reactions. Additional adverse events have been reported since marketing ROGAINE and include eczema; hypertrichosis (excessive hair growth); local erythema (redness); pruritus (itching); dry skin/scalp flaking; sexual dysfunction; visual disturbances, including decreased visual acuity (clarity); increase in hair loss; and alopecia (hair loss).

What are the possible side effects that could affect the heart and circulation when using ROGAINE?

Serious side effects have not been linked to ROGAINE in clinical studies. However, it is possible that they could occur if more than the recommended dose of ROGAINE was applied, because the active ingredient in ROGAINE is the same as that in minoxidil tablets. These effects appear to be dose related; that is, more effects are seen with higher doses.

Because very small amounts of minoxidil reach the blood when the recommended dose of ROGAINE is applied to the scalp, you should know about certain effects that may occur when the tablet form of minoxidil is used to treat high blood pressure. Minoxidil tablets lower blood pressure by relaxing the arteries, an effect called vasodilation. Vasodilation leads to fluid retention and faster heart rate. The following effects have occurred in some patients taking minoxidil tablets for high blood pressure:

Increased heart rate: some patients have reported that their resting heart rate increased by more than 20 beats per minute.

Salt and water retention: weight gain of more than 5 pounds in a short period of time or swelling of the face, hands, ankles, or stomach area.

Problems breathing: especially when lying down; a result of a buildup of body fluids or fluid around the heart.

Worsening or new attack of angina pectoris: brief, sudden chest pain.

When you apply ROGAINE to normal skin, very little minoxidil is absorbed. You probably will not have the possible effects caused by minoxidil tablets when you use ROGAINE. If, however, you experience any of the possible side effects listed above, stop using ROGAINE and consult your doctor. Any such effects would be most likely if ROGAINE was used on damaged or inflamed skin or in greater than recommended amounts.

In animal studies, minoxidil, in much larger amounts than would be absorbed from topical use (on skin) in people, has caused important heart-structure damage. This kind of damage has not been seen in humans given minoxidil tablets for high blood pressure at effective doses.

What factors may increase the risk of serious side effects with ROGAINE?

People with a known or suspected heart condition or a tendency for heart failure would be at particular risk if increased heart rate or fluid retention were to occur. People with these kinds of heart problems should discuss the possible risks of treatment with their doctor if they choose to use ROGAINE.

ROGAINE should be used only on the balding scalp. Using ROGAINE on other parts of the body may increase minoxidil absorption, which may increase the chances of having side effects. You should not use ROGAINE if your scalp is irritated or sunburned, and you should not use it if you are using other skin treatments on your scalp.

Can people with high blood pressure use ROGAINE?

Most people with high blood pressure, including those taking high blood pressure medicine, can use ROGAINE but should be monitored closely by their doctor. Patients taking a blood pressure medicine called guanethidine should not use ROGAINE.

Should any precautions be followed?

People who use ROGAINE should see their doctor 1 month after starting ROGAINE and at least every 6 months thereafter. Stop using ROGAINE if any of the following occur: salt and water retention, problems breathing, faster heart rate, or chest pains.

Do not use ROGAINE if you are using other drugs applied to the scalp such as corticosteroids, retinoids, petrolatum, or agents that might increase absorption through the skin. ROGAINE is for use on the scalp only. Each 1 mL of solution contains 20 mg minoxidil, and accidental ingestion could cause unwanted effects.

Are there special precautions for women?

Pregnant women and nursing mothers should not use ROGAINE. Also, its effects on women during labor and delivery are not known. Efficacy in postmenopausal women has not been studied. Studies show the use of ROGAINE will not affect menstrual cycle length, amount of flow, or duration of the menstrual period. Discontinue using ROGAINE and consult your doctor as soon as possible if your menstrual period does not occur at the expected time.

Can ROGAINE be used by children?

No, the safety and effectiveness of ROGAINE has not been tested in people under age 18.

Caution: Federal law prohibits dispensing without a prescription. You must see a doctor to receive a prescription.



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PM HOTLINES

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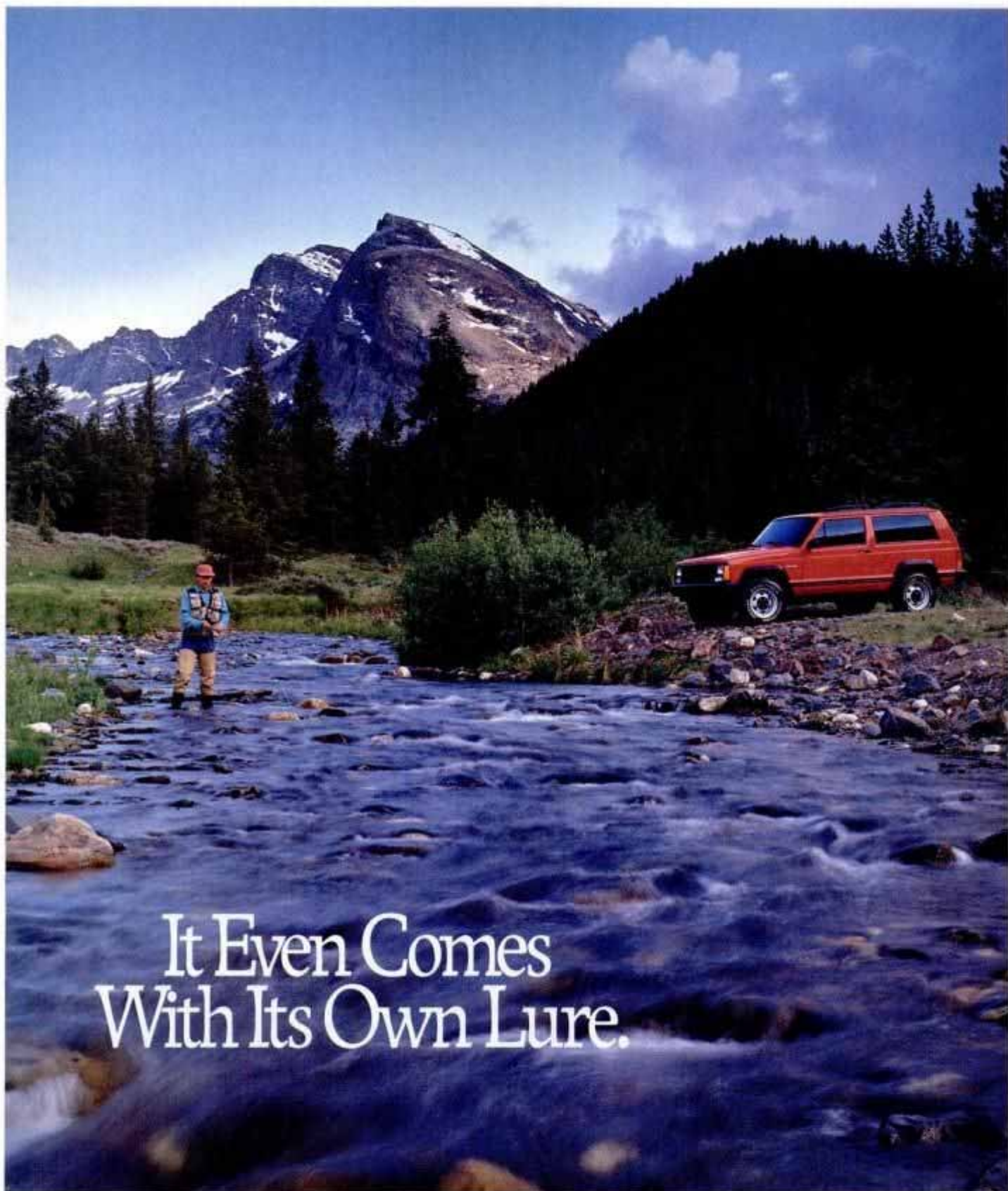


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LETTERS

Flying High



A helicopter in every garage? Not! How about one on every acreage to begin with. I'm sure those living in the country who commute hours every day into the city to work could improve their quality of life if they owned such a marvelous craft. Your article gives a well-balanced insight into the capabilities of the homebuilt helicopter, but as a veteran rotary-wing pilot I couldn't help notice that you transposed the in and out of ground-effect figures for the Mini 500. The remainder of the article, however, was accurate enough to heighten my interest in both the Mini 500 and CH-7 Angel.

TRACY TYNDALL
CARP, ONTARIO, CANADA

Science/Technology Editor Abe Dane replies: *The ground-effect figures looked strange to us too, but the Mini 500's maker stands by them, citing the aircraft's high-mounted rotor.*

I'm an aeronautical engineering student at Wichita State University and I usually refrain from purchasing magazines. But your cover story on "Sky Scoot-

ers" caught my eye. I've been looking for current, quantitative information on homebuilt helicopters and your magazine delivered with flying colors. You've rejuvenated my interest in owning one someday. Thank you.

NEAL E. MAY
WICHITA, KS

It Fits The Bill

You stated that Jim DeLaurier and Jerry Harris built the first true Ornithopter, but didn't the Smithsonian commission a man to build one three or four years ago? I remember seeing pictures of a scale pterodactyl flying under its own "wings" years ago.

DOUG PACKER
EULESS, TX

Science/Technology Editor Abe Dane replies: *Several readers have questioned whether the ornithopter that received PM's 1992 Design & Engineering Award was really the first of its kind. So far, however, no one's come forward with compelling evidence of prior flights by machines that we think can properly be called ornithopters. Our definition (see "The First Ornithopter," page 96, Jul. '92) is simply "a machine that flies like a bird." That means*

it has to have two flapping wings (not partial-span flapping tips), it must be controllable and it must have achieved sustained flight (not a powered glide, like the pterodactyl reader Packer mentions, or a rubber-band-powered hop). Like any definition, it's arbitrary, but you have to draw the line someplace. Now that we've spelled it out, we'd be glad to know of any prior machines that fit the bill.

Old Car Restoration

My husband and I have been reading about your Camaro restoration project with great interest. We ordered my Camaro in June of '69 while living in Chattanooga, Tennessee. It's in excellent condition and has all of the original equipment, including paint, convertible top and vinyl rear window. It has a 350 V8 engine with power windows, power brakes, automatic transmission and only 55,000 actual miles on it. My husband promised me a convertible when we got married, and he kept

his word. As you can see by its mint condition, it's my pride and joy.

BUNNY & SPEEDY SPEAR
FORT MYERS BEACH, FL

I am a 17-year-old arm-chair mechanic who is trying to teach himself how to work on cars and I found your series very interesting and exciting. The fact that I drive an '86 Camaro made it even better.

MATT TIMPANY
TOPEKA, KS

I would like to point out that the first step in any restoration should be research. Find out exactly what you have and what it should be. If you decide to deviate from that, at least you will know what you'll end up with.

HERB GRIFFIN
FORD RESTORATIONS
ST. JOHNSVILLE, NY

This has been one of the most interesting series you've ever published. I bought a 1972 Corvette that needs to be restored and the source list you provided has been helpful. I have called several of the suppliers and am beginning to collect catalogs for when I take my Vette off the road.

THOMAS H. ALSBROOKS
ALBUQUERQUE, NM

It was nice to see a good general article on auto restoration. However, no where was it mentioned that in 1954 POPULAR MECHANICS published the first known book on this subject, "How To Restore Antique And Classic Cars." It started me on my more than 30-year interest in working with old cars.

JIM SCHILD
FLORISSANT, MO



As the original owner of this 1969 Camaro convertible, reader Bunny Spear has kept her classic in mint condition.

Letters are subject to editing for length, style and format.

TIME MACHINE

90 YEARS AGO: APRIL 1903

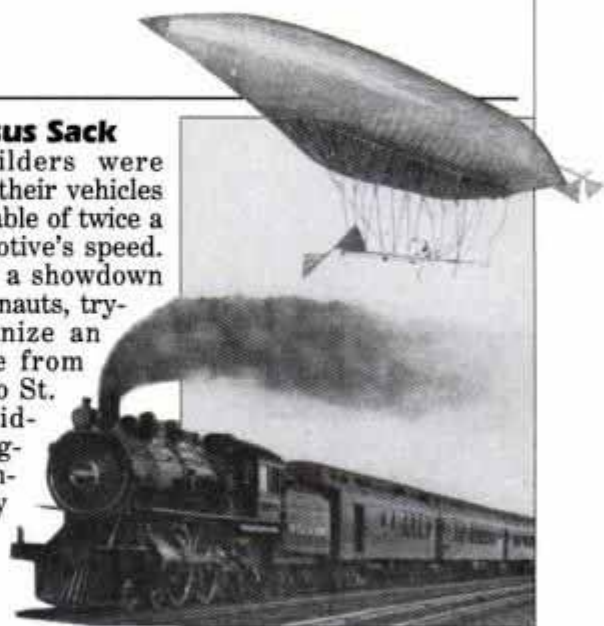


Worth Its Salt

In Death Valley, America's borax barons made their fortunes by exploiting the region's inhospitable "scum marshes." Workers stripped off the crystalline crust, and mule teams hauled the mineral to ramshackle borax works, where crushers pulverized it into a fine powder. Purified by repeated precipitation, borax was then shipped around the world for such varied uses as meat preservation, soldering flux and soap.

Track Versus Sack

Airship builders were pumping up their vehicles as being capable of twice a steam locomotive's speed. For a while a showdown loomed. Aeronauts, trying to organize an airship race from New York to St. Louis, considered challenging the Twentieth Century Limited, the world's fastest long-distance train.

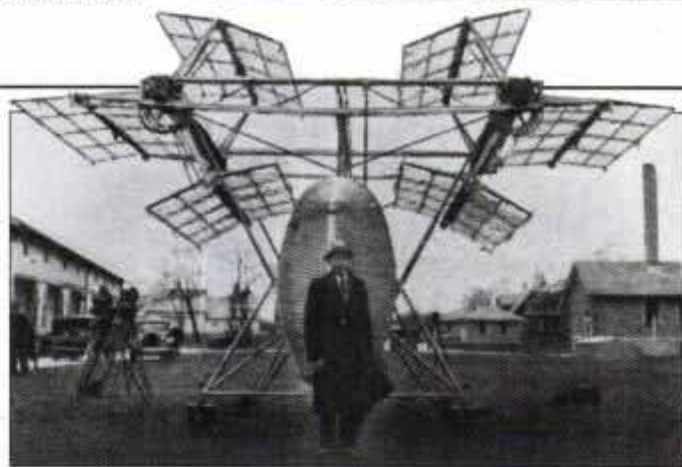


60 YEARS AGO: APRIL 1933



Flying Boat

Aviation's golden age inspired some real flights of fancy. For example, a London model-plane designer grafted oceanliner features into a proposed trans-Atlantic airliner. A glassed-in promenade deck would run atop the main cabin, shielded from engine noise by arched wing roots. Should the plane be forced down in water, the wings would jettison and tail-mounted water propellers would spin into action, whisking the fuselage to shore.

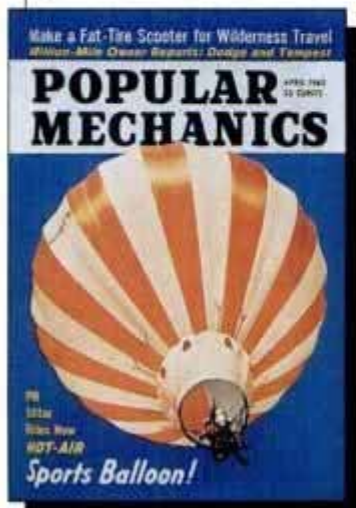


Flapping Goose

Meanwhile, a New Jersey inventor promised birdlike flight in the "Gray Goose." As six wings rotated, the

blades turned horizontal on the downstroke and vertical on the upstroke. Unreported is whether anyone braved the cockpit.

30 YEARS AGO: APRIL 1963



Hot Air

From the Stratosphere Bowl—the Black Hills valley where the Army launched high-altitude balloons—we tried out the latest in sport hot-air balloons. Derived from a naval research balloon, the one-man *Vulcoon* was designed to take the work out of ballooning. Seated beneath two burners, the pilot simply kept an eye on three instruments and a hand on one of two valves. Our verdict: "Most pleasant and exhilarating."

Stress Test

Science had caught up with life's day-to-day strains. NASA had an electronics package gauge stress by measuring heart rate, respiration rate and skin temperature. Researchers found that roller-coaster riders were far more rattled than John Glenn was during his Earthward plunge in a Mercury capsule. And Glenn's heart and respiration rates during his orbits were easily exceeded by palpitating freeway drivers. **PM**



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Tampering sets off a loud electronic warning.

TriggerAlarm is not a keyed lock. Removing it requires somewhat greater dexterity than opening a "child guard" medicine cap. In an emergency, an adult can disarm the alarm with a 2-digit security code. But for children, TriggerAlarm is difficult to remove, and can be an effective deterrent.

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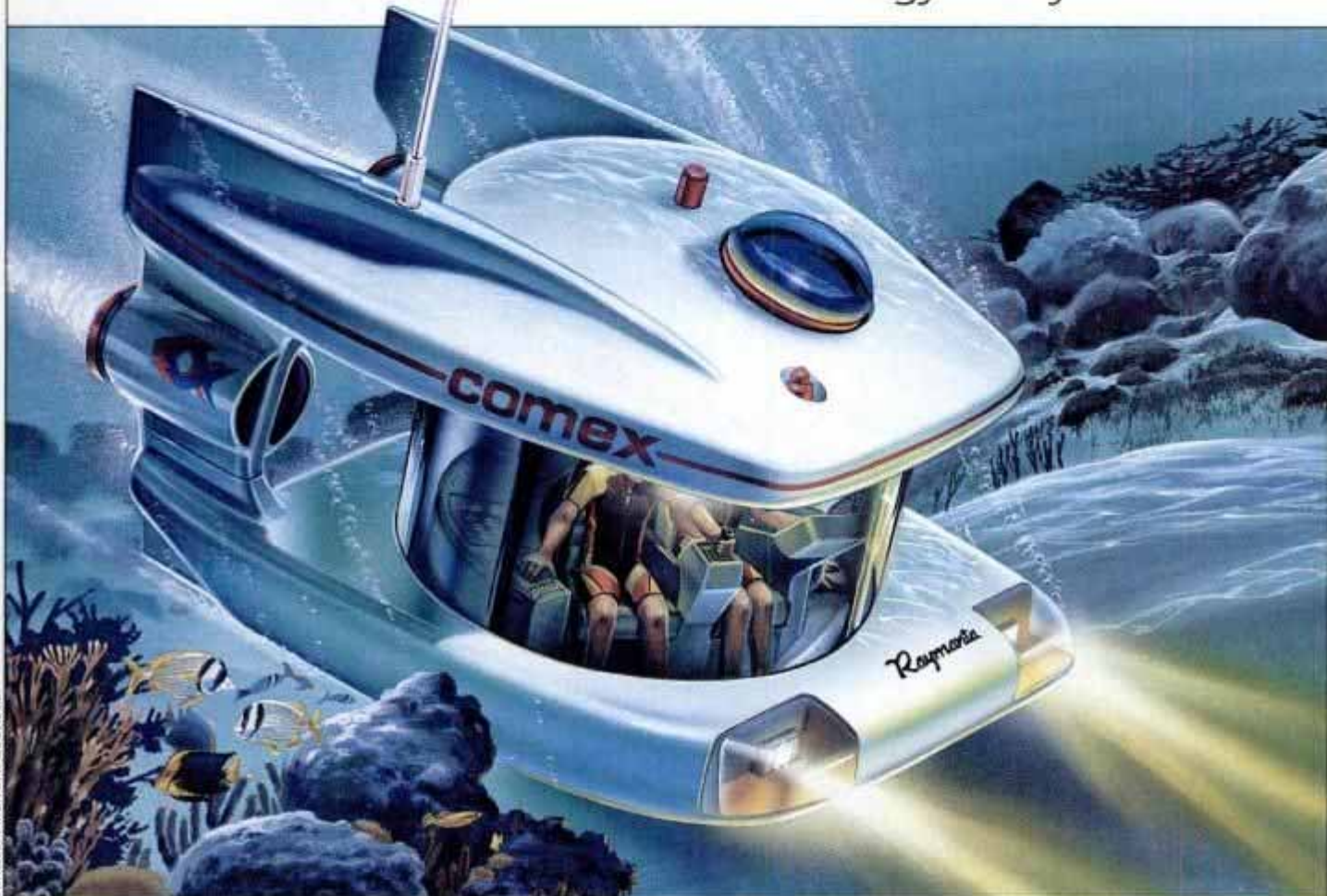
•No gun lock or safety device, including TriggerAlarm and TriggerShield, can offer absolute protection against the accidental or deliberate misuse of guns. Keep your gun unloaded and out of the reach of children.



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TECH UPDATE

News Of Tomorrow's Technology Today



Personal Viewmobile Of The Deep

MARSEILLES, FRANCE—Submersibles with clear plastic hulls have the potential to revolutionize underwater leisure. So far, however, only the French outfit Comex Marine Parks has put one in regular operation—the Seabus, currently diving off the coast of Monte Carlo. Now Comex is scaling down the same acrylic-hull technology to give small groups and well-heeled individuals deep-sea views.

The Raymanta 6 vaguely suggests a bulbous, aquatic Honda Civic—although at \$1 million, it's hardly an economy vehicle.

Beyond its acrylic hull, the little submersible has

an unusual upper fairing. Small underwater vehicles are typically topped with a flanged deck that provides at least 30 in. of freeboard to allow disembarking in choppy waters. But the Raymanta's slim upper surface is sculpted for hydrodynamics.

That means Raymanta must dock with a dedicated mothership or pontoon to load and unload passengers. If seas are too rough, a rubber buoyancy tube will inflate around the hull to pop the sub's top 3 ft. above the waves.

Comex will fit the sub

with the usual safety measures required for classification by the American Bureau of Shipping.

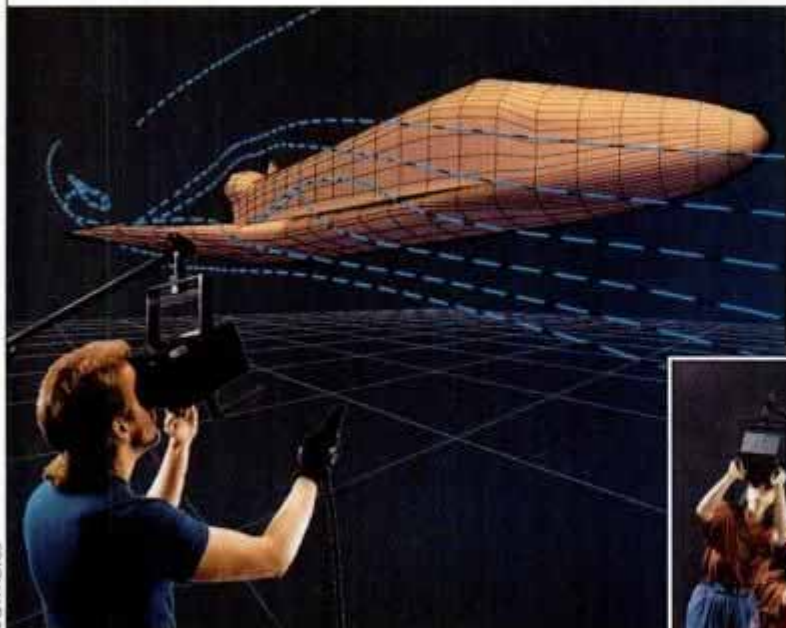
With clear, 8½-ft.-dia. pressure hull, streamlined Raymanta 6 scoots to 200-ft. depths on twin 2½-hp thrusters.

Highlights This Month

- **Wind Tunnels Of Your Mind**—Virtual-reality aerodynamics.
- **Ground-Up Chopper**—New copter is first clean-sheet design in a decade.
- **Incredible Shrinking Dome**—Telescope building telescopes itself.
- **Ballistic Birdshot**—Hyperspeed weapons carry shotgun warheads.
- **Hail To The Caddy**—President Clinton's White House wheels.
- **Ready AIM Fired**—AIM-120A AMRAAM missile makes its debut.

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributors: Philip Chien, Mike Fillon

Wind-Tunnel Vision



MOFFET FIELD, CA—Researchers can now explore aerodynamic cyberspace with the Virtual Wind Tunnel, developed at NASA's Ames Research Center.

The system harnesses a supercomputer and two virtual-world interfaces: a VPL Dataglove, which tracks hand motions,

and a stereo display.

First the computer calculates the twists and turns of air flowing over a surface, loading the data into memory. Peering through the display, the user then perceives himself to be in a vast chamber with the test object.

The Dataglove allows the user to place or rearrange visualization tools in the virtual airflow—especially so-called buggers, which release a steady stream of particles into the wind. A user can also shrink himself to be enveloped by a vortex, hover over the entire flow field and even run time backward.

Other institutions are adopting the hardware to visualize water flow and cosmological phenomena.

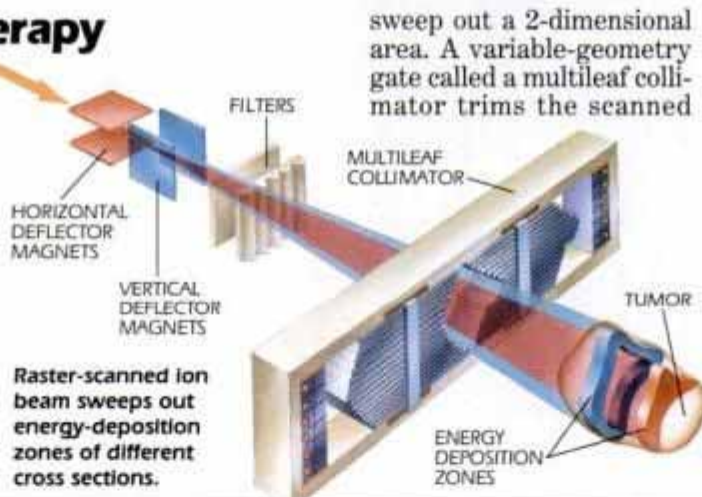


Virtual Wind Tunnel allows researchers to highlight flow field and swing point of view to different positions.

Raster Beam Therapy

BERKELEY, CA—Engineers at Lawrence Berkeley Laboratory are fine-tuning a technique that delivers a barrage of tumor-killing particles the way an electron gun delivers a TV picture.

In 3D conformal therapy, a beam of heavy ions shoots from the lab's Bevatron particle accelerator. The ions pass through raster-scanning magnets that cause the beam to



sweep out a 2-dimensional area. A variable-geometry gate called a multileaf collimator trims the scanned

area to match the cross section of a tumor at a given depth.

Swapped in and out between magnets and collimator, filters absorb some of the ions' energy to vary their penetrating power. As a result, the scanning beam can deposit its energy in a series of cross-sectional layers until the entire depth of the tumor has been blasted.

The lab has treated some patients on an experimental basis.

Showstopper Chopper

MESA, AZ—A new McDonnell Douglas helicopter hovered in its maiden flight December 18, marking the debut of the first clean-sheet helicopter design in more than a decade.

Whereas most new civilian helicopter designs derive from existing

MD Explorer hops into the air during 20-minute maiden flight.

military aircraft, the MD Explorer was blueprinted from scratch.

The 8-place, twin-engine

chopper shares its no-tail-rotor technology with its smaller cousin, the MD 520N, introduced in 1991.

Weighing in at only 3000 pounds, the Explorer can hoist another 3000 pounds or carry 2550 pounds internally.

Contributing to this performance is its composite fuselage—a blend of Kevlar, carbon-epoxy and fiberglass.

McDonnell Douglas expects FAA certification by October 1994, with deliveries beginning thereafter. And a military version is already on the drawing board.



(More Tech Update on page 16)

We have seen
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The 1993 Buick Roadmaster Sedan meets the 1997 federal side-impact standard — four years in advance.

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safety standard today, four years in advance. With a standard driver air bag, anti-lock brakes and a full-perimeter frame, the Roadmaster Sedan is a very safe car to drive.

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Countdown For Comet

WALLOPS ISLAND, VA—A small constellation of fledgling space companies has been working to get the first Commercial Experimental Transporter, or Comet, ready for launch.

Scheduled at press time for a March 31 blastoff, the rocket will carry a double payload. While an unpressurized service module remains in orbit, a pressurized recovery module will

plunge back to Earth a month after launch. Comet will put recoverable research—materials processing and the like—in microgravity for twice the duration of a long Shuttle flight.

Last October, Space In-



Engineers assemble microgravity experiments from academia and industry, while rented Canberra drop-tests Comet recovery system.

Investigators there will be able to manage orbiting experiments.

The second Comet flight will include some unprecedented orbital acrobatics. At the end of the mission, the service module will dock autonomously with that left over from the first Comet flight. Unlike the Russians, NASA has only docked spacecraft under astronaut control.

dustries Inc. (SII) tested the parachute/airbag recovery system by dropping a mockup off an old British Canberra bomber rented from a private owner.

Meanwhile, in Webster, Texas, SII has set up a small mission-control center, consisting simply of computers, telemetry terminals and projection TVs.



Simple, privately run mission-control center tracks Comet.

Telescoping Scope Dome

KIRTLAND AFB, NM—Engineers are putting the finishing touch on the adaptive optics facility at the Starfire Optical Range (see "Star Search," page 60)—an observatory

that itself telescopes.

Built by Coast Steel and Bradbury & Stamm, the building looks like a cylindrical steel water tank capped by a flat dome. During use, the building

folds down around the telescope like a collapsible cup. Not only does this free trapped interior air that causes local turbulence, but the telescope is then free to rotate at an astonishing 11° per second.

Phillips Laboratory will use the telescope—the Defense Department's biggest ever—for missile-tracking experiments.

Crane lowers gimbal and mount for Starfire telescope through roof of collapsible dome.



Magnetic Juice Holder

LOS ALAMOS, NM—Physicists at Los Alamos National Laboratories say they've overcome a critical drawback of the magnetic energy-storage ring—a proposed ½-mile-wide coil of superconducting cable, flooded with electrical current. The unhealthy intensity of its electromagnetic field would create a broad forbidden zone around such a ring.

The Los Alamos solution is to build modules with eight smaller rings, roughly 17 ft. in diameter. In each ring, the current would flow in the opposite direction of its neighbors. As a result, the field strength would drop off sharply with distance from the module.

Modular energy-storage cylinders feature eight coils and little electromagnetic pollution.

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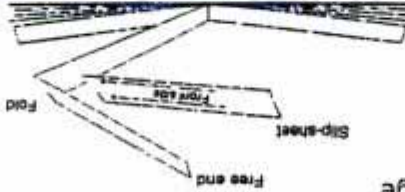
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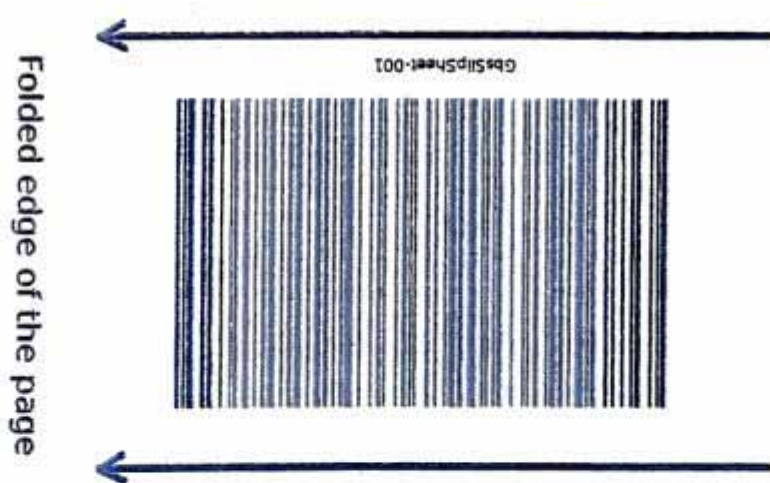
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Foldout slip-sheet



Inverted Foldout slip-sheet

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Inverted Back

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Shotgun Bullets

ZURICH, SWITZERLAND—The Swiss firm Oerlikon-Contraves is developing a new generation of anti-aircraft ammunition with the smarts to use last-second fire-control data in deciding when to deploy a lethal blast of fragments. This combination of precision timing and kinetic impact should be just the ticket for fast-moving targets like standoff missiles.

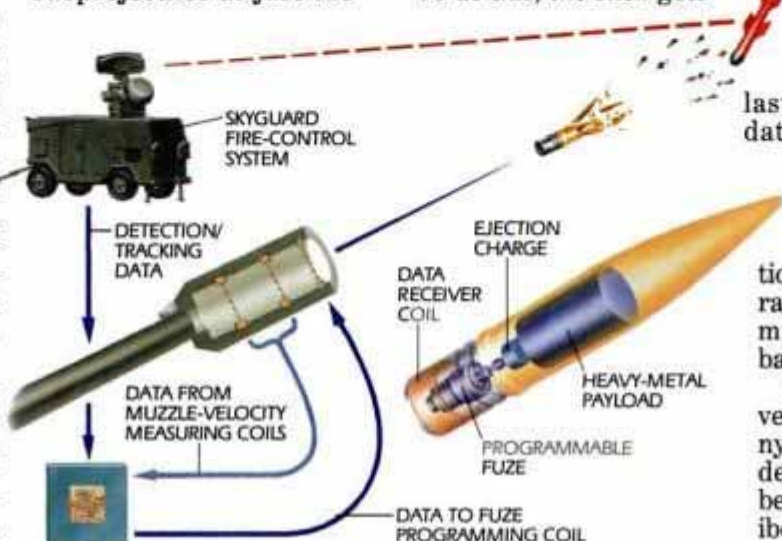
Called AHEAD (for Advanced Hit Efficiency And Destruction), the ammo incorporates a programmable fuze and a heavy-metal payload that breaks

into a swarm of spin-stabilized subprojectiles. An AHEAD shell blows out its subprojectiles at just the

right moment in front of a moving aerial target.

To do this, the shell gets

AHEAD ammo picks up fuze-timing instructions as it passes through the gun muzzle, with devastating effect for the missile target.



last-minute fuze-setting data from the muzzle of the gun. Two coils measure the shell's speed and combine it with target information from the fire-control radar. A third coil transmits the time setting back to the shell.

The ammo is under development for the company's 35mm SkyGuard air-defense guns, but could be adapted for other calibers in the future.



Saddam, Meet AMRAAM

INCIRLIK, TURKEY—Last December 27, the Iraqi Air Force was unfortunate enough to get a firsthand introduction to the Advanced Medium-Range Air-to-Air Missile, the AIM-120A AMRAAM.

Although the Mach-4 missile was designed to give fighter pilots extra firing range, its first combat use came as an F-16C of the 363rd Fighter Wing and an Iraqi MiG-25 closed head-on to within only 3

miles of each other in Iraq's disputed southern "no-fly" zone.

First introduced in 1988, AMRAAM has a top range of more than 31 miles. Steered initially by guidance information from the carrier aircraft, the 12-ft., 345-pound missile switches

to its own nose-mounted active radar, allowing the pilot to veer away as it homes in.

Production of the missile continues at Hughes and Raytheon plants. Planned upgrades include subtleties such as electronic counter-countermeasures.

Shaped-Charge Space Junk

SAN ANTONIO, TX—Tank-killing shaped-charge warheads are finding peaceful employment as space-debris simulators in a unique facility at Southwest Research Institute. The hypervelocity launcher shoots small projectiles at speeds that even gas guns can't match.

The device uses an anti-tank round, which has its

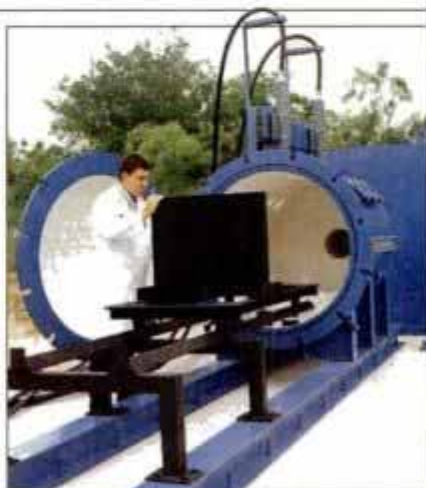
nose hollowed out into a funnel-shaped cavity lined with metal. When detonated, the cavity concentrates the blast the way a reflector lamp focuses light. The result: The lining melts and shoots forward in a narrow armor-piercing jet.

The jet can hit velocities of nearly 25,000 miles per hour—the same speeds reached by orbiting debris. To give their research verisimilitude, SWRI engineers had to rig the round

to spit out a spherical glob rather than a long jet. They did this by placing small chunks of copper inside the hollow nose.

Besides clobbering spacecraft materials, the launcher may help missile-defense and shock-physics research programs.

SWRI shaped-charge launcher fires chunks of aluminum at spacecraft material.



Shotgun Missiles

ALBUQUERQUE, NM—

The venerable rocket sled at Sandia National Laboratories is now testing hardware for hypervelocity missiles that would spray their targets with heavy-metal buckshot. Speed rather than explosives would supply the destructive punch.

Such a weapon would behave like the reentry vehicle of an intermediate-range ballistic missile, arcing hundreds of thousands of feet through the atmosphere. On the way down, a rocket engine would boost the missile to a speed as high as Mach 14.

Just before impact, the kinetic-energy warhead would release a shower of 1000 pellets or darts. Moving at breakneck speed,



A kinetic-energy warhead explodes into a cloud of tungsten pellets traveling at a speed of Mach 4.25.



the pellets could penetrate 1/2-in. armor while the heavier darts could burrow through 6 ft. of concrete.

The Defense Advanced Research Projects Agency is sponsoring the tests. So far, at Mach-4.25 speeds, the warhead has released its projectiles in a cloud only 50 ft. wide. The results suggest that hypervelocity missiles, fitted with aerodynamic control surfaces, could offer pinpoint accuracy without collateral damage.

Clinton's New Caddy

WASHINGTON, D.C.—As President Clinton brings a fresh administration to the Capitol, he also brings a new limo to the White House garage. Replacing George Bush's Lincoln Town Car (see "Cars Of The Presidents," page 36, Jan. '93) is a trio of specially equipped 1993 Cadillac Fleetwood Broughams. But as usual, the Secret Service has cloaked many

of the limousine's details.

The vehicle stretches nearly 4 ft. longer than the production Brougham built in Arlington, Texas. And the roof stands 4 in. higher, to give

New presidential Fleetwood limo comes straight from GM's Tech Center.

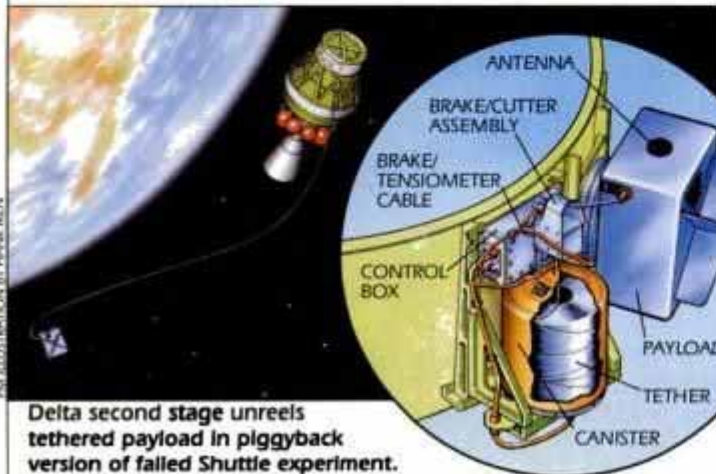
crowds a good look at the new President—and to accommodate armor.

The limo's weight remains classified, but it's

heavier than it looks—oversize wheels and tires and beefed-up power brakes attest to its presidential weight.



Rope Tricks In Orbit



Delta second stage unreels tethered payload in piggyback version of failed Shuttle experiment.

HUNTSVILLE, AL—Although a snag cut short last year's tethered-satellite Shuttle experiment, NASA hasn't given up on stringing out lines in space. The research will continue with piggyback payloads on Delta II launches.

Bolted to the rocket's second stage will be the Small Expendable Deployer System (SEDS). Once each Delta has deployed its primary cargo, SEDS will begin unreeling a miniature payload on a tether.

The first SEDS shot was scheduled for March and featured a 12-mile tether tipped with instruments. The payload will collect information on the tether's movements in space.

A second mission will deploy a conductive tether to measure Earth's magnetic field, and a third will attempt to generate electricity with a conductive tether.

A fourth SEDS mission will feature a small satellite at the end of a 28-mile tether, whiplashed up into a higher orbit.

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 **TOYOTA**



DODGE INTREPID ES

THE INTREPID CHALLENGE

Dodge's new LH sedan takes on the class of the midsize field.

BY TONY SWAN, Automotive Editor; PM Photos by George Olson

• After our first hands-on experience with Chrysler's new LH trio—Dodge Intrepid, Eagle Vision and Chrysler Concorde—it seemed clear that these new sedans would be winners.

But as always, we reserved final judgment pending a road test versus prime competition. In the case of the Dodge Intrepid, according to Chrysler's marketing minions, this means the Ford Taurus, Toyota Camry, Chevrolet Lumina and Pontiac Bonneville. (It also means the Nissan Maxima, but Nissan was unable to supply us with a test car.)

There are several other cars that fall into this same general marketing sphere—the Honda Accord, Mazda 626 and Nissan Altima, for example—but the midsize sedan class has separated itself into bigger and smaller subsegments. Since the Intrepid's interior volume index nudges into the EPA's full-size category, we limited our test fleet to the biggest—and most powerful—of the Intrepid's key competitors.

As a result, all the cars were equipped with V6 engines, although Fours are standard in some of them. All had automatic transmissions, and all were

THE INTREPID CHALLENGE

equipped with a goodly array of comfort/convenience features, as well as antilock brakes and, with one exception, a driver's airbag.

After a week of driving on Southern California byways, we emerged with a clear sense of a winner. Beyond that, though, we wound up with five different rankings, which tells us, perhaps, that the manufacturers are doing a good job of creating distinct personalities for their cars. In any case, beyond first place the cars are listed in alphabetical order.

Dodge Intrepid ES

This is the one we all agreed on. Besides being far better than any sedan Chrysler has offered in recent memory, the Intrepid also beats its competitors on two key points.

The first of these—interior volume—is a function of the car's overall size. Thanks to the inspired work of Tom Gale and the Chrysler design staff, the Intrepid doesn't look big—until it's parked next to a Camry, Taurus, Lumina or Bonneville. But it certainly looks big from the inside, particularly in the back seat. Although none of these sedans is cramped, the Intrepid offers real move-around space for five. You'd

have to be an NBA center to get your knees near the front seatbacks.

The Intrepid's second strong suit—exceptional handling—was achieved in spite of its size. A combination of big dimensions, front-wheel drive, strut suspension (front) and plenty of curb weight isn't the best recipe for agility, but Chrysler's LH platform team has done an exceptional job in the area of chassis rigidity. When you start with a stiff chassis, getting precise, athletic handling is relatively easy, and this is just what the Intrepid delivers.

Our ES test car was equipped with the optional Performance suspension package, but even the basic Intrepid changes directions like a halfback, an important element in active safety.

On the passive-safety side of the ledger, all the LH sedans include standard dual front airbags. Antilock braking is standard on the ES, optional on the base car, and a traction-control system is available with the ABS package. Braking performance is outstanding.

The dashboard includes knee bolsters, to keep you from getting crunched down into the footwells if you hit something hard, and the front

shoulder belts are height adjustable.

The 3.5-liter dohc 24-valve V6 in our test car delivers respectable power. It doesn't hustle the Intrepid up to 60 mph with quite as much urgency as some of the others, but it produces good passing response and thrives on high-speed cruising.

We did find a few nits to pick. The rakish windshield, a key element in the cab-forward design, creates a vast, arid plain of useless space atop the dashboard. The audio controls seem to have been designed for elfin fingers, and checking the overhead digital info panel means you have to take your eyes off the road.

Those squinty headlights look sexy, but they don't do a very good job of showing the way at night. And as much as we liked the BMW-esque handling of our ES tester, its ride may be a trifle stiff for some tastes.

However, we emerged with a sense that this car represents an important milestone, not only for Chrysler, but for the art of the American sedan in general. Its build quality is as good as any, its styling makes the others look a bit older, its interior redefines family sedan roominess, and it's a real pleasure to drive.

In his final TV ad as Chrysler



SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ DISPLACEMENT (ci/cc)	ENGINE HP, NET/ TORQUE (ft.-lb.)	ENGINE/ DRIVE LAYOUT	TRANS- MISSION TYPE	WHEELBASE/ LENGTH (in.)	TRACK FRONT/REAR (in.)	WIDTH/ HEIGHT (in.)	HEAD-, LEG-, HIPROOM F/R (in.)	CURB WEIGHT (lb.) HP/WEIGHT RATIO (lb./hp)
Chevrolet Lumina Euro 3.4	\$ 17,685/ \$ 18,437	DOHC 24V V6 207/3392	200 @ 5000 rpm/ 215 @ 4000 rpm	front/ front	4-speed automatic	107.5/ 198.3	59.5/ 58.0	71.0/ 53.6	F: 38.7/42.4/52.3 R: 38.0/36.9/52.3	3516/ 17.58
Dodge Intrepid ES	\$ 17,189/ \$ 23,173	SOHC 24V V6 214.7/3518	214 @ 5800 rpm/ 221 @ 2800 rpm	front/ front	4-speed automatic	113.0/ 201.7	62.0/ 62.0	74.4/ 56.3	F: 38.4/42.3/56.4 R: 37.2/38.7/58.1	3315/ 15.49
Ford Taurus SHO	\$ 24,829/ \$ 28,806	DOHC 24V V6 195.2/3200	220 @ 6200 rpm/ 215 @ 4800 rpm	front/ front	4-speed automatic	106.0/ 192.0	61.6/ 60.5	71.2/ 54.1	F: 38.3/41.7/55.2 R: 37.6/37.5/54.8	3084/ 14.02
Pontiac Bonneville SSE	\$ 24,844/ \$ 26,404	OHV V6 231/3800	170 @ 4800 rpm/ 225 @ 3200 rpm	front/ front	4-speed automatic	110.8/ 201.2	60.8/ 60.6	73.6/ 55.5	F: 39.2/42.0/57.2 R: 38.3/38.6/57.1	3507/ 20.63
Toyota Camry XLE	\$ 21,875/ \$ 23,938	DOHC 24V V6 180.6/2959	185 @ 5200 rpm/ 195 @ 4400 rpm	front/ front	4-speed automatic	103.1/ 187.8	61.0/ 59.0	69.7/ 55.1	F: 38.4/43.5/56.0 R: 37.1/35.0/56.8	3285/ 17.76

1. Times from a steady-state 40 to 70 mph.
2. Best speed achieved while weaving through 8 cones placed in line, 100 ft. apart. Speeds provide index of transient response.
3. G-force generated during steady-state travel around a 200-ft.-dia. circle. Chart number is an average of best clockwise and counterclockwise.
4. Based on 12 basic maintenance functions.



CHEVROLET LUMINA EURO 3.4



DODGE INTREPID ES



**CHEVROLET LUMINA
EURO 3.4**

Chairman, Lee Iacocca introduced the new LH sedans and concluded by saying, "When it's your last time at bat, it's nice to hit a home run."

He neglected to mention it was a grand slam.

**Chevrolet Lumina
Euro 3.4**

Chevy's family hot rod polarized our test crew more than any car in this group. While all hands appreciated the punch of its 3.4-liter dohc 24-



Lumina's 3.4-liter dohc 24-valve V6 engine won praise, interior drew pans.

valve engine—GM's oddly named Twin Dual Cam V6—some found its raspy exhaust growl pleasing while

others found it intrusive. The same division of taste applied to the Euro 3.4's high steering effort, which some



TEST RESULTS

STEERING TYPE/TURNS LOCK-TO-LOCK	TURNING CIRCLE (ft.)	WHEELS/ TIRES	BRAKE SYSTEM FRONT/REAR (in.)	FUEL ECONOMY (MPG EPA city/hwy.) PM test	ACCELERATION 0-60 MPH (sec.) 1/4-MILE (sec. @ mph)	PASSING ¹ ACCELERATION 40-70 MPH (sec.)	BRAKING 60-0 MPH (ft.)	700-FT. ² SLALOM MPH	200-FT. ³ SKIDPAD (lateral g)	PM ⁴ SERVICEABILITY INDEX
Power rack & pinion/2.26	39.0	16 x 6.5-in. alloy P225/60R16	4-wheel disc, ABS 10.5/10.1	17/26 29.0	7.9 16.0 @ 85.3	7.6	129	57	.77	6
Power rack & pinion/3.38	37.6	16 x 7-in. alloy P225/60R16	4-wheel disc, ABS 11.1/10.6	18/26 25.4	8.6 16.6 @ 86.1	7.6	116	58	.79	8
Power rack & pinion/2.7	38.6	16 x 6-in. alloy P215/60R16	4-wheel disc, ABS 10.0/10.1	17/28 24.9	7.6 15.7 @ 88.0	7.4	132	56	.76	7
Power rack & pinion/2.86	38.7(L) 40.3(R)	16 x 7-in. alloy P225/60ZR16	Disc/drum, ABS 10.9 vented/8.85	19/28 26.8	9.1 17.3 @ 79.1	7.9	116	53	.77	8
Power rack & pinion/3.0	36.7	15 x 6-in. alloy P205/65HR15	4-wheel disc, ABS 10.7 vented/11.3	18/25 27.1	8.7 16.7 @ 82.2	7.9	126	56	.77	7



FORD TAURUS SHO



PONTIAC BONNEVILLE SSE



TOYOTA CAMRY XLE

THE INTREPID CHALLENGE

equated with a sporty feel while others found it to be excessive and deficient in on-center road feel.

With its stiffer suspension and aggressive tires, the Lumina gave a good account of itself in our slalom runs, and its dragstrip performance was second only to the Taurus SHO. It also surprised us by turning in the best fuel economy on our 100-mile mostly highway loop.

However, in our subjective ride and handling evaluations, the Chevy was at the bottom of the pack in terms of ride harshness, and its seating comfort didn't win many friends. The old-fashioned horizontal instrument panel also drew criticism.

Unlike most of the fleet, our test car was not equipped with a driver's airbag but did have antilock braking, which is standard on the Lumina Euro, optional on lesser models. Braking performance was only so-so by contemporary standards, although it was better than the Taurus.

Due for replacement in mid-'94 as a '95 model, the Lumina design isn't aging as well as the Taurus. Nevertheless, some of our testers liked the jaunty Euro trim package—and the dynamic properties that go with it.

Ford Taurus SHO

The Taurus reclaimed America's best-seller honors from Honda's Accord in '92, and it may be that this car contributed in a small way to the victory. Certainly there's been a small but persistent chorus of demand for a self-shifter since Ford introduced the



DODGE INTREPID ES



Intrepid's seductive blend of styling, roominess, power and agility got top marks.

SHO edition, with its potent 3.0-liter dohc 24-valve Yamaha V6, back in '88.

Well, here it is, and we give the new powertrain very high marks indeed. For automatic transmission applications, the SHO (for Super High Output) V6 has a little more displacement—3.2 liters—for a little more low-end torque. The 4-speed automatic, adapted from the auto used with Ford's 3.8-liter pushrod V6, is beautifully matched to the engine's powerband—smooth on upshifts, easy to kick down.

There's some torque management programmed into the computer, to soften the shifts, but the automatic still gets power to the pavement quickly, which in turn gets this car up to 60 mph quicker than anything else in the group.

Inside, our leather-lined test car exuded quality—excellent seats, classic white-on-black instruments and Ford's well-designed control layout. It also had dual airbags, optional on all Taurus models.

On the other hand, anticipating a kinder, gentler breed of driver, the Taurus engineers softened the strut damping and the suspension bushings, which provides better compliance at the expense of more body roll in hard cornering. We also felt there was a little too much assist in the new variable-assist power steering. The bottom line is a car that's faster than its suspension.

We were also surprised at this car's braking performance. It looks good on paper, with 4-wheel ventilated discs bolstered by ABS, but stopping distances were the longest in the group. The all-season Eagle GA tires (versus Eagle GT+4s) certainly contribute to this, and conspire with the softer suspension to limit the car's handling.

After eight years, the Taurus is finally beginning to show its age. That once-radical profile is becoming a little too familiar, and the cowl high versus competitors.

But it's hard to argue with success. The Taurus still affords a comfortable, roomy interior, generous trunk space and high quality throughout.



FORD TAURUS SHO



With 4-speed automatic, Taurus SHO is a potent businessman's express.



PONTIAC BONNEVILLE SSE



Pontiac Bonneville SSE combats boredom with useful electronic goodies.

And for the driver who likes to mix the occasional acceleration rush into his daily rounds, this package delivers. Pronto.

Pontiac Bonneville SSE

GM's Excitement Division has prospered in recent years by creating nifty trim and convenience packages that score well with the upwardly mobile, and in this sense the Bonneville SSE is right in step with its kin. Redesigned just a year ago, the Bonneville is stylish and distinctive, without being flashy.

It's also a big car. Its interior dimensions compare favorably with the Intrepid, and there's lots of luggage space under the rear decklid.

Our Bonneville SSE had excellent leather-clad bucket seats (optional) with a host of power adjustments including several lumbar support and torso bolster tweaks for the driver and front seat passenger. Besides the usual array of power equipment, the SSE's list of goodies included an electronic compass, a head-up display in the lower left windshield and Pontiac's array of steering-hub-mounted audio controls. We love all of it.

At the test track, the Bonneville's inherent understeer held it back in the slalom derby. However, its torquey 3800 V6 (the 205-hp supercharged version, standard with the SSEi, is available as an option) delivered good acceleration, and braking performance was exceptional.

As our slalom test suggested, the SSE wasn't as athletic on twisty roads as the Intrepid. However, its

ride quality rates with the Camry for best-of-the-bunch. Stir in quiet operation, good looks and a wonderful array of useful driver amusements and you have a car that makes a very pleasant traveling companion.

Toyota Camry XLE

We keep hearing various members of the automotive press say the Camry has no character. This is absolute nonsense. The Camry is as smooth, quiet, refined and comfortable as anything in its class. Its handling is

totally devoid of surprises, it stops without drama and, with its 3.0-liter 24-valve V6, it's got enough scoot to make 0-to-60 mph a matter of about 8 seconds.

The no-character rap probably comes from the fact that the Camry doesn't intrude on the driver's consciousness in any way—precisely what most owners want.

While it's true that the Camry won't dart through a set of switchbacks with the authority of the Intrepid, its supple suspension produces an exceptionally tranquil ride.

Quality is also the word that describes the Camry's assembly, finish and materials. Our XLE test car had a leather trim package, which eliminated our reservations about the cloth upholstery material in LE editions, as well as a full complement of power accessories, a sunroof and, like all these cars, a very good sound system.

Although there's lots of front-seat legroom in the Camry, its rear-seat legroom measures up as the tightest in this quintet—though it doesn't feel like it. The Camry also has the smallest trunk in the group, which means they're all big.

All things considered, we think the Camry's character is well suited to its intended market. It's attractively styled and exceptionally well made, with good power and excellent road manners. It goes about its job unobtrusively. And while it may lack the size and panache of the Intrepid, we regard it as one of the best buys in its class. **PM**



TOYOTA CAMRY XLE



Quiet and comfortable, Toyota Camry XLE does everything well.

BOATS

SMALL CRAFT WARNING

We test six of the new class of small, affordable fun boats. Boating will never be the same.

BY JOHN WOOLDRIDGE, Contributing Editor
PM Photos by Skip Gandy



SEA RAYDER



SEA-DOO EXPLORER

● As you rip into a full-speed, wheel-lock turn, g-forces slam you into the side of the boat. Your minijet throws up a wall of water and you neatly swap ends. As the bow whips across the wake, you straighten the wheel and jam the throttle forward. In a flash, you're racing back the way you came, and your passengers are screaming, "Let's do it again."

This is the new breed of fun boat that's taking the marine industry by storm. It's agile, acrobatic and a lot like a personal watercraft (PWC), but it's equipped with boatlike amenities that PWCs will never have.

To find out exactly how jet power transforms small boats into new-wave fun machines, PM brought together four of the hottest new models for a little head-to-head action. As a kicker, we also brought in two small outboard boats, which are red-hot chili peppers in their own right.

Bayliner Jazz

Sassy graphics and a splashy ride make the wedge-shaped Jazz an instant hit with the young at heart. Complementing its bold appearance is a bag of handling tricks that in-

cludes nose diving and end swapping. Importantly, these thrills are delivered by a stable platform that's impossible to tip.

The Jazz is clearly aimed at the PWC crowd, and it hits its mark. Top speed is a zingy 41 mph. Hole-shot marks are adequate, as are those for the handling course, which are affected by the hull's sled-like bottom.

The cockpit is generally wide open, except that legroom is cramped for tall drivers. Interestingly, the small steering wheel has a short 135° turning radius that produces instant response. A tournament ski-shift throttle adds a touch of performance class.

Jazz features include an integral swim platform, foredeck and seat pads, numerous nylon/foam grips and tie-down straps to secure kneeboards and skis. The Jazz was the first of boating's true wild things to debut this year, and it appears that Bayliner has struck all the right notes.

Boston Whaler Rage

When it was introduced a little more than a year ago, the Rage broke new ground. Based loosely on the Whaler 13, the Rage's hull was the first to give boaters a taste of new-wave minijet action in a boat known for its unsinkable reliability.

While the Rage maneuvers as freely as the other jet boats, it lagged behind in the performance categories due to its 50-horse Yamaha engine, which is a fine powerplant but small compared with the competition.

In place of a standard steering wheel, the Rage is equipped with handlebars and a twist throttle on the grip. A shifter is located on the console.

After we fixed some initial porpoising by adjusting the cavitation plate, the Rage was able to send up walls of water with the best of them. Topnotch workmanship is evident in the glasswork, hardware and overall



SMALL CRAFT WARNING



BAYLINER JAZZ

construction. It doesn't come cheaply (\$9995 without trailer), but it's consistent with Whaler's philosophy of building to last.

Chris-Craft Caper

For the outboard set, the Chris-Craft Caper is the closest thing on the water to a minijet. It's flashy, fun, affordable, and, when equipped with a 90-horse Evinrude, it's fast, too. You won't be doing end-for-end swaps, but you will air-out the hull at speeds the minijets can't match.

Cavernous is the only way to describe the storage under the Caper's foredeck, but tie-downs or gear nets would be helpful. The PM test team



BOSTON WHALER RAGE

liked the plush swivel buckets that enable the front passenger to swing around to become a ski observer. A unique grabrail that surrounds the cockpit is also noteworthy, but overall cockpit space is limited. For lovers of Mazda-Miata-style road-

sters, this coziness won't be that much of a problem.

Excel 16DX

One of the newest names in boating is Excel, a division of Wellcraft. And, right out of the blocks, its 16-ft. bowrider emerges as a sporty subcompact with outstanding value. Equipped with an 85-horse Yamaha outboard, the 16DX is a sweet-handling runabout that scored among the leaders in performance.

Features we especially liked are the removable stainless-steel ski tow

pylon, huge aft sunpad, radio/cassette and overall sense that the 16DX has everything a large boat has but shrunk down to a sports-car package. Like the Caper, the 16DX won't swap ends in the manner of minijets, but it will blow their doors off.



BAYLINER JAZZ



BOSTON WHALER RAGE



CHRIS-CRAFT CAPER

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/MODEL/ ADDRESS	PRICE	LENGTH/WIDTH/ COCKPIT DEPTH	FUEL CAPACITY/ WEIGHT/DRAFT	ENGINE	DECK AREA (sq. ft.)/DECK LAYOUT	STORAGE SPACE (cu. ft.)	SPECIAL FEATURES
Bayliner Jazz P.O. Box 9029, Everett, WA 98206	\$7995 With trailer	14'/68" 21.5"	17 gal./ 1000 lb./8"	Mercury Sport Jet/90 hp	20.16/Side console, 3-across seating	9.9/Adequate for day fun	Ski harness, deck tie-downs
Boston Whaler Rage 1149 Hingham St., Rockland, MA 02370	\$9995 Without trailer	13'6"/72" 14.5"	6 gal./ 750 lb./6"	Yamaha Jet/50 hp	30/Center console, 3-across seating	14.5/Sufficient for most uses	Handlebar steering, twist throttle
Chris-Craft Caper 8161 15th St. E., Sarasota, FL 34243	\$10,695 With trailer	16'8"/84" 29"	21 gal./ 1100 lb./25"	Evinrude Outboard/90 hp	7.22/Bucket seats, 3-across seating	56.24/Huge enclosed foredeck	Swiveling buckets, swim steps
Excel 16DX 1651 Whitfield Ave., Sarasota, FL 34243	\$8995 With trailer	15'11"/72" 25"	12 gal./ 1340 lb./11"	Yamaha Outboard/85 hp	14.15/Side console, 3-across bow	30.66/Generous, sensible layout	Ski pylon, bow seating, swim steps
Sea-Doo Explorer 6545 U.S. Hwy. 1, Palm Bay, FL 32905	\$8995 Without trailer	13'/81" 13"	12.8 gal./ 650 lb./12"	Bombardier-Rotax Jet/60 hp	13.3/Center tandem, 3 other seats	5.53/Leave gear at dock	Handlebar steering, thumb throttle
Sea Rayder 2600 Sea Ray Blvd., Knoxville, TN 37914	\$7995 With trailer	13'6"/80" 19.5"	15 gal./ 875 lb./11"	Mercury Sport Jet/90 hp	19.06/Side console, 3-across seating	17.35/Copious for a minijet	Ski tow eye, aft sunpad

Helm features on the Jazz are a short-radius wheel and superb instrumentation. A drawback is tight legroom.



The center-console Rage features handlebar steering, twist throttle and a minimum of instrumentation.



The Caper also takes a minimalist approach to the driver's helm, but there's loads of legroom.

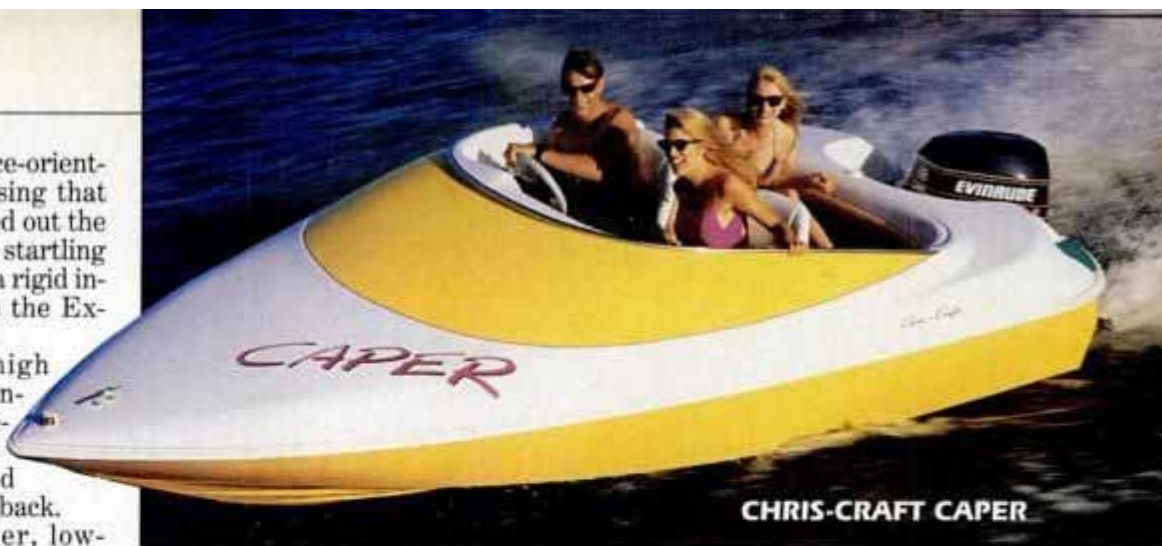


Sea-Doo Explorer

Given Sea-Doo's performance-oriented heritage, it's not surprising that the Canadian company pulled out the stops for its jet boat. What's startling is Sea-Doo's decision to use a rigid inflatable boat (RIB) to give the Explorer a distinct personality.

The Explorer scored high marks in hole shot and handling despite having the second smallest engine. On top end, its small engine and wind-buffeting tubes held it back.

However, the 3-chamber, low-



CHRIS-CRAFT CAPER

EXCEL 16DX



pressure tubes make the Explorer a perfect big-boat tender and an excellent dive boat. They also add stability, even while carrying five people.

The test team was particularly impressed by the Explorer's PWC-style steering and handling. Despite its

basically conservative design, the Explorer fits right in with the rest of our fun-boat fleet.

Sea Rayder

Like Bayliner's Jazz, the Sea Rayder is a Brunswick Co. product, but

that's where comparisons end. Unlike the Jazz's ultrahip focus, the Sea Rayder is a sensibly detailed minijet that's finished with the same standards of quality and style you'd expect from a Sea Ray.

Among the leaders in top speed and hole shot, the Rayder was unsurpassed on the handling course. It pins corners like it's riding on rails, thanks to a mod-V bottom. Close-ratio steering instantly points in the direction you want to go.

Comfortable seats, a console that fits tall drivers, a wide-open cockpit, pleasing graphics, an aft sun deck, twin swim steps and a ski tow eye are a few of the outstanding features. Sea Rayder possesses more boat-like qualities than the other minijets, yet sacrifices none of the freewheeling fun. Who could ask for more? **PM**



EXCEL 16DX



SEA-DOO EXPLORER



SEA RAYDER

TEST RESULTS

TOP-END SPEED (mph)	ACCELERATION 0-25 MPH (sec.)	HANDLING COURSE (sec.)	SOUND LEVELS IDLE/WOT (dBA)	FUEL ECONOMY AT WOT (gph @ rpm)	FIT & FINISH	FUN FACTOR
41 Tops among jets	6.61 Very responsive	23.44 Good, but a slider	80/ 108	10.5 @ 5400	Splashy colors, creative use of new materials	For the wet and wild at heart
33 Slightly underpowered	7.66 Sufficient for fun	27.24 Sluggish, slides	78/ 104	4.5 @ 6000	Rich glasswork, topnotch hardware	Can do everything except pin your ears back
45 Fleet's fastest	5.7 Good response from prop	22.35 Slight ventilation in turns	78/ 98	8.5 @ 5000	Clean and tidy inside and out	Miata-like concept makes outboarding fun
44 Fast and smooth	4.99 Snaps your head back	21.29 Superbly surefooted	75/ 97	9.5 @ 5500	Raises the standards for entry-level boats	The best of traditional outboard values
33 Tubes hold it back	5.27 Quickest jet	23.05 Responsive handling	80/ 103	5.8 @ 6500	Smoothly detailed, simple design	Rides and feels like a super-stable PWC
40 A water scorcher	6.49 Among the leaders	19.27 Mod-V pins turns	80/ 108	10.5 @ 5170	Pleasing graphics, superb craftsmanship	Best of the boat and PWC worlds

Complete instrumentation, radio/cassette player and drink holders highlight the Excel's dash.

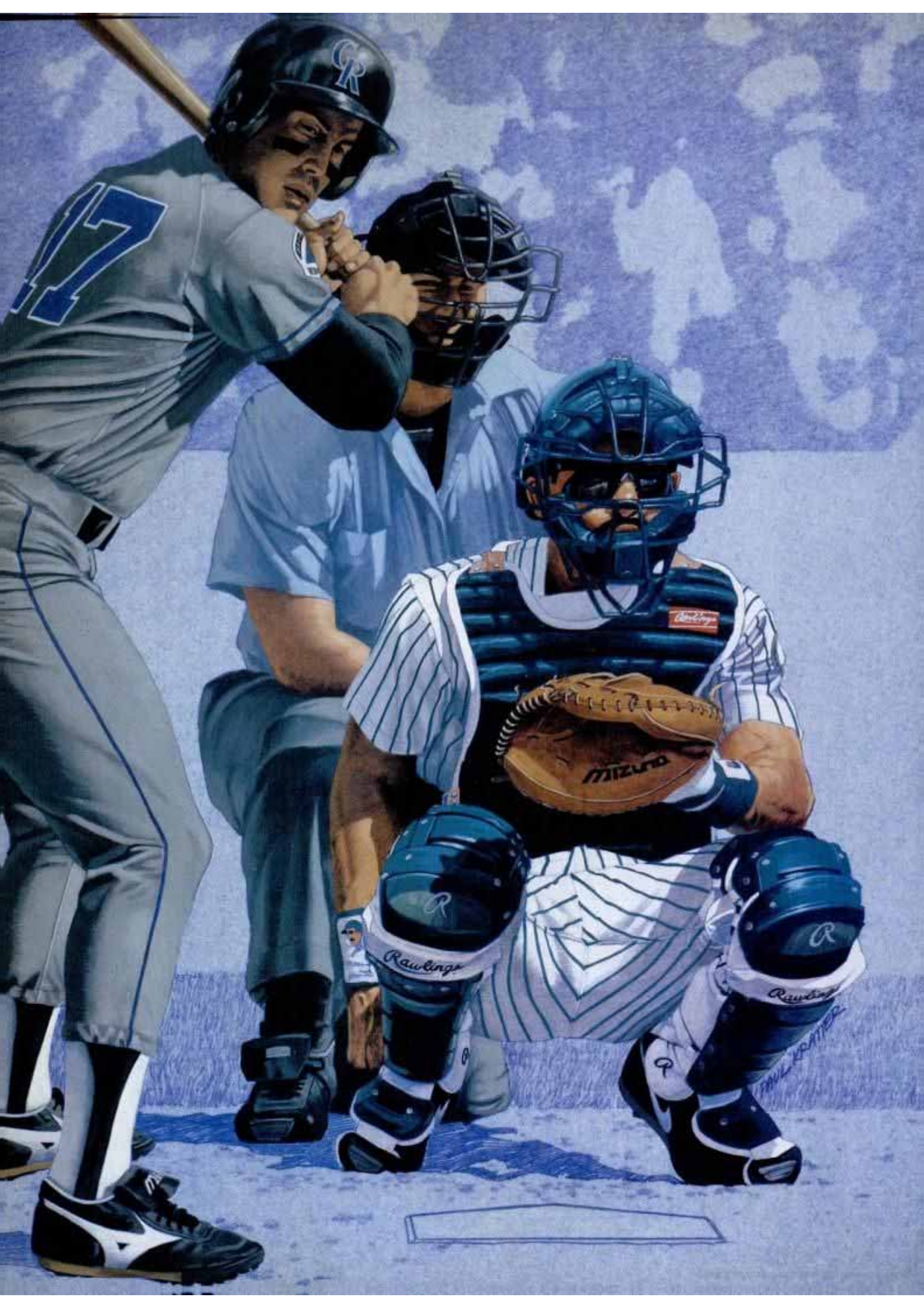


Short-radius handlebar steering, thumb throttle and a speedo give the Explorer a PWC-style helm.



The side console on the Rayder has a short-radius wheel, good instrumentation and legroom.





TOOLS OF IGNORANCE

Baseball catchers dress for battle. Here's a history of survival wear for the game's toughest position.

BY STEPHEN A. BOOTH, Contributing Editor; PM Illustrations by Paul Kratter

● The field position denoted in the scorebooks as "2" has never been an easy job. Errant balls, foul tips and flying bats are all a source of pain for catchers. Collisions at the plate occur with regularity, some more painful than others. No protection short of a bunker could have spared 23-year-old Ray Fosse the career-shortening injury he sustained in the 1970 All-Star Game. Catcher-turned-announcer Tim McCarver says he still suffers from nerve damage in his neck caused by back-to-back plate collisions a quarter of a century ago. Today, catchers like Benito Santiago (pictured at left) of the expansion Florida Marlins often put their bodies literally on the line, most often the one on the third-base side.

Baseball, though it sometimes seems the most tradition-bound of sports, has always shown that All-American penchant for tinkering and innovation. This quest for the better mousetrap has been amply applied to catcher's gear. The evolution of the equipment corresponds to actual changes in the tactics and rules of the game. The tinkering continues. This season a new "digital" catcher's mitt, designed to soften the ball's impact and reduce errors, makes its debut.

Catchers are expected to take their lumps without grumbling. But the early efforts of catchers to protect themselves met with a lot of flak. A typical reaction came from the crowd at the Polo Grounds when baseball's New York Giants opened the 1907 season against the Philadelphia Phillies. As the Giants took the field, star catcher Roger Bresnahan looked more like a goaltender than a backstop when he squatted behind the plate in a pair of thickly upholstered shin guards.

It was the first time a catcher had dared to don the protective gear in open view, and the crowd's reaction came as quick as a foul tip and just as nasty.

"Spectators howled with delight when a foul tip in the fifth inning rapped the protectors sharply," reported *The New York Times*. Bresnahan, more concerned about his livelihood than remarks about his manliness, ignored the insults from fans and foes.

Bresnahan's shin guards were the final pieces of the catcher's armor, following the glove, mask and chest

protector. This kit was lovingly dubbed "the tools of ignorance" by Herold "Muddy" Ruel, a lawyer turned backstop who caught for greats like Walter Johnson with the Washington Senators in the 1920s. Ruel probably would have stayed a mouthpiece if he'd caught in the late 1860s. The first piece of protection for catchers, a rubber mouth protector, dates to that era, purloined perhaps from the sport of bareknuckles boxing.

The changing rules of engagement

Backstops began crowding the plate in 1880 when a rules change dictated that the final strike, including foul tips, had to be caught on a fly for a putout. Pitchers had begun throwing overhand by the mid-1880s, and the mound was moved progressively farther from home plate until it reached its current 60 ft. 6 in. in 1893. To better frame the pitches, field bunts and throw out base-stealers, some catchers had begun inching closer to the plate as early as 1875.

Gloves then masks came into use in this period. Charles Waitt, a first baseman, is credited with being the first to skulk onto the diamond with a glove—flesh-colored, fingerless and padless—in 1875. Star pitcher Albert Spalding made it a manly thing in 1877, boldly donning a black glove that was fingerless but padded. Ever the entrepreneur, Spalding envisioned big sales for his mail-order sporting goods business. Catchers were among his best customers.

By 1890, ex-catcher Harry Decker had patented the "Decker Safety Catcher's Mitt," a contraption that was basically a glove stitched to the back of a round pad that covered the palm of the hand. These gloves were literally flat pillows that got their pockets broken in on the job—at the expense of the catcher's palm.

"They were still pretty small, flat and had no shape when I came into the big leagues in 1937," recalls former Brooklyn Dodger catcher Mickey Owen, who turns 77 this year.

"A fellow from Rawlings came in one day, Harry Latina, asked us a lot of questions and said he could build a better mitt. And he did," Owen tells PM. Harry "Bud" Latina, the legendary "glove doctor," was Rawl-

TOOLS OF IGNORANCE

The Mask



1876



1910



1930

The Mitt



1883



1905



1930

ings chief designer for four decades. "He made a real change in the depth of the mitt so the ball would really stick," says Owen.

According to Owen, Latina's innovations made catching easier, but you still had to use two hands. Modern mitts, he contends, have evolved to match today's style of baseball.

"Catchers now have to one-hand or backhand the ball," he points out. "They have to work much lower than we did because the pitching's low now—at or below the batter's knees. When you're catching that low you can't hold two hands or even one with the fingers pointing up and parallel to your body."

Catcher Earl Battey, a 3-time Gold Glove winner, notes that mitts have changed substantially even since he was battery mate with Gold Glover Jim Kaat on the Minnesota Twins in the 1960s.

"Today's mitts have multiple breaks and a long oval pocket, more like a first baseman's," says Battey. "When I played, we had a pocket but no breaks, and we caught two-handed so the ball wouldn't pop out." One-handed catching became possible with the hinged mitt, popularized by Johnny Bench and Randy Hund-

ley in the late 1960s. With these, a spring-action hinge snaps the mitt closed on contact with the ball.

Man in a mask

Masks were more obviously a protective device. The first was invented by an Ivy League man, Fred Thayer, who in 1876 adapted a fencing mask for Alexander Tyng, then catcher

for the Harvard Nine.

At first, Thayer's better mouse-trap was derisively called a rat-trap. But the catcher's mask caught on quickly among pros and amateurs alike, and was widely used by the 1880s. Besides affording protection, it helped fielding from the very first game. Harvard's Tyng made only two errors in that April 12, 1877,

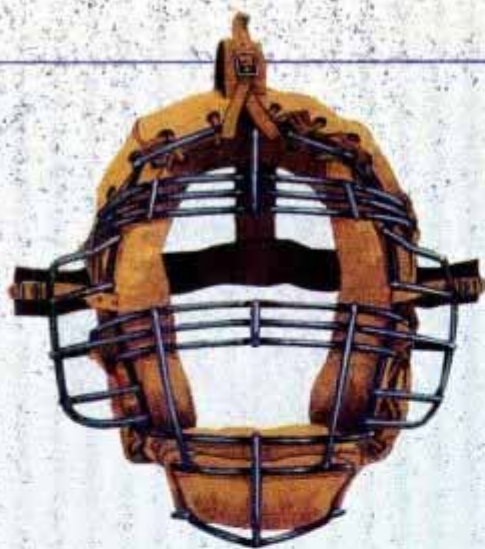
The Shin Guard



1905



1930



1940



1979



1992



1950



1992

match—exceptionally low even for a pro catcher in those days.

Thayer's patented mask went into the Spalding catalog for the 1878 season and adaptations followed quickly. Its simple forehead- and chin-rests were embellished with padding—made from "imported dog skin" according to one Spalding catalog—to insulate the steel-mesh

frame from the catcher's face.

Better visibility was always a goal in catcher's masks. Wire-basket cages worn by players like Roger Bresnahan gave way to the greatly improved peripheral vision of so-called "Open Vision" and "Wide Sight" masks by the 1911 season.

The "platform mask"—a one-piece aluminum casting with horizontal

crossbars instead of soldered mesh—was patented by umpire James E. Johnstone in 1921. Mesh still evolved, though, getting springy, shock-absorbing action and ball-deflecting shapes in the 1920s.

Other mask materials have come along, but carbon-steel wire mesh remains the material of choice to this day, according to Ken Nimmons, president of Schutt Manufacturing Co., a leading maker of protective headgear.

"Catchers prefer the welded-wire guard because it has better air movement, and fewer massive bars that could obstruct visibility," says Nimmons. "We use carbon-steel wire because it's flexible but strong. You want some deformation in the mesh to take some of the shock."

Earl Battey, meanwhile, notes that a change in pitching and catching styles is the reason why today's catchers are wearing masks with throat protectors, popularized by Dodger catcher Steve Yeager in the 1970s but available even in 1903.

"We had masks with a little piece that came off the chin, but I didn't use it when I played because it wasn't an issue," he says. "With two-handed catching your hands followed the ball into your body. In the process, you were tucking in your chin so your throat wasn't exposed. Catchers today one-hand the ball farther away from their bodies and they're frequently looking up, so the throat's more exposed."

The latest-version mask has the throat protector integral with the wire face cage.

Among the tools of ignorance, the designs of masks and mitts have evolved the most, in response to the way baseball is played. By contrast, shin guards and chest protectors haven't changed as much.



1950



1980

TOOLS OF IGNORANCE

The Chest Protector



1906



1920



1950

The curiosities that Roger Bresnahan wore 86 years ago actually were a modified version of the leg guards worn by cricket players. Rods of light cane encased in padded fabric covered the shins, and padding protected the knees. Over time, padded leather covered the kneecaps, insteps and ankles. Hard, heavy fiberboard appeared in Rawling's guards in 1916 and during the 1920s and '30s it supplanted cane. By the 1960s, light but tough molded plastics replaced fiber. How tough? Announcer and former catcher Tim McCarver survived two collisions in which the spikes of ex-Met Tommy Agee became embedded in the guards.

Today's chest protectors, although ribbed with light but shock-absorbing poly foam, have come full circle from the original fur-stuffed sheepskin "breast protectors" worn under the uniform until 1884.

Along the way, catchers and umpires got inflatable vests. "Gray's Patent Body Protector" with its rubber-bladder ribs sold for \$10 in 1891, twice the price of stuffed canvas or leather. Although umps stuck to inflatables until modern times, catchers quickly went for the maneuverability that lightweight stuffings like kapok afforded. It enabled them to crouch and to run to back up bases.

Stopping the spin

Not every development meets with acceptance, of course. Neither Owen nor Battey think much of another innovation in catcher's mitts—the oversized "Big Bertha" designed by Baltimore Orioles manager Paul

Richards in the late '50s to help his receivers handle the maddening knuckleball of Hoyt Wilhelm. Such baskets grew to a 45-in. circumference before being regulated to 38 in. in '65.

"The surface area might help you knock down the ball, but it hinders your view and cuts down your hand mobility," says Battey.

Owen, who, by his own description, "boxed" with a few knucklers, notes another consideration.

"Even if you catch the ball in that glove, it's hard to find it in time to catch base-stealers."

Owen, fittingly, is keenly interested in the latest wrinkle in mitts, a "digital leather" glove made by Franklin.

The innovation is already found in Franklin's current line of fielders' gloves and will make its debut in catchers' mitts this August. The facing leather is etched with a pattern of grooves and diamonds which has a two-fold purpose. First, the pattern absorbs the shock of impact. Then, its contours grab the ball and stop its spinning action.

Both attributes might turn some hard-hands into soft ones. Webbing, air or gel cushions and other elements of glove design have dealt with the velocity of batted and pitched balls, but only lately have manufacturers turned their attention to the spin factor. The rotation on a baseball can be

Inside The Modern Vest



1992

quite high—1800 rpm or more on a curveball, for example. Franklin likens its digital leather to the road-gripping pattern of a tire.

That leaves the near-spinless knuckleball to contend with—a problem sure to compound as more hurlers follow last year's pitching phenom, knuckler Tim Wakefield of the Pittsburgh Pirates. What do you do when glove technology is of little help?

"You just have to box with it," advises Earl Battey.

PM



SONY MINIDISC
PLAYER/RECORDER

SOUND WARS

Two new digital sound formats challenge the compact disc for musical supremacy. Here's our hands-on evaluation.

BY FRANK VIZARD, *Electronics Editor*

• Once again, it's a battle for your ears. While the compact disc is the dominant musical format of the day vis-à-vis vinyl records and analog cassettes, CDs have their limitations. First, you can't record your own music. Second, the physical size of the disc—roughly 5 in. in diameter—means there are limits to how small and portable a CD player can be.

It is on these two fronts that two new digital sound formats mean to challenge CD's dominance. One, the Digi-



PHILIPS DIGITAL COMPACT CASSETTE PLAYER

SOUND WARS

ital Compact Cassette (DCC), is a tape housed in a shell the same size as the familiar analog cassette used for years by so many people. The second, the Minidisc (MD), is a disc 2½ in. in diameter housed in a plastic shell that looks very much like a computer disk.

Both formats let you record your own music. Both formats are intrinsically more rugged, making them more suitable than CDs for music on the run. And, in the case of DCC, your existing library of tapes does not become obsolete—your analog tapes will play on a DCC machine.

For the moment, neither DCC nor MD is tackling the other head on, but they will compete directly by year-end. DCC is now available as a component-size tape deck meant to be connected to an existing home audio system. MD players and recorders are for portable listening through



headphones, although they can also be connected to a home audio system. While portable, the Sony MD players are larger and heavier than existing Walkman-type analog cassette players. The MZ-1 recorder/player we reviewed, for example, measures 4½ × 1¾ × 5½ in. and weighs 1 pound 8 ounces. MD players, though, are destined to become smaller.

The trick, of course, is in how to get all the data stored on a CD onto a

thin strip of DCC tape or onto a tiny MD. The answer, strangely enough, is to leave out data.

Both DCC and MD take advantage of the limitations of the human ear. For example, a whisper might be audible in a quiet room but it will not be heard on a busy, noisy street. The whisper on the busy street is below the threshold of human hearing so it isn't necessary to record that data.

Both formats approach this principle in different ways, technically speaking, but the result is the same—less space is needed to record the same amount of audible music. DCC uses about one-quarter of the digital data required by a CD, while MD uses about one-fifth.

One consequence of this technology is that traditional lab tests for audio gear are no longer an accurate reflection of how the equipment performs. Graphs produced

The Shape Of Things To Come



● While DCC begins its life as a home audio component and Minidisc debuts as a portable, both formats are destined to go head to head later this year.

Philips, for example, already has a DCC portable prototype built (above left). Panasonic, though, seems more aggressive, promising a portable DCC player in August. The Panasonic RQ-DP7 will operate for 2 hours from a rechargeable battery, says the company. Panasonic is also set to introduce a DCC receiver for the car. The CQ-DC1 also operates as a CD-changer controller.

On the Minidisc (MD) front, portables are destined to get even smaller than Sony's inaugural product. Denon (upper right), Aiwa and Sanyo are among the companies soon to debut tinier MD portables.

The Sanyo MDX-P1, for instance, is a play-only model weighing just ½ pound and measuring 3.4 × 1.4 × 5.2 in.—a little more than half the size of a personal CD player. In the MDX-P1, the shock-resistant memory is stretched out to 10 seconds, virtually eliminating any chance of skipping during playback. The MDX-P1 runs on alkaline batteries and not rechargeables. List price is \$600.

Aiwa, meanwhile, wants to make a player that clips onto your arm (lower right). The headphones clip onto your ears, completing the concept.

Sanyo is also expected to introduce



both a car player and a home player by year-end. Sony will also have a car player and a mini-component MD system. Alpine is expected to have a car MD player as well.

—F.V.



DCC machines can display a variety of textual information stored on the tape.

using standard testing procedures imply that both formats are unlistenable. This is very far from the reality of the situation.

With no readily acceptable scientific approach available, PM relied upon its ears. For our listening tests, we used a fine Onkyo Integra DX-708 CD player as our reference machine. The MD player, of course, was the Sony MZ-1 recorder/player, listing for \$750. (Sony has a player-only model listing for \$550.)

The DCC machine used was the Optimus DCT-2000 model from Tandy. Other DCC machines are available from companies like Technics, Marantz and Philips, the inventor of the DCC format. Most DCC machines currently list for between \$800 and \$1000.

The MDs we used were made by Sony, naturally. The DCC blank tape was made by BASF. A blank 60-minute MD lists for \$14. A longer 74-minute blank disc will be available as well. A blank DCC tape lists for \$9 in a 75-minute length and \$10 in a 90-minute length. A 105-minute and a 120-minute length will also be available from BASF. Prerecorded MD titles list for \$15. Prerecorded DCC software is priced at about \$16.

The importance of the CD player here is the digital output. While copies can be made onto DCC or MD using standard analog methods, connections made via the digital inputs and outputs allow you to make exact, pristine duplicates of the original. Both formats inscribe copies with a code that prevents you from digitally copying the copies.

Recording with both formats is different than with analog tape decks. Basically, the process is worry-free when using the digital connections. Record levels are automatically optimized so there is no chance of distortion in the copy. In the DCC format, the hardest chore is setting digital

ID markers at the beginning and end of sides A and B of the tape. This task is done at the touch of a button. When the machine encounters the marker at the end of side A, it automatically reverses to the beginning marker on side B. This way you don't have to listen to long minutes of unrecorded tape.

Both the DCC and MD machines are able to display textual information recorded onto the tape or disc. This information is contained in the table of contents digitally inscribed on the tape or disc. Album title, artist, track titles and other information are available at the touch of a button. While this information is abundant on prerecorded DCC and MD titles, CDs are less textually prolific. The MZ-1 does have a small keyboard that lets you add text on a track-by-track basis onto an MD. This feature is handy if you're making a recording from a number of different CDs.

Generally speaking, the MD format is easier to manipulate than DCC as far as dividing or combining tracks, re-recording and adding material at a later date. The MD advantage is mostly due to the speedy access time afforded by the disc format. As with analog cassettes, a lot of time is spent in rewind and fast forward with DCC.

Which format sounds the best? As far as DCC and CD are concerned, there is no audible difference. In listening to DCC and CD versions of

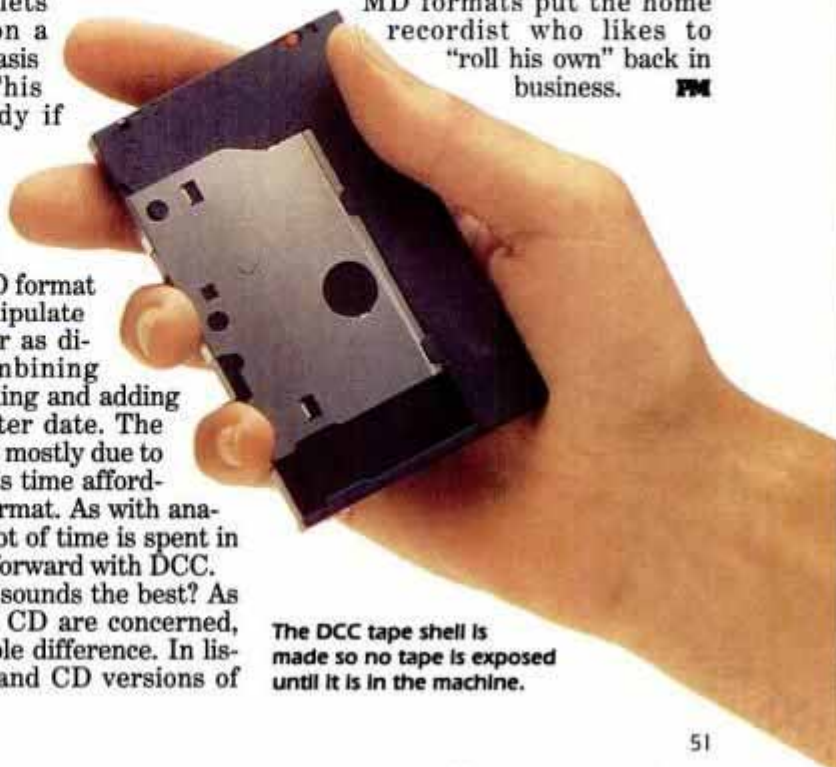
the same material and to DCC copies we made of CDs, there was no variation in sound quality between the two. Our listening tests included a wide range of music, ranging from artists like Bonnie Raitt to James Galway and The Chieftains.

Comparing MD to either DCC or CD is a bit unfair at this point since both the DCC and

CD machines are much larger and, we suspect, have more sophisticated processing circuitry. Considering its diminutive size, though, the Minidisc player is very impressive. Clearly, it is much better than an analog tape player and it is nearly as good sonically as DCC or CD. A discerning ear can hear differences, particularly during relatively quiet music passages. These differences are not unsettling, but they are present.

Any shortcomings MD possesses, though, probably will be masked by the initial MD music catalog. The initial MD releases are heavily skewed toward pop music, a highly processed music genre that generally is not technically demanding. DCC releases, by contrast, are spread more evenly across a variety of genres.

In any event, both the DCC and MD formats put the home recordist who likes to "roll his own" back in business. **PM**



The DCC tape shell is made so no tape is exposed until it is in the machine.

HOW TO RESTORE



Part 7: It's Done!

BY RICH TAYLOR, Contributing Editor; PM Photos by Jean Constantine

● Our 1967 Camaro convertible is a running, driving automobile. What a blast! There's absolutely nothing as rewarding as rumbling down the street in a car you've brought to life with your own hands. You and this inanimate object share a surprisingly intimate bond—you've touched its every nut and bolt, you know its

weaknesses and its strengths.

What's our Camaro like to drive? In a word, fun. The new HO 350 V8 that Chevrolet supplied is one strong engine, and the throb-thrumm, throb-thrumm of the dual exhaust is enough to give you goosebumps. It'll light up the tires at any speed. Combined with our TH700 4-speed auto-

matic and 3.70:1 differential, it absolutely rockets the 3300-pound Camaro to highway speeds.

We're still putting on some mostly easy break-in miles, but our Quarter jr. software (\$95 from Racing Systems Analysis, Box 7676, Phoenix, AZ 85011) predicts 0-to-60 times of less than 6 seconds and quarter-mile



AN OLD CAR



Our flawless 1967 Camaro, looking totally authentic from Bow Tie mirrors to redline bias-ply tires (above). Fortunately, the badges from our car were salvageable, although reproductions are available from several sources in the aftermarket.

performance in the 14.5-second range at more than 100 mph. That's hot. Thanks to the TH700's overdrive Fourth gear, we're expecting to see 20- to 25-mpg cruising on the highway. There are very few 1993 convertibles that offer this combination of performance and economy, and certainly not with this degree of style.

Thanks to front disc brakes and proper brake balance front to rear, our Camaro stops, if not on a dime, at least on a quarter. It also can get around a corner much more com-

petently than a stock '67 Camaro. Credit our heavy-duty antisway bars, gas-filled shock absorbers and poly-graphite suspension bushings. A 25-year-old Camaro is never going to outhandle a new Corvette, but our handling is good. Damn good.

The days before these photos were taken were spent "detailing" the Camaro. You'd be amazed at how much dust can settle on a car sitting quietly in the garage. We used a mild household spray cleaner without ammonia and plenty of clean, soft towels to wipe off everything under the hood. Likewise, we wiped down the top and interior with vinyl cleaner, vacuumed the floors and trunk, polished the chrome with Simichrome and the convertible-top rear window with plastic polish. And we used whitewall tire cleaner to dress the old-style Coker redline tires.

No matter how careful you are, it's inevitable that you'll get chips in the paint during months of work. After cleaning all the body panels, I liberated a small artist's brush from my wife's watercolor set and trimmed it down to a fine point. We have a small bottle of paint left over from spraying the car. I put just a dab of this in a clean paper cup, added a drop of hardener, stirred well and carefully filled the paint chips. It took three coats to get some of them back to level.

After a day to harden, I carefully wet-sanded these spots with 1500-grit paper wrapped around a scrap of cardboard to make a finger-size sanding block. I followed this with ultra-fine buffing compound, then buffed and waxed the whole car. With even a modicum of regular care, it should look like a new 1967 Camaro for another two decades.

A couple of readers have written to us saying something along the lines of, "Nobody could restore a car like this at home. It's too difficult." Nonsense. There is nothing that we have done to this Camaro that any enthusiastic POPULAR MECHANICS reader couldn't do with time, patience and relatively inexpensive hand tools. We started with a real rust bucket, but we did that deliberately to show you what can be done if you've a mind to.

In the real world, we'd recommend that you start with a car that's structurally sound. But nothing we've done is too difficult for a home mechanic. Nothing.

Was it worth it? Well, it depends on how you figure. For all intents and purposes, Camaro No. 4524 is a brand-new car. It will last as long—and in most ways, outperform—a comparable 1993 Camaro. If you start with a reasonably solid car and do the work yourself, you'll spend far less than the \$25,000 a new Camaro convertible costs. You'll enjoy the intangible



When we bought it, our Camaro was a rust bucket ready for the scrap heap. Now it's literally better than a new car.

HOW TO RESTORE AN OLD CAR



Parchment deluxe interior sets off our red exterior to perfection and exhibits the blend of sportiness and luxury that helped make the Camaro such a hit in the first place.



Optional wood-grain wheel and gauges make our Camaro top of the line. Modern B&M shifter hints at non-stock drivetrain.

satisfaction of having built your car yourself, and you'll know a lot more about it than the typical new-car owner. If you think of it as a hands-on course in auto mechanics, the price is cheap.

You probably will not make a fortune restoring a car in your garage, even if it's a Ferrari. On the other hand, unlike most new cars, a moderately priced muscle car like our Camaro will never depreciate in value. PM's Editor-In-Chief Joe Oldham owns a similar 1969 Camaro convertible that he and his two teenage sons have driven daily for the past eight years. It looks better than the day he brought it home, drives like a new car and is worth two or three times what he paid for it. Can you say that about your car?

Restoring old No.

From every angle, our Camaro looks like a brand-new 25-year-old car... but it drives like the hottest 1993s.



Surprise! Engine compartment is totally 1967, except for the '93 HO 350 V8 and TH700 4-speed overdrive transmission.

4524 was a lot of work, but also a lot of fun. If you're the kind of person who spends all day in an office, as most of us do, sanding a fender in the evening is a lot healthier therapy than downing a 6-pack in front of the TV. Restoring an old car is a hobby that you can get into—literally and figuratively—and go somewhere. If you're like us, you'll probably find that once your car is finished, you'll be chomping at the bit to get going on the next restoration. Happily, there's always another car. **PM**

SOURCE LIST

Some of the suppliers for this project:

- Auto Body Specialties, P.O. Box 455, Middlefield, CT 06455; (203) 346-4989 (Body parts)
- B&M Automotive Products, 9152 Independence Ave., Chatsworth, CA 91311; (818) 882-6422 (Engine and drivetrain components)
- Campbell-Hausfeld, 100 Production Dr., Harrison, OH 45030; (513) 367-3130 (Air compressor and air tools)
- Chevrolet Division, General Motors Corp., 30007 Van Dyke Ave., Warren, MI 48090; (313) 492-8855 (Engine and transmission)
- Classic Industries, 17832 Gothard St., Huntington Beach, CA 92647; (714) 847-6887 (Full line of Camaro parts and accessories)
- Coker Tire, 1317 Chestnut St., Chattanooga, TN 37402; (800) 251-6336 (Repro tires)
- Custom Auto Sound, 808 West Vermont, Anaheim, CA 92805; (800) 888-8637 (Replacement car radios)
- Daytona Mig, 1821 Holsonback Dr., Daytona Beach, FL 32117; (800) 331-9353 (Mig welder)
- D&R Classic Automotive, 31 W. 208 Diehl Rd., Suite 107, Naperville, IL 60563; (708) 369-2030 (Camaro restoration parts)
- DTS, 22250 Scherman Rd., Warren, MI 48089; (800) 521-0628 (Ring and pinion)
- Eagle Equipment Co., 23 Wetherill Place, Plainville, MA 02762; (800) 535-0016 (Lift)
- The Eastwood Co., 580 Lancaster Ave., Frazer, PA 19355; (800) 345-1178 (Specialized restoration tools)
- Echlin/Accel, Box 142, Branford, CT 06405; (203) 481-5771 (High-performance ignition products)
- Gearbox Grannies, 3944 Indian Ripple Rd., Dayton, OH 45440; (513) 429-5642 (Even more specialized restoration tools)
- General Motors Service Parts Operations, 6060 W. Bristol Rd., Flint, MI 48554; (800) GM USE US (Body, suspension and trim parts)
- Goodyear Tire and Rubber Co., P.O. Box 9125, Akron, OH 44305; (216) 796-2490 (Contemporary tires)
- Jones Racing Products, Route 611 and Annawanda Rd., Ottsville, PA 18942; (215) 847-2028 (Engine accessory drives)
- Kanter Auto Products, 76 Monroe St., Boonton, NJ 07005; (800) 526-1096 (Springs, shock absorbers)
- Minisport, Jackson Hill Rd., Sharon, CT 06069; (203) 364-0311 (Auto restorations)
- OEM Glass, P.O. Box 362, Route 9 East, Bloomington, IL 61702; (800) 283-2122 (Auto glass)
- PST, P.O. Box 396, Montville, NJ 07045; (800) 247-2288 (Suspension bushings, antisway bars)
- Sharon Auto Body, Route 343, Sharon, CT 06069; (203) 364-0128 (Finish bodywork and painting)
- Rallye Wheel Components, 3633 Lancaster Dr., Eugene, OR 97404; (508) 689-6867 (Rallye wheels and trim)
- TIP Sandblast Equipment, P.O. Box 649, Canfield, OH 44406; (800) 321-9260 (Sandblaster, bead blast cabinet, paint sprayer)
- Walker Manufacturing, 1201 Michigan Blvd., Racine, WI 53402; (800) 767-DYNO (Exhaust system)
- Wurth USA, 93 Grant St., Ramsey, NJ 07446; (800) 526-5228 (Fasteners)



CHRYSLER MINIVANS

A ringing endorsement for the Dodge Caravan, Plymouth Voyager and Chrysler Town & Country.

BY MICHAEL LAMM, Contributing Editor; PM Photos by Rich Cox



● In our first Owners Report (Aug. '84) of the then-new Dodge Caravan and Plymouth Voyager, survey respondents indicated that they found their new vehicles to be extremely well-engineered, well-built, roomy, comfortable, easy-to-drive, thoughtful alternatives to Detroit's traditional station wagons.

There were a couple of things our 1984 respondents didn't like about the early Caravans and Voyagers, however: tepid power and indifferent fuel economy. Original engine options were limited to a pair of 4-cylinders. Even with a 5-speed manual transmission,

those 4-bangers didn't give the '84 models the grunt owners wanted. Nor did they measure up to their EPA fuel economy projections. Real-world fuel economy ranged from 19.0 to 25.5 mpg, according to our 1984 respondents.

Though their appearance is familiar, today's Caravans and Voyagers are considerably changed—bigger, heavier and better equipped. You can still get a Chrysler minivan with a Four, but only 17.3% of our 1992 owners did so. The rest went for one of the two V6 engines offered.

CHRYSLER MINIVANS



Mitsubishi-supplied V6 ranked behind Chrysler's 3.3-liter V6 in our survey.

More power and more weight hasn't improved fuel economy—our owners reported anywhere from 18.2

A small percentage of the owners suggested a redesign of the instrument panel.

to 24.1 mpg. But only 4.5% of them said this was below their expectations, compared to 23.6% in 1984.

Interior comfort and the standard driver's airbag drew high praise.

In 1987, Chrysler introduced the long-wheelbase Grand versions of the Caravan and Voyager. The luxu-

SUMMARY OF CHRYSLER MINIVAN OWNERS REPORTS*

Total miles driven	1,287,284	2.5-liter Four	20.6/24.1	Average	3.2	Poor	0.9
Average miles driven	6101	3.0-liter V6	19.5/23.9	Poor	0.9	Comfort opinion, rear seats:	
Purchase price:		3.3-liter V6	18.2/22.8	Driver sightlines:		Excellent	41.3%
Average	\$18,161	Engine choice:		Excellent	53.3%	Good	49.3
Range	\$12,600-\$24,000	3.3-liter V6	44.4%	Good	41.2	Average	7.5
Why did you choose a Chrysler minivan?		3.0-liter V6	38.3	Average	6.5	Poor	1.9
Past experience	31.2%	2.5-liter Four	17.3	Poor	0.0	Mechanical trouble?	
Roominess	27.4	Transmission choice:		Specific likes:		No	72.1%
Styling	17.7	3-speed automatic	55.0%	Comfort	42.4%	Yes	27.9
Reputation	13.4	4-speed automatic	44.5	Handling	40.4	What type of trouble?	
Price/value	9.7	5-speed manual	0.5	Roominess	40.4	Complaints not statistically significant	
Handling	9.1	Engine power:		Styling	22.7	Dealer repairs satisfactory?	
Model choices:		Excellent	53.2%	Power	20.7	Yes	82.1%
Standard Plymouth Voyager	18.3%	Good	40.4	Ride quality	20.2	No	17.9
Standard Dodge Caravan	16.4	Average	5.6	Vision	14.6	Dealer service opinion:	
Dodge Grand Caravan LE	11.9	Poor	0.9	Specific dislikes:		Excellent	49.1%
Plymouth Grand Voyager LE	10.0	Handling:		No complaints	13.6%	Good	36.0
Dodge Caravan SE	9.1	Excellent	57.8%	Noises and rattles	12.4	Average	12.4
Plymouth Voyager SE	6.8	Good	38.1	Price	9.0	Poor	2.5
Dodge Grand Caravan SE	5.9	Average	4.1	Passenger mobility/rear legroom	6.2	Number of vehicles owned:	
Dodge Caravan LE	5.9	Poor	0.0	Fuel economy	4.5	This vehicle only	14.5%
Plymouth Grand Voyager SE	4.6	Braking:		Seatbelts	4.5	Two vehicles	66.5
Plymouth Voyager SE	3.7	Excellent	51.2%	Suggested changes:		Three vehicles	14.5
Dodge Grand Caravan ES	3.2	Good	42.4	Better passenger mobility	12.9%	Four or more	4.6
Dodge Caravan ES	1.8	Average	6.0	No changes	10.0	Principal driver:	
Plymouth Grand Voyager	1.4	Poor	0.5	Redesign instrument panel	8.6	Female	56.4%
Dodge Grand Caravan	0.9	Overall performance:		Make dual airbags standard	7.1	Male	36.8
Options/Accessories:		Excellent	53.0%	Make ABS standard	7.1	Equal	6.8
Air conditioning	100.0%	Good	43.8	Eliminate rattles and noises	5.7	Age distribution of owners:	
7-passenger seating	99.5	Average	3.2	Improve outside mirror controls	5.7	Under 29	6.9%
Antilock brakes	39.0	Poor	0.0	Workmanship opinion:		30-49	57.2
Digital instruments	19.3	Control layout:		Excellent	51.8%	50-plus	36.0
Handling package	18.7	Excellent	44.2%	Good	44.0	Based on your experience, would you buy a Chrysler minivan if you had it to do over again?	
Integrated child seats	14.3	Good	49.3	Average	3.7	Yes	78.9%
Towing package	7.4	Average	5.6	Poor	0.5	Maybe	18.8
All-wheel drive	3.6	Poor	0.9	Comfort opinion, front seats:		No	2.3
Cellular phone	2.4	Instrumentation:		Excellent	61.4%		
Avg. mpg, city/hwy:		Excellent	46.8%	Good	33.2		
		Good	49.1	Average	4.5		

* Percentages might not equal 100% due to rounding up or insufficient data.

rious Town & Country came along in 1990, using the same extended wheelbase.

Then in 1991, all three nameplates got a complete redesign, inside and out. Exteriors now appear less boxy. Interiors look even less spartan, more friendly. And all-wheel drive has joined the list of powertrain options. In 1992, Chrysler stole another march on its competitors by becoming the first minivan manufacturer to offer a driver's airbag, with a passenger's airbag as an option. Other safety options included 4-wheel antilock brakes and integrated fold-down safety seats for children.

The quality of Chrysler's new-generation minivans got respectable marks, with just more than half of our owners judging it as excellent and another 44% rating it as good. And most of the members of the survey group hadn't suffered through any mechanical problems.

No particular problem showed up enough for us to tabulate, and all complaints were relatively minor, like rattles in the sliding door, cold-engine hesitation and improper wheel alignment.

A number of details received praise from our owners. For example, turn signal repeater chimes remind drivers when a signal is operating when it shouldn't be, and another chime lets drivers know when the fuel level is getting low. The many storage compartments complement the fold-out cup holders, and there's a slide-out storage tray under the front passenger seat.

Harness hassles

In the negative column, owners criticized the shoulder harnesses, especially those near the sliding door. They tended to entangle passengers getting in or out, and the straps chafed against some passengers' necks.

The small horn buttons on the airbag steering hub tend to be hard to find in an emergency. And a number of buyers felt that Chrysler charges too much for options, which are often wrapped in packages that include equipment they don't want.

No better choice

Even so, owners of these minivans told us unequivocally that they couldn't have made a better choice. Nearly a third of our survey group had owned Caravans and Voyagers before. More significantly, almost 80% said they would buy a Chrysler minivan again.

As one owner put it, "It's a hard vehicle to outgrow." **PM**



Although owners like the looks of their second-generation Chrysler minivans, styling was fourth among best-liked features. Comfort, handling and roominess had the top spots.

EDITORS REPORT

No Weak Points

● Creating a new market segment—which is exactly what Chrysler did when it launched its minivans 10 years ago—means that you'll eventually find yourself defending it. When it became clear that Chrysler had answered a need no one else had recognized, competing manufacturers mobilized to respond with minivans of their own.

But despite the offerings of GM, Ford, Toyota, Mazda, Nissan, Mitsubishi and, most recently, Volkswagen, Chrysler's minivans still dominate sales and give every indication of continuing to do so.

Based on our Chrysler minivan experience, including the Voyager pictured here, we see two main reasons for this remarkable performance.

First, Chrysler's basic emphasis on carlike driving still sets the Mopar minivans apart from most of the crowd. Only the Mercury Villager/Nissan Quest are favorably comparable on this score. Mitsubishi's Expo twins are smaller, aimed at a distinct sub-mainstream niche.

Second, Chrysler offers a much broader variety of models and equipment than its competitors. With apologies to Mr. Shakespeare, you could call it the *As You Like It* approach to minivan marketing.

Our sample Voyager reflected the other traits that have helped to keep Chrysler's minivans on top—good fit

and finish, quiet operation, smooth ride, good road manners, adequate power (from its Mitsubishi-supplied 142-hp 3.0-liter sohc V6) and contemporary styling.

In our travels around Los Angeles, our Voyager turned in overall fuel economy of just over 20 mpg, which is fairly typical for the class. We found no hint of squeaks or rattles, even though our tester had almost 10,000 miles on its odometer.

The Voyager's handling rates as thoroughly predictable. It resists haste in hard cornering, but so do most minivans.

Thanks to its recent redesign, the Voyager and its stablemates are well provided with small-object storage. About the only item missing from the interior inventory is a readily accessible coin holder—not exactly what you'd call a weak point.

Every design has its limits, of course. If we wanted real towing capabilities—say 5000 pounds or so—we'd look at one of the rear-drive pickup-truck-based minivans like the Chevy Astro, GMC Safari or Ford Aerostar. The front-drive Chrysler minis don't do this.

What they do is provide pleasant, well-made, versatile family hauling. Some of the competing makes may do certain things better, but Chrysler's all-around minivan competence still sets the pace. —Tony Swan

THIS BEAUTY IS A BEAST.

Go play in the dirt. Throw some mud.
Do all this in a new Ford Ranger 4x4
and answer the call of the wild.

Then give it a wash. Polish it up. Cruise
down the boulevard and let the same



Buckle up— together we can save lives.

Материал, защищенный авторским правом

Ranger answer the call of the road.

Underneath its beautiful new shape you can get the growl of an

available 4.0 liter V-6. Com-

bine that with pushbutton four-wheel

drive, a new wider stance, and you've

got a truck that'll eat up the dirt and smooth out the street.

THE 1993 FORD RANGER.

The new 1993 Ford Ranger XLT 4x4.

A real beauty. With teeth in it.

the best never rest



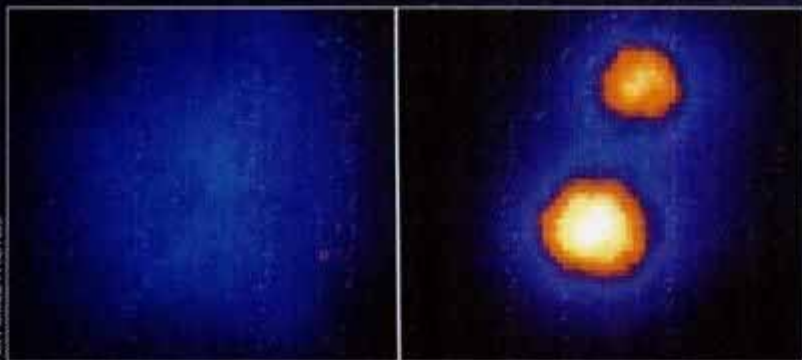
THE BEST-SELLING AMERICAN TRUCKS
ARE BUILT FORD TOUGH.



STAR SEARCH '93

Mammoth mirrors and Star Wars razzle-dazzle team up to probe the cosmos like never before.

BY GREGORY T. POPE



AIR FORCE PHOTOS

Laser beam ignites artificial guide star while adaptive optics tame turbulence. Result: Object normally seen as blob (left) shows up plainly as double star (right).



PM ILLUSTRATION BY PAUL DAVARE

Guide star winks into life as a laser beam stimulates atmospheric sodium into fluorescing. Backscatter shines bright enough to highlight the turbulence, mapped by a wavefront sensor. A deformable mirror then flexes to compensate. Starlight passing through the same column of turbulence is also corrected.

● For a second, the stars stopped twinkling in the summer of 1982. Atop Mount Haleakala, on the Hawaiian island of Maui, a crew of engineers was waiting to ricochet a laser beam off a small plane circling 10,000 ft. above them. They planned to route the beam through a deformable mirror that would wiggle and flex to compensate for atmospheric turbulence.

To test this apparatus, known as adaptive optics, the engineers photographed a bright star off the mirror before firing the laser. The mirror did its job: It literally shook the twinkle out of the starlight. A passing astronomer might have gasped at the image's clarity. But no astronomers passed by that night, because the test was a classified military experiment.

Charles Primmerman, of MIT's Lincoln Laboratories, recalls the effort that he directed: "Our attitudes were kind of interesting back then. We did the star compensation and said, 'That's nice. It's working.' Then we basically threw the data away."

The reason: Analyzing starlight wasn't in their game plan. Their focus was strictly on how well the mirror kept a laser beam from spreading out and weakening. After all, their sponsor was the Strategic Defense Initiative (SDI) Organization.

But that was a decade ago. Today, SDI has buried its ground-based laser weapon program. In May 1991, SDI and Air Force officials lifted the special-access veil from adaptive-optics hardware. Now astronomers are starry-eyed over a technological windfall—the ability to wipe away the starlight smudging caused by Earth's atmosphere. Combine adaptive optics with the worldwide building boom in giant telescopes, and stargazers predict a golden age of astronomical discovery.

All done with mirrors

Here, in principle, is why astronomers see great things in adaptive optics. Light from a star arrives cleanly at our planet as a flat wavefront—a cluster of light waves locked into phase. But then the wavefront must negotiate the atmosphere's swirling pockets of warm and cool air. At different temperatures, air refracts light at different angles. So once it strikes an Earth-bound telescope mirror, the starlight is no longer in phase, the wavefront is no longer flat—it's as crinkly as aluminum foil, the image broken and distorted.

But if the light is shunted through an array of lenses known as a wave-

STAR SEARCH '93

front sensor, a computer can literally map the topography of the wrinkled wavefront. The computer then commands the deformable mirror to work the kinks out of that topography. The mirror responds by flexing to restore the wavefront to its original flatness.

Piezoelectric actuators beneath a thin glass surface carry out these orders hundreds of times per second, resurfacing the mirror every time wind rearranges the atmosphere's hot and cold air pockets. The mirror's movements span less than a hair's breadth. "We're not talking about a funhouse mirror here," says Robert Q. Fugate, who directs the Air Force research at Phillips Laboratories, Kirtland AFB, New Mexico. "You couldn't even tell it's moving when it's in operation."

Military adaptive-optics research has been concerned with imaging ballistic missiles vaulting out of the atmosphere. As far back as 1982, this

question piqued SDI and Air Force scientists: What if light from a missile is too faint to provide a usable map of the atmospheric distortion?

Their solution was to run the mirror off a bright artificial guide star planted high in the atmosphere. The star-making machine: a laser beam focused 5 miles overhead, where air molecules reflect its light back to Earth in a phenomenon known as Rayleigh scattering. Even better, a laser trained about 54 miles above sea level can tickle floating sodium atoms into fluorescing brightly.

If positioned correctly, the guide star's light will shoot through the same shifting air pockets as light from the observed object and drive the adaptive optics. Optical tricks can filter the laser light out of the image.

In separate efforts spanning the past five years, both Fugate and Primmerman have demonstrated guide-star technology. Now civilian scientists are picking up the thread.

The University of Illinois' Laird Thompson, for example, is assembling apparatus for visible-light astronomy using a Rayleigh-scattering laser. At Lawrence Livermore National Labs, physicist Claire Max is creating sodium-layer guide stars with a kilowatt laser. Meanwhile, at the University of Chicago, astronomer Edward Kibblewhite is trying to adapt Lincoln Labs' equipment to do astronomy in the infrared spectrum.

But it's likely that the first adaptive-optics system with a guide star will emerge from Fugate's work, at an observatory under construction at Kirtland's Starfire Optical Range (see [Tech Update, page 16](#)). Fugate foresees first light this summer, and full-scale operation.

Giants on the Earth

What excites astronomers even more, however, is that the adaptive-optics windfall comes as huge telescopes are springing up across the



SANTA BARBARA INSTRUMENT GROUP PHOTO

High-Tech Amateur Nights

•While exotic new equipment sharpens the vision of professional astronomers, things are looking up for backyard stargazers as well.

Perhaps the brightest news is the price drop in charge-coupled device (CCD) cameras which capture images digitally. "They add an area to amateur astronomy that didn't exist two or three years ago," says Alan Dyer, associate editor of *Astronomy* magazine. "Faint objects show up that would be well beyond the reach of regular techniques." Santa Barbara Instrument Group and Spectra-Source Instruments are the big players in the low-cost CCD game.

Meanwhile, the same technology that aims the monster telescopes can now point the garden variety. Observatories have largely switched to altitude-azimuth mounts, which pivot around two axes like camera tripods. The hardware is lighter and simpler,

and computer-driven motors can nudge the telescope to track its target as the sky wheels overhead.

A computer-driven alt-azimuth mounting is available for amateurs in Meade Instruments' LX200. Now Software Bisque's *The Sky*, when twinned with optical encoders that retrofit to the telescope-drive mechanism, can slew the LX200 to point at whatever part of the night sky the software is displaying. Bisque is writing a subfunction for *The Sky* that will support CCD photography.

All this means you can chart the sky, point your telescope, snap a photo and look at it without dragging your eyes from the computer. It may not match squinting into an eyepiece for fun, but this is how the pros do it.

—G. T. P.

Computer-driven motors, as on Meade's LX200 (right), combine with digital imaging for backyard telescopes.



MEADE INSTRUMENTS PHOTO



globe. Thanks to advances in mirror fabrication and polishing, the big primary reflectors on these observatories will be fine-tuned for adaptive optics. "Starting about five years ago," says Thompson, "every astronomer could see adaptive optics on the horizon. Every new mirror made for a big telescope will meet that specification."

Biggest of all will be the twin 394-in. mirrors of the W. M. Keck Observatory on Mauna Kea, Hawaii. The first of these behemoths, a patchwork of hexagonal mirrored segments, is just a few weeks from delivering its first images. The second will be finished in 1996.

Keck will see some competition, however, from new telescopes with single-piece mirrors in the 300-in. class. One of these, run by the National Optical Astronomy Observatories, will aim a 315-in. mirror from Mauna Kea, construction beginning

next year. An exact clone of the telescope, planned for Cerro Tololo, Chile, will depend partly on foreign funding. The dual project, designed to watch the sky's Northern and Southern hemispheres, is dubbed Gemini. Meanwhile, next door to Keck, Mitsubishi Electric is building Subaru—a Japanese telescope with the world's largest single-piece mirror, a 327-in., 30-ton slice of fused glass.

Two rival technologies are bringing these monster mirrors to life.



One is the meniscus mirror, a thin concave layer of glass supported by hundreds of small active pistons. The underlying machinery adjusts the curvature of the mirror to prevent it from warping under its own weight. Corning Glassworks is manufacturing the Subaru and Gemini mirrors, while Germany's Schott Glass Technologies is casting four 323-inchers for a new European facility, the Very Large Telescope, to be built in Chile.

The other option for outside optics is the spun-cast mirror, developed by Roger Angel at the University of Arizona. Here, a huge furnace spins fast enough that centrifugal force spreads the molten glass to the correct curvature. As a bonus, the bottom of the mirror blank is honeycombed, leaving a stiff, lightweight structure.

Combined with adaptive optics, these light-sensitive giants will give astronomers cosmic zoom lenses trained on the universe's unsolved mysteries. "We'll get detailed pictures of the formation of planets around young stars, and clues to the evolution of galaxies," predicts Sidney Wolff, Gemini's project director. "We're just getting tantalizing hints now. We can bring distant galaxies within reach."

Making The World's Biggest Mirror

1 Vaportized silica-titanium glass is laid down in a furnace and cooled to form 5-ft.-dia. disc called a boule.

2 Four boules are fused together, then sawed in half, forming a 10-in.-thick disc.

3 Disc is ground and polished down to a 9-in. thickness.

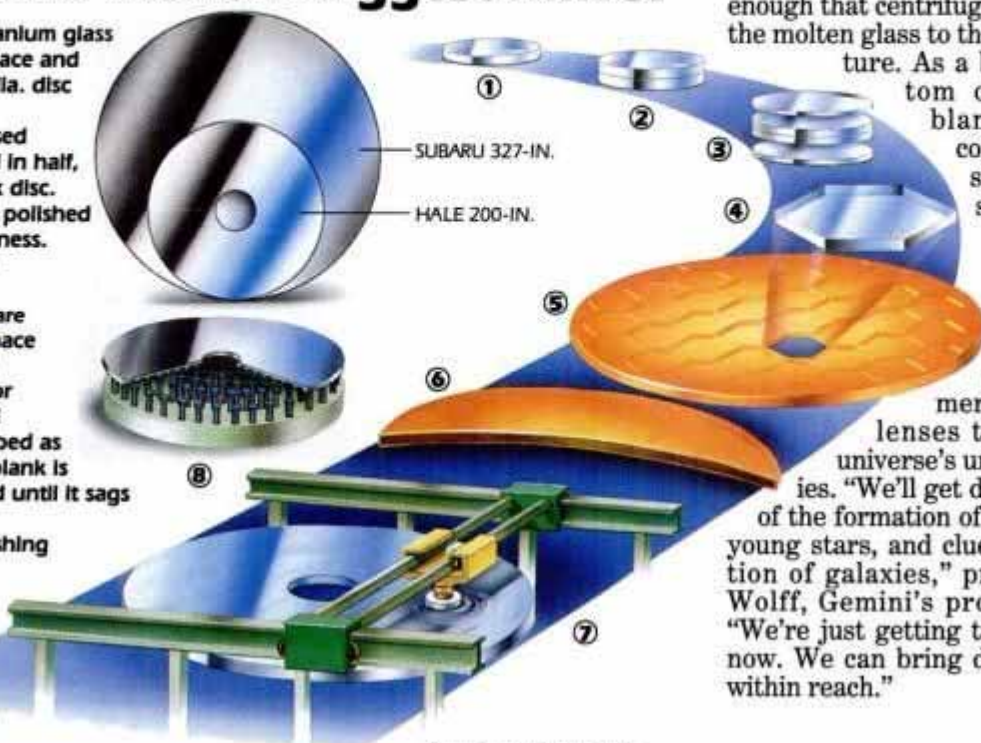
4 Disc is sliced into a hexagon shape.

5 Hexagonal blocks are assembled in the furnace and melted together.

6 After cooling, mirror blank is removed and furnace floor is reshaped as convex mound. The blank is reinserted and heated until it sags into concave form.

7 Three years of polishing ensue.

8 Final mirror rests on bank of 264 actuators.

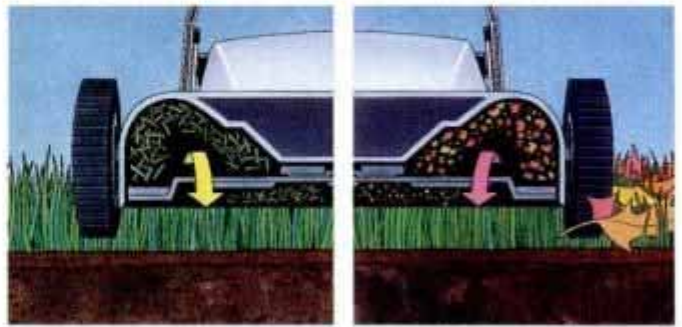


PM ILLUSTRATION BY PAUL DIMARE

NO CORD. NO GAS. NO BAGS. NO HASSLES.

MEET THE MULCHINATOR™ CORDLESS MULCHING MOWER

Ryobi takes the hassles out of lawn care with our new 24-volt cordless mulching mower — the Mulchinator. This unique, rechargeable mower saves you time and work. Unlike gas mowers, there's no refueling, no oil and no stopping to empty a grass catcher. The Mulchinator packs enough power to mulch a half-acre lot on a single charge; that's equal to a 100' x 210' lot! The motor is amazingly quiet too — a feature sure to please your neighbors, especially during early morning cuttings.



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Space-saving, upright storage.

The Mulchinator™ Cordless Mulching Mower.

Our unique Turf Injector™ mulching action turns clippings and leaves into super-fine nutrients and propels them down to the soil, where they decompose quickly. So your grass grows greener and thicker, without thatch build-up.

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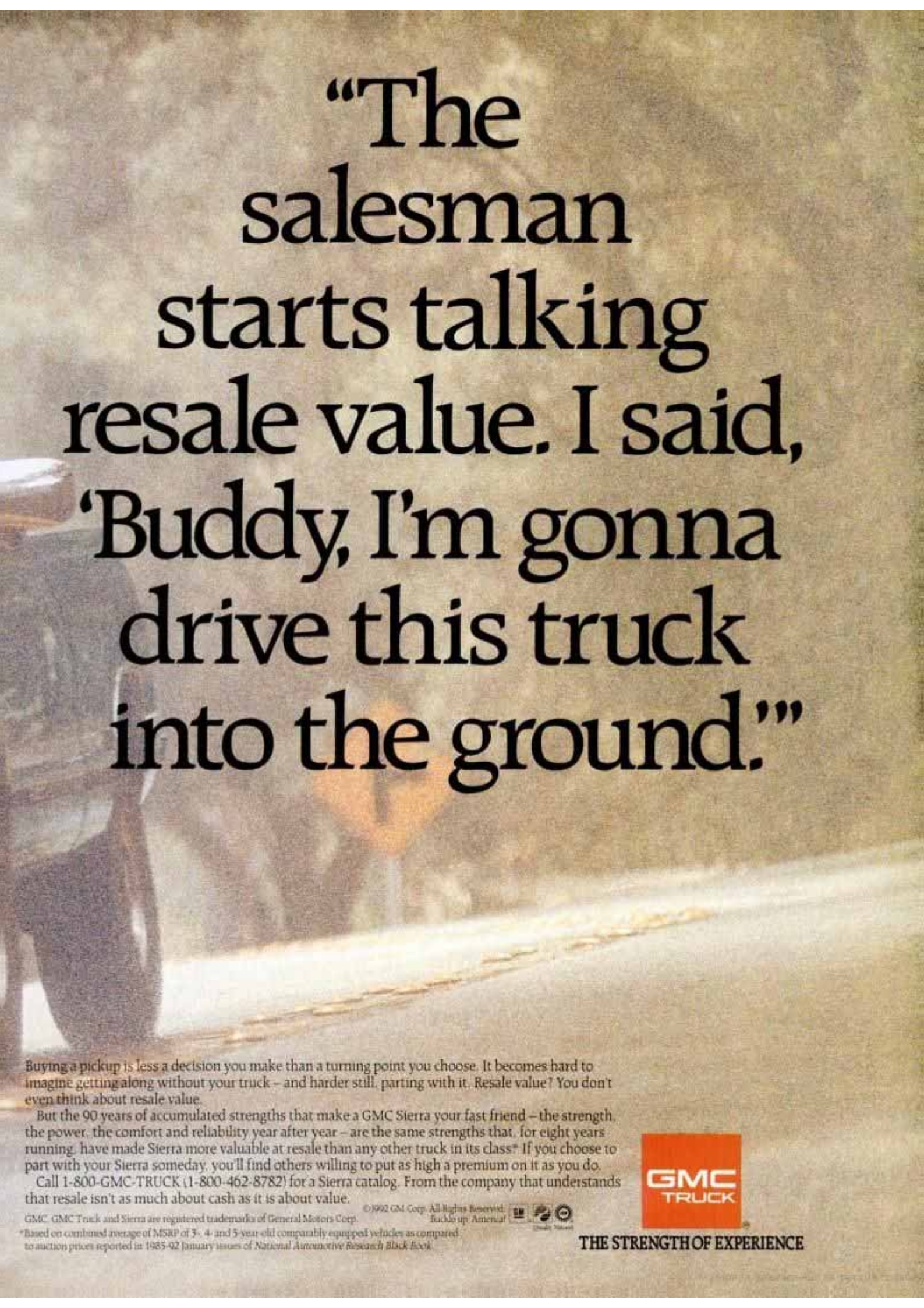
SPECIAL SECTION

Annual HOME IMPROVEMENT GUIDE

Great Projects, Tips And Techniques To Make
Your Home Look Better, Work Better

- Build A Small Backyard Deck
- Paint Aluminum Siding
- Repair Sidewalks
- Fix Broken Windows
- Install An Outdoor Faucet
- Lay Vinyl Floorcovering
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- **Plus:** A Comprehensive Collection Of Tools That No Homeowner Should Be Without





“The
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starts talking
resale value. I said,
‘Buddy, I’m gonna
drive this truck
into the ground.’”

Buying a pickup is less a decision you make than a turning point you choose. It becomes hard to imagine getting along without your truck – and harder still, parting with it. Resale value? You don't even think about resale value.

But the 90 years of accumulated strengths that make a GMC Sierra your fast friend – the strength, the power, the comfort and reliability year after year – are the same strengths that, for eight years running, have made Sierra more valuable at resale than any other truck in its class*. If you choose to part with your Sierra someday, you'll find others willing to put as high a premium on it as you do.

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*Based on combined average of MSRP of 3-, 4- and 5-year-old comparably equipped vehicles as compared to auction prices reported in 1985-92 January issues of National Automotive Research Black Book.

THE STRENGTH OF EXPERIENCE

ESSAY

THE JOY OF DOING IT YOURSELF

BY TIM ALLEN

I've always loved POPULAR MECHANICS. Ever since I was a kid I've often dreamed of the predictions promised for the future, though I must confess to a few disappointments. Where are those backyard monorails in tubes? All we have is Amtrak. Or cars that can fly? I guess the American Automobile Association squelched that one. Or how about cities in bubbles? Is Biosphere II the best we can do?

But enough about the future. We're talking about do-it-yourself.

I'm a nut about building things. I've always loved the before-and-after process. I'm also a sucker for the makeovers you see on "Home Again With Bob Vila" and "This Old House." Or even the ones you see on "Sally Jesse Raphael," some of those beauty makeovers qualify as home improvements if you ask me.

I think what attracted me to tools in the first place was their possibilities. I mean, they are, in effect, weapons for pacifists. You can't help

but get pumped up at the thought of nail guns, ripping routers, pneumatic drills, acetylene torches with gouging tips and dado-head buzz saws. Arrgh, arrgh, arrgh!

Experts in psychology and sociology claim that men enjoy building things because they can't have babies. I think that's a pretty good analogy. For the do-it-yourselfer, it's almost a parent-child bond that develops over the course of a project. The difference is that a baby will wake you at 3 am, a do-it-yourself project will keep you awake until 3 am.

Half the fun of building a do-it-yourself project is in the planning and preparation. Drawing up sketches and blueprints, going to the hardware store and the lumberyard—the twin states of nirvana for D-I-Yers—picking out all the supplies and raw materials and finally strapping on the toolbelt, the holster of home repair.

As much as I love doing it myself, sometimes the job calls for the big guns—the guys with

“Doing it yourself is an act of creation.”



the heavy-duty equipment. Still, it's fun to watch them using all that heavy artillery—cement mixers, back hoes, trenchers, earth-movers, steamrollers. Arrgh!

Just watching these guys in action gives me such a vicarious thrill that I want to jump in and help. But I've learned from personal experience that this can be both dangerous and costly. Besides, professionals usually frown on that sort of thing:

“Please take off the drywall stilts, Mr. Allen.”

“Turn off the steamroller, Mr. Allen.”

“You're gonna pay for that, buddy!”

All in all, doing it yourself is, in effect, an act of creation, and the phrase “do-it-yourself” has one magic word in it: you. What you build becomes your creation, your baby. Something to think about when you're contemplating using the cheap nails.

FM

Tim Allen's ABC-network show “Home Improvement” has been in the top-10 ratings for two consecutive seasons.

SPRAY CONTROL FROM 1/4" TO

Our New Wagner FineCoat just sprayed the 1/4" mark at the right, actual size. And it could have just as easily covered the entire page in one quick pass. FineCoat gives you more control in spray painting and wood finishing than a brush, spray can or conventional paint sprayer.

The secret is FineCoat's High Volume/Low Pressure technology that uses a low pressure air supply system. It's the same technology professionals have used for years. It lets you apply paint or fine finishes, even indoors, with virtually no overspray.



Actual spray pattern.



Your hand never had this much control.

With FineCoat, 1/4" to 12" is just the beginning of control. You can also adjust the spray to a vertical, horizontal or circular pattern, without changing nozzles. Adjust the pressure and you can get within inches of your project, without runs. FineCoat even helps control your time. You'll probably finish spraying and cleaning up in less time than you thought.



*FineCoat gives you pinpoint control so you can easily spray almost any paint, stain or finish on projects that would otherwise be time consuming to finish by hand. *Not recommended for spraying heavy-bodied latex paint.*

Control over more paints and finishes.

FineCoat can spray almost any paint or finish you can think of. It handles:

- enamels
- varnishes
- shellacs
- lacquers
- oils
- stains
- urethanes.

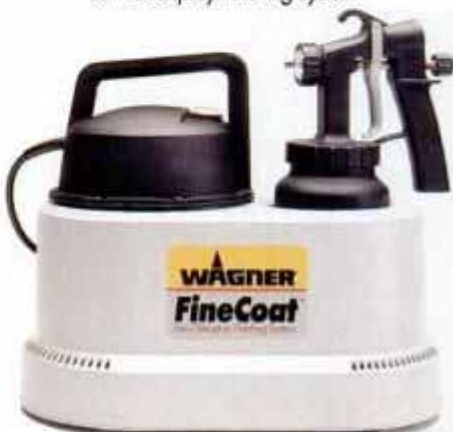
FineCoat even comes with helpful hints for thinning and spraying these different materials.*

Find out more about the Wagner FineCoat. Call the toll-free number below. We'll send you free literature on FineCoat or give you the name of the nearest FineCoat dealer. If you want a first-hand demonstration, call and order a FineCoat VHS videotape for just \$3.



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Homeowner's Toolkit

TEXT AND PHOTOS BY MERLE HENKENIUS



Moving into a new home may seem like a ticket to trouble-free living, but that's not always the case. A new home is like a new car, it sometimes takes a little while to work out all the bugs. Even a high-end custom home will harbor a few blemishes and oversights that you'll need to straighten out. Combine these with the inevitable upgrades most of us make after moving in and you can see the usefulness of having some tools on hand.

Of course, you may not want all the tools we've compiled here for our new homeowner's toolkit, but if you did have them all you could tackle just about anything. If the total investment is too much right now, then simply buy the basics at first and add the specialty tools as need dictates. Here's our selection, with a few words on each tool's features and likely uses.

Claw hammer—A good finishing hammer will last a lifetime and help

you through a wide variety of improvement and repair projects. A hammer with a steel or fiberglass handle will be the most durable, especially when pulling nails. We suggest one with a curved claw and a 16-

ounce head. This combination will work well on rough carpentry as well as on finish work. A quality hammer, in the \$16-to-\$20 range, can mean the difference between driving nails and bending them.

HOME IMPROVEMENT GUIDE

Handsaw—Next on your list will be a good crosscut saw. Handsaws cost a good deal less (\$10 to \$16) than power saws and work just as well in limited-use situations. You'll also be able to reach into spaces too cramped for a circular saw. A 10-point crosscut, having 10 teeth points per inch, will serve you well around the house and yard. This saw will cut clean enough for most finish work and quickly enough for most rough work. If you'll be doing mostly rough carpentry, a 6- or 8-point saw will speed your work substantially.

Conversely, saws with more teeth per inch (12 and 14 are typical) cut slowly but leave a very fine edge.

Hacksaw—There are many occasions when a hacksaw comes in handy, from cutting plumbing pipes to trimming downspouts and slicing through ceramic tile. The most important thing to look for is rigidity. A saw that flexes when used will bend or break the blade, or will simply refuse to cut straight. Most are adjustable and will accept 10- or 12-in. blades. Look for a brand that allows two different blade installations, either straight or at a 45° angle. A good hacksaw will cost between \$12 and \$16. And you should buy extra blades. These are often sold in packs of five for around \$3.

Tape measure—The best advice we can give in selecting a tape measure is to avoid the short and narrow. For general household use, choose one that is at least 3/4 in. wide and 16 ft. long. Beyond that, it's a matter of which style appeals to you most. Some tapes have the thumb-latch on the top, others on the front. And remember, a broken tape does not mean a ruined tape measure. Replacement tapes are available for most brands. Our tape cost \$11.

Block plane or Surform tool—For trimming marginal amounts of stock from lumber and other materials, consider buying a plane or Surform tool. Because planes require exact adjustment and dull easily in untrained hands, a Surform tool is a good household alternative. This type of plane has a replaceable, slotted blade that gouges out narrow ribbons of wood, plastic, vinyl and even aluminum without clogging. A Surform tool will not yield the clean, hard-edged surface of a block plane, but it's a snap to use. We paid about \$12 for this 10-in. model.

3/8-in. VSR drill—Another tool that will quickly earn its keep is a 3/8-in. drill. While cordless drills are ideal



for the quick fix, a cord-type drill is more versatile. It can be used for boring holes and running a wire brush or sanding wheel. And it's a powerful tool for driving all manner of screws. And because you won't be

paying for a charger, you'll get more power per dollar invested. Look for one with a variable-speed reversible (VSR) motor capable of at least 2000 rpm. The tool we chose has 2.8 amps of power and offers an industry-

2-FT. LEVEL



TONGUE-AND-GROOVE PLIERS

HOT GLUE GUN



DUCT TAPE



LOCKING PLIERS



DRAIN AUGER



HAMMER



MULTI-TESTER



3/8 IN. VSR DRILL



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4-IN-1 TOOL



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SHARPENING STONE



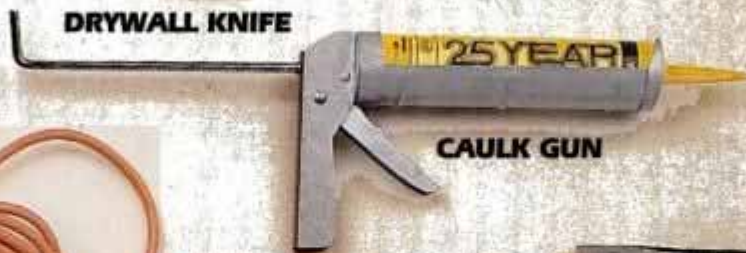
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You'll also want a selection of drill bits and possibly a few specialty attachments. We chose a 13-piece high-speed steel bit set with sizes graduat-

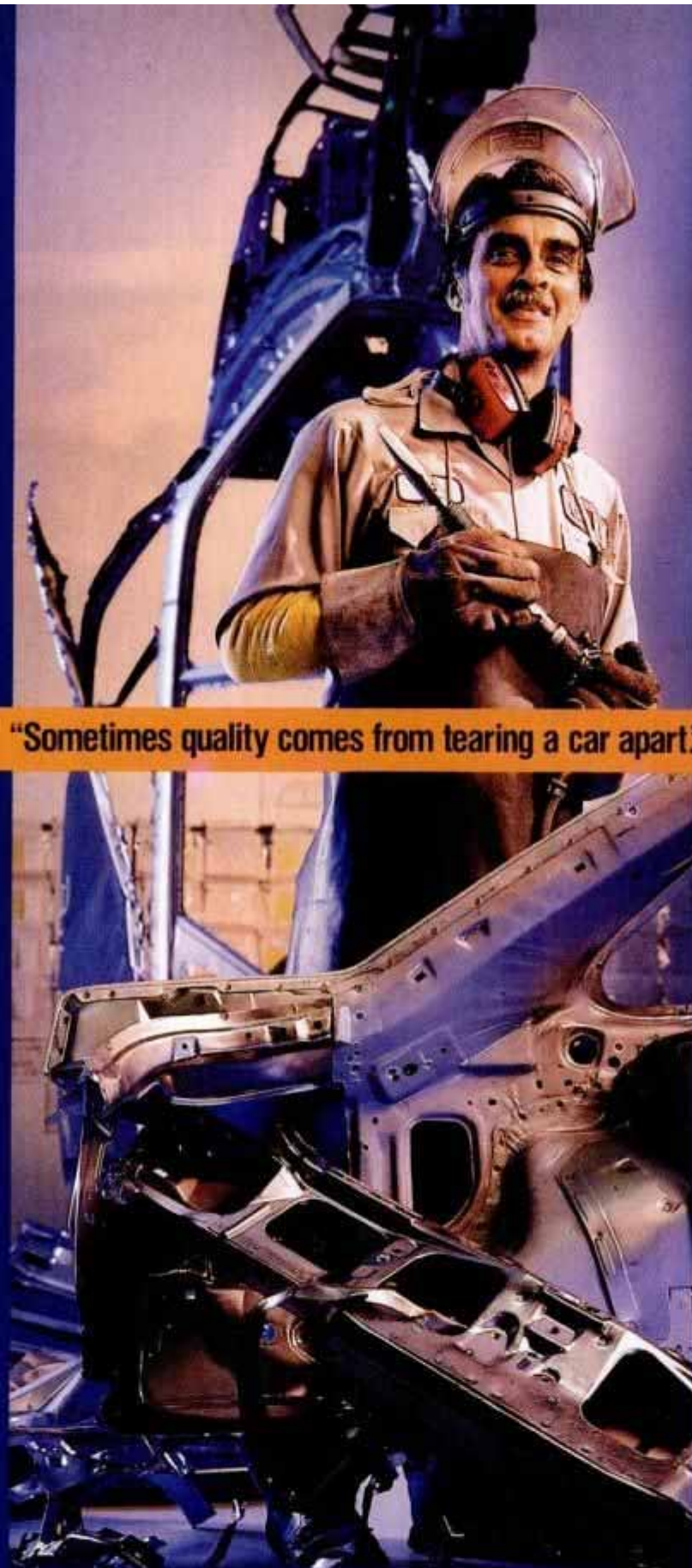
ing from 1/16 to 1/4 in. Buying bits in a case makes selection easier and also reveals at a glance which sizes you'll need to replace.

In addition to the \$16 bit set, we chose a 1/2- and 3/4-in. spade bit for

larger holes in wood. Spade bits are reasonably priced, around \$2.50 apiece, and are easily resharpened.

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—To keep your projects well powered. (Please turn to page 106)



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Easy Backyard Deck

TEXT AND PHOTOS BY MERLE HENKENIUS



One area where builders often economize lies just beyond the back door. Open that door and it's usually one or two steps down to a modest concrete slab. These patios are often thrown down for around \$100 and spend the ensuing years creeping steadily away from the foundation.

If this sounds familiar, you might consider forsaking that patio entirely

and building a deck on top of it. While decks can be obscenely expensive, they don't need to be. We built this simple 10 × 12-ft. deck for around \$350.

Its advantages are that the deck is at floor level, it will never rot and it has frost footings—so it will stay put. Even though it's small, it's large enough to accommodate a gas grill, a few chairs and a small table for

that morning newspaper and first cup of coffee.

Location

With a relatively small concrete slab, you can simply dig the post footings outside the slab perimeter. In our case, a footing placed outside the slab would have extended the deck past the house by several inches. With this in mind, we opted to cut the slab at each footing location, so we could maintain the original 10 × 12-ft. footprint.

Material selection

Although galvanized casing nails are acceptable, we chose to use rust-proof coated screws in all instances where fasteners would be visible. These were coarse-thread deck screws, driven in with a screw gun. Where joist hangers were needed, we used code-required hanger nails, which are shorter and heavier than common nails.

The lumber you choose will need to be rot-resistant. The most common choices are cedar, redwood and pressure-treated pine (CCA). Each has its advantages and its shortcomings. Redwood and cedar make the most attractive decks when new, but are a little pricey. Because we wanted to keep costs as low as possible, we chose pressure-treated stock. We used 2 × 10s, 2 × 8s and 4 × 4s for the structural components and 2 × 6s for the decking.

Frost-proof footings

As mentioned earlier, we decided to cut the slab at each footing location. While sawing concrete may seem daunting, it's really fairly easy. All it will take is a circular saw and one or two masonry blades (around \$7 each). While you can rent a demolition saw, we used an old circular saw that had been dropped from a ladder once too often. While its bent baseplate makes ugly work of lumber, it handles concrete just fine. The goal is to score the concrete roughly one-third of the way through (Photo 1). Then, break the slab inside the score lines with a 3-pound hammer.

With the concrete removed from the footing locations, use a post-hole digger to dig holes past the frost level in your area (Photo 2). Accept-



1 Begin by laying out the deck location. If concrete must be cut, use masonry blade in an old circular saw to score surface.



2 Use a post-hole digger to dig pier footing holes below the frost line. Square off the bottoms of the holes.

HOME IMPROVEMENT GUIDE



3 If the house siding leaves a large gap between siding and ledger, tack a strip of treated lumber to the ledger.



4 Attach the ledger to the house siding with a couple of screws, then bore four lagbolt clearance holes in the ledger.



5 Slide a lagbolt and washer into each ledger hole and tap with a hammer. Then drive into the rim joist with a wrench.



6 After screwing the side rim joists to the house ledger from the outside, nail a corner bracket to both on the inside.



7 After setting the 4 x 4 posts, plumb them in place. Then screw the rim joists to them with three or four long screws.



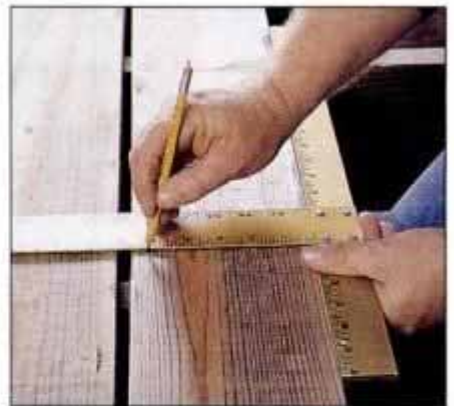
8 With the rim joists squared and fastened to the posts, mount the 2 x 8 ledger plates to the inside with screws.



9 Lay out the outside rim joist for the deck joists and install a joist hanger at each mark. Slide joists into place.



10 Use spacer sticks to maintain $\frac{3}{8}$ -in. gap between deck boards and a $\frac{1}{8}$ -in. space alongside the rim joists.



11 To keep screw rows straight, draw a line across the boards above each joist. We used a drywall square to do this.

able footing designs vary, but we chose to fill the bottom 8 in. of our 36-in.-deep holes with gravel. Then we set the 4 x 4 posts on this gravel base and packed soil firmly around each post. The rigidity of the deck will keep them from moving laterally.

As for the number of footings, we placed one at each outside corner and centered one along the front of the deck. We also installed one post on each side, halfway between the corner posts and the house. As such,

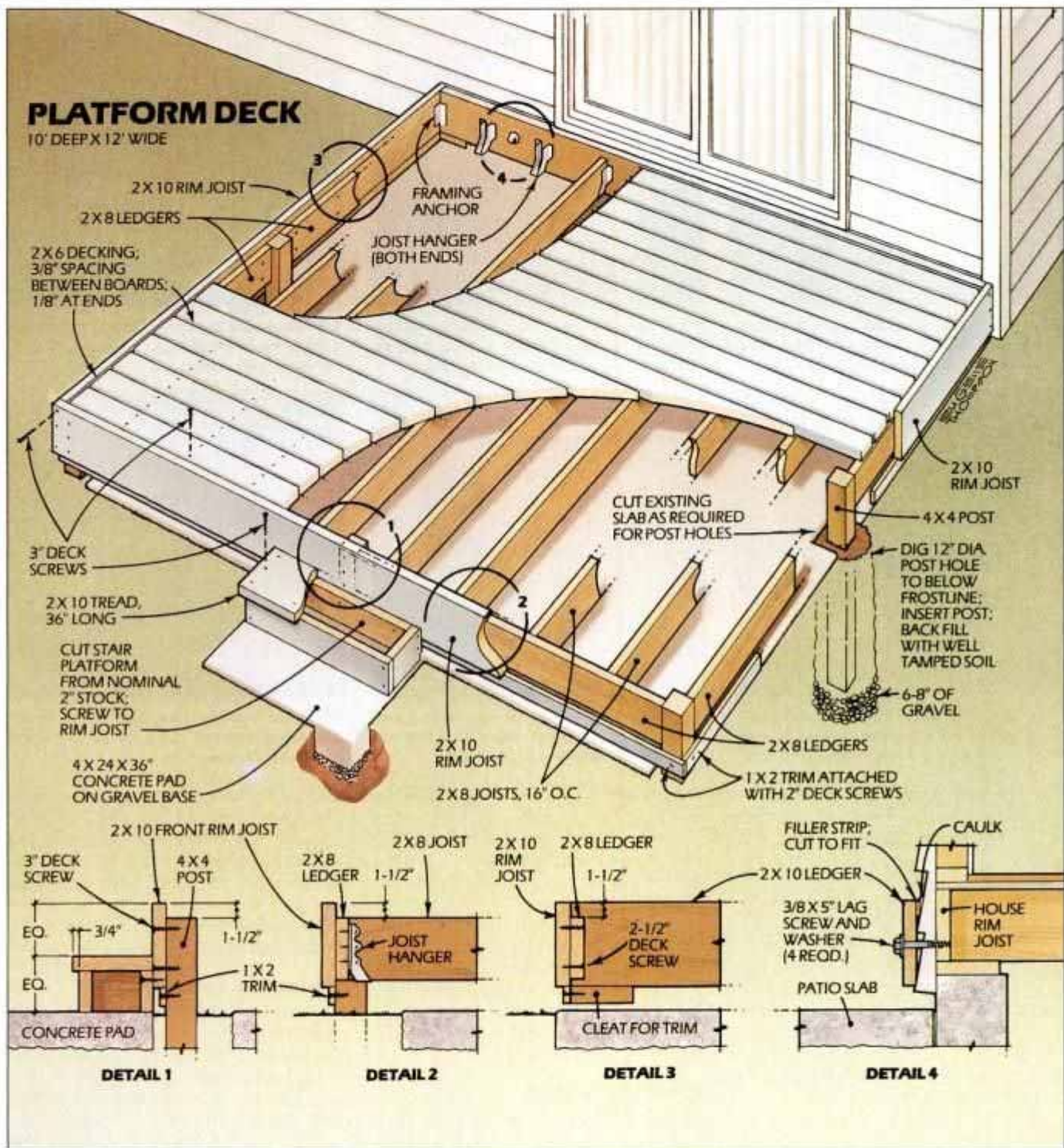
our longest rim joist span was less than 6 ft.

Easy framing method

Framing methods vary, but we chose to build a deck that hides the end cuts of the decking lumber. To achieve this no-reveal look, we built the perimeter frame with 2 x 10 lumber. We then lined them with 2 x 8 ledgers, securing them to the inside of the rim joists with 2½-in. screws.

Step by step

After digging the post footings and adding the gravel, we put off installing 4 x 4 posts until the box was built and squared up. To build the box, start by trimming a 2 x 10 joist (because of its position against the siding, now called a ledger) 3 in. short of the overall deck width. (If your home has lap siding, and if the gap left between the top of the deck ledger and the siding is more than ¼ in., you'll want to cut a strip of lum-



ber to fill this gap. The best approach is to tack this strip to the rim before mounting it on the siding as shown in Photo 3. Keeping it level, screw or nail this ledger to the house (Photo 4). Then, bore holes through the ledger at four points along its length and use 5-in. lagbolts to bind it to the rim joist of the house (Photo 5).

With the 2 x 10 ledger mounted on the house, cut the side joists to length and prop them up temporarily. Then, screw them to the ends of the ledger

on the house. For added strength, nail a corner bracket to the inside of this joint (Photo 6). Finally, cut the front rim joist and screw it to the fronts of the side joists, using 3-in. screws.

With the basic box completed and propped up temporarily, measure from corner to corner to square it. If necessary, tack braces diagonally across the corners to keep it square while you install the posts. At this point, you'll also want to level the deck in all directions.

To install the posts, simply set them in the post holes and mark and cut them to the correct length. Be sure to hold the tops of the posts 1 1/2 in. below the rim to accommodate the decking. Finally, plumb each post in its hole and secure the rim to the posts with 3-in. deck screws (Photo 7). Screw the corner posts from both directions. With all posts secured, backfill around them.

Your next step will be to screw the 2 x 8 ledger plates to the three 2 x 10

HOME IMPROVEMENT GUIDE



12 Drive the deck screws with a standard drill or a screw gun like we did. Set screws just below the surface.



13 Preassemble a box step using the drawing as a guide. Set it on a poured concrete pad or a few concrete blocks.



14 Make sure the top of the box is parallel to the top of the deck. Then attach it to the deck with screws.



15 Complete the step by installing a tread. Use at least three screws on the sides and several along the front and back.



16 To protect the siding behind the ledger from water exposure, seal the top joint with a bead of silicone caulk.



17 After sanding away any rough spots and removing the dust, cover the deck with wood sealer or an oil-base stain.

rim joists (Photo 8). Remember to hold these exactly $1\frac{1}{2}$ in. down from the top of the rim joists. (The 2×10 ledger on the house will not need an additional 2×8 ledger, because the joist hangers can be tacked directly to it.)

With the ledgers in place, lay out the 2×8 joists on 16-in. centers along the front rim and on the house-side ledger. Then cut the joists to length and set them in the hangers (Photo 9). Finally, nail the joists through all openings in the hangers, using the special hanger nails.

Decking

Now that the box is complete and the joists are in place, it's time to cut the 2×6 decking planks to length.

Choose the straightest 2×6 you can find for the first deck plank. Then, screw it to the joists and ledgers using 3-in. screws. Start the decking at the front of the deck and proceed toward the house.

While the first plank can be placed against the rim, all subsequent planks should be spaced roughly $\frac{3}{8}$ in. apart. To maintain this spacing, make a spacer stick and use it at

each screw location (Photo 10). When dealing with warped lumber, screw the nearest point and pry the rest of the plank over one joist at a time, securing it as you go. Use two screws per plank, per joist.

For the best nailing, it's a good idea to draw a straight line across the boards above each joist (Photo 11). And for ease of installation, you can use a screw gun instead of a standard drill to drive in all of the deck screws (Photo 12).

Building a step

Most do-it-yourselfers find stair building a frustrating experiment. With that bit of discouragement behind us, here's the good news. When we're only talking about a step or two, a simple box will work just fine. All you'll do is build an open box (Photo 13) and screw a plank on top of it. If you need two steps, build two boxes. You can set the box on buried concrete blocks, or you can pour a small concrete pad, as we did. Just make sure your step support is level.

As a general rule, a step's rise should not exceed $7\frac{1}{2}$ in. and its tread should be at least 10 in. deep

and 36 in. wide. Minor compromises are acceptable. Major ones are not. To split the difference between pad and deck, which was 14 in., we built our box $5\frac{1}{2}$ in. high. After screwing the box to the deck (Photo 14), we screwed a 2×10 plank over it, making an even, 7-in. rise (Photo 15).

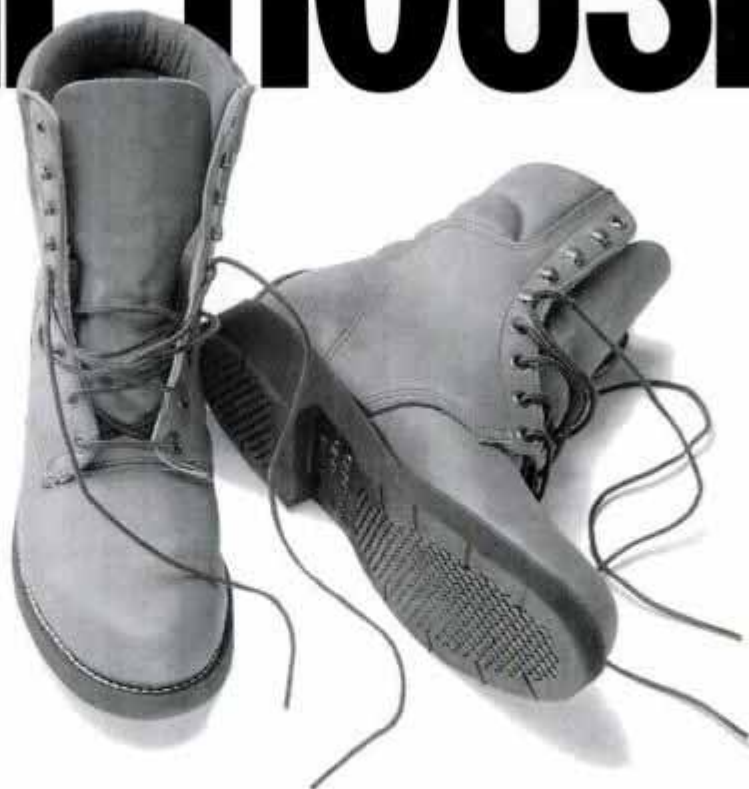
Finishing touches

Ask around and you're sure to hear that deck lumber needs to cure for six months before being stained or sealed. Our recommendation is that you not ask around. Months of sun and rain will only degrade the surface of the lumber, and it's the surface that the sealant is designed to protect. Besides, these are exactly the conditions that cause lumber to cup and warp.

Before applying stain or waterproofing, take the time to caulk the top of the ledger board (Photo 16) and to sand away any imperfections on the surface of the deck. These include rough spots, grade stamps and pencil marks. Then, apply an even coat of oil-base stain and keep off of the deck for several days (Photo 17).

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Painting Aluminum Siding

TEXT AND PHOTOS BY MERLE HENKENIUS



Aluminum and steel sidings, which took the nation by storm in the '50s and '60s, are showing their age. Of course, the allure of these products was the maintenance relief they offered—namely, an end to regular and costly painting. To a great extent, aluminum and steel sidings have fulfilled that promise. But with much of it in place for nearly a generation now, a

good many homeowners have opted to dress it up, ironically, with paint.

In many cases, tastes have simply changed. Yesterday's visionary colors have become today's eyesores. Moreover, the factory-applied paint coatings keep chalking over, leaving a dusty, lackluster appearance. This chalking (easily seen by rubbing your fingertips over the siding as shown in Photo 1), while unattrac-



1 Wipe your fingers across the siding to check for chalking. If heavy dust comes off on your fingertips, consider painting.



2 Rinse the siding with water first, then scrub the surface with a mild household detergent and stiff cleaning pad.

tive, is no accident. Paint coatings made for metallic surfaces are designed to chalk. Chalking allows the paint to slough off tree sap, bird droppings and other natural stains.

If chalking is your only complaint, then a good scrubbing may be all your siding needs. If you've wondered, however, if your steel or aluminum siding would hold a coat of paint, without initiating the very cycle of repainting that you spent good money to avoid in the first place, the answer is a qualified yes.

While your own paint job will not likely hold up as well as a factory coating, metallic surfaces generally hold paint better than wood or composite-fiber surfaces. The reason is that metal does not absorb and release moisture with changes in temperature and humidity. This breathing process is what causes paint to blister and lose its grip on wood and hardboard sidings.

Paint choices

Choosing the right paint is critical. You'll only want to do this once, so a garden-variety latex is out of the question. Instead, choose a high-quality, and slightly higher priced, 100% acrylic paint. The 100% acrylics bond well to metal siding and dry to a hard, smooth finish. Just as importantly, acrylics have what the paint industry calls good leveling characteristics. Simply put, when brushed on, the paint levels out many of the brush marks before skinning over. As such, the paint doesn't look as though it was swabbed on with a broom.

Surface preparation

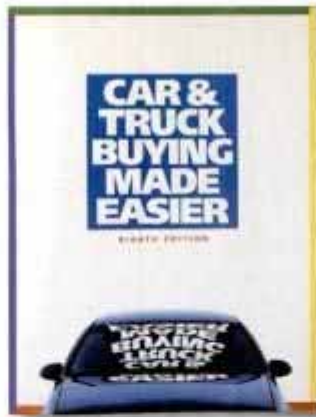
As you've guessed by now, the most critical step in surface preparation is the removal of chalk buildup. While the pros often use power washers and detergent, a bucket of warm soapy water and a scouring pad will work just as well (Photo 2). Use a mild household detergent that can be easily rinsed away. Simply scrub a manageable area and rinse it thoroughly before moving on.

You'll also want to seal any seams between exposed wood and siding (Photo 3). Just use a top-quality silicone exterior caulk that can expand

(Please turn to page 84)

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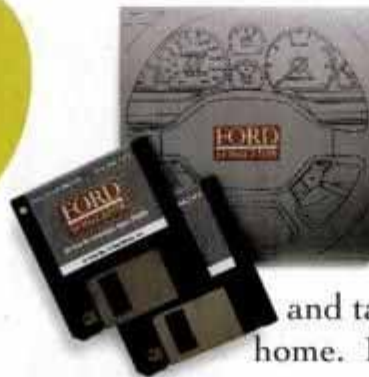
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and contract with the seasons. Pay particular attention to plumbing and electrical openings (Photo 4), as well as dryer vents and phone and cable-TV entrances (Photo 5).

If one or two laps of siding are badly damaged, your options will vary. Check with a siding wholesaler or installer about replacement. A perfect match, however, may not be possible. Many of the older manufacturers have long since gone out of

business and new siding locking systems may not be compatible.

Applying the paint

Painting aluminum requires no special skills, but close attention to detail improves the final appearance. As always, start painting from the top and work down. Paint the field first, then the trim. Make sure you load the brush with plenty of paint and smooth out your strokes carefully.

When it comes to painting the inner surfaces of J-molding and the siding that abuts it, the brushwork can be tricky. It's easy to load too much paint into these narrow strips, and because your brush must lay against the siding, it's easy to drag fresh paint off of the siding near the J-molding. If this is a problem, paint the inside channel of all J-molding first. Then paint the rest of the siding after this paint dries. **FM**



3 Use silicone caulk to seal all joints where the wood and siding meet. Pay special attention to windows and doors.



4 Apply silicone caulk around all outdoor electrical fixtures to prevent any water from entering these boxes.



5 Fill any holes, like these that were left when a phone line was moved. Keep caulk flush with the surrounding surface.



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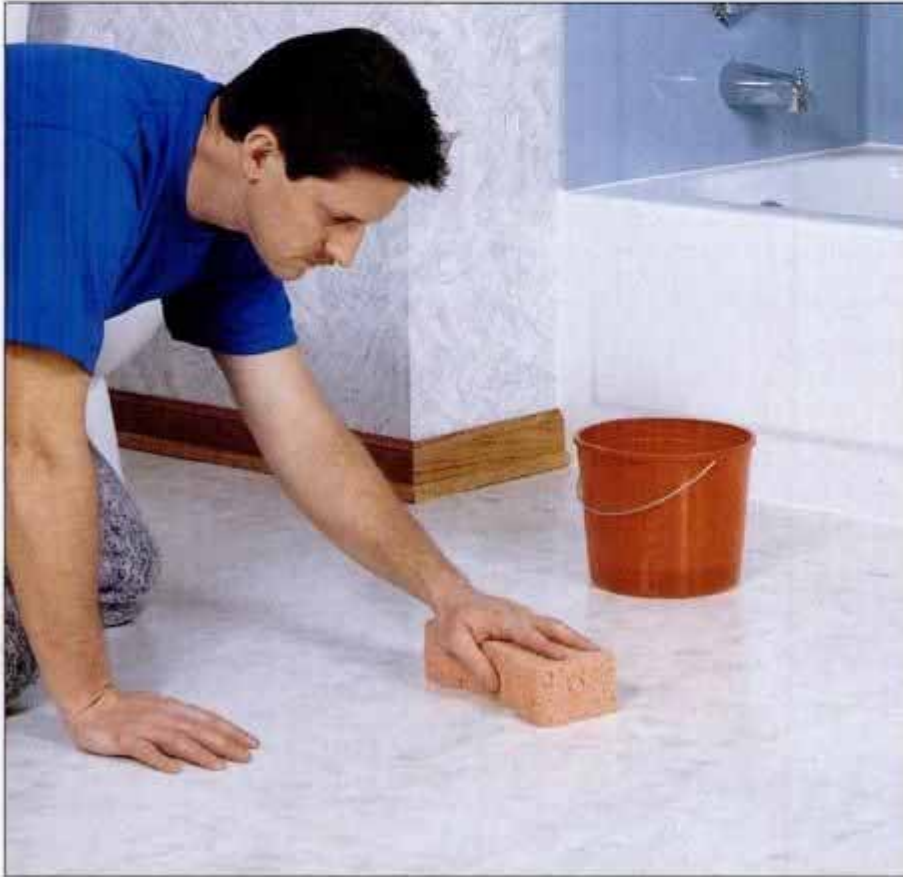
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Foolproof Vinyl Flooring

TEXT AND PHOTOS BY MERLE HENKENIUS



The thought of installing sheet-vinyl flooring can be intimidating, especially when you consider that one or two mistakes can ruin the whole sheet. The problem is compounded by the fact that few rooms are truly square, and that most have obstacles and offsets to accommodate.

How do professional installers keep from making costly mistakes?

When a room is complicated, a pro will make a paper pattern of the room and transfer that pattern onto the vinyl. As such, the paper becomes a one-of-a-kind template and every wobble and bobble, every offset and obstacle is factored in before cutting.

There's no reason why you can't do the same. In fact, the Armstrong flooring people have come up with a goof-proof installation kit that allows

you to do just that. The kit includes the pattern paper, instruction booklet and transfer tools. While there are enough sheets of 3 x 6-ft. paper to accommodate a 600-sq.-ft. room, and you could easily add your own paper to fit a larger room, our flooring project was a good deal smaller.

We chose to use the kit on a bathroom, which, while small, required a fairly complicated pattern. Our flooring installation was the finishing touch on a general paint-and-paper bathroom upgrade.

Advance considerations

The first thing to decide is whether you'll take up the existing flooring. If your floor has suffered water damage and dry rot, or could simply use a layer of underlayment to make it more uniform, then by all means make those corrections before installing new vinyl. (Do keep in mind, however, that laying underlayment on a floor can be quite a bit of work. Not only will you have to scribe all the sheets to fit, you may also need to cut off the bottom of any doors to allow clearance above the now-thicker floor. The cracks between the underlayment panels must be filled and the depressions caused by the numerous nails required to install the panels must also be filled.) If not, there's no reason why you can't lay your new vinyl directly on top of the old. In fact, there are several good reasons why you might.

At the top of the list is the fact that, as described above, installing underlayment is a lot of work. Next in line is the disquieting notion that



1 Begin floor preparation by removing the baseboard shoe molding with a flat pry bar. Pull nails from the back of board.



2 New vinyl flooring should be installed under, not around, a toilet. Remove the toilet and reset it later.



3 For best results, apply an etching solution—using a disposable roller—to deglaze the surface of the old floor.

HOME IMPROVEMENT GUIDE



4 Once the etching is dry, apply two coats of primer. The second coat should be at a right angle to the first.

many resilient flooring and flooring adhesives installed prior to the early 1980s contained asbestos.

This asbestos is perfectly safe when left in place, but tearing it up will send some of it airborne, unless precise EPA abatement procedures are followed. All and all, a vinyl-over-vinyl installation is a good choice. Of course, you'll need to do some pretty exacting surface prep to make the job last.

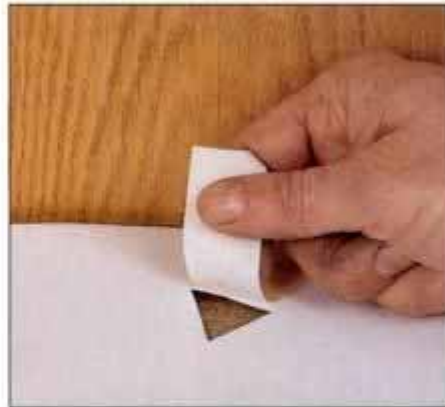


5 Lay down the paper sheets around the perimeter of the room. Then fill in the middle and tape all the sheets together.

Materials

There are two types of vinyl for this kind of installation. One requires gluing the entire floor, the other just the perimeter. (We opted for the full-adhesive variety.) When choosing your flooring, make sure that both you and your supplier know which type you've chosen and that your methods are adjusted accordingly.

Secondly, if your existing flooring has an embossed surface pattern,



6 To hold the paper in place, cut 1-in. triangular slots every couple of feet and apply tape across the slots.

you'll need to fill these depressions with embossing leveler. Without it, the old floor's pattern will telegraph through your new flooring.

And because resilient flooring is designed to repel just about everything, you'll also need to degrade and prep the surface with an etching solution and primer. Beyond these steps, it's pretty much a measure, cut and glue sequence.

Besides the Armstrong pattern kit, we used only common household tools, and all support products were from a typical flooring supply store.

Step by step

Start by removing all of the base shoe (quarter-round). Just pry it loose with a small pry bar (Photo 1). If it comes off intact, you can reuse it. If not, installing a new base shoe often goes a long way toward improving the final appearance of your installation.

If your room is a bathroom, you'll also need to take up the toilet. Just shut off the water and bail out the tank and bowl. Then, loosen the closet bolts at the base of the toilet and the compression fitting on the water supply tube. Lift it from its flange and carry it to another room (Photo 2). Remember to lift with your legs, not with your back. And be sure to set the toilet on newspapers to keep the bowl wax from making a mess. If you damage the wax seal when moving the toilet, replace it with a new one before reinstalling the toilet. To keep sewer gases from invading the room, plug the drain flange with a rag.

And finally, if your old flooring was caulked along a tub or cabinet, carefully slice away the caulk with a razor blade or blade scraper.

This done, it's time to cut the surface glaze on the old flooring. Our etching liquid came in concentrated form and needed to be diluted with

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7 To scribe the exact perimeter of the floor, insert the ballpoint pen into the roller disc and trace around the room.



8 Once the outline is complete, roll up the paper and lay it over the vinyl. Draw a cutline directly onto the vinyl.

water. Even so, this is a very caustic solution. Wear rubber gloves when mixing and when applying it with a brush or sponge. Carefully paint the solution on with a brush around the perimeter. Then, roll the rest of the floor with a paintroller and inexpensive disposable roller cover (Photo 3).

After the etching liquid has dried, coat the old vinyl with a quality floor primer, again using a paintroller and brush. The Color Tile primer we used goes on white and dries clear. It's a good idea to use two coats of primer, allowing time for drying between coats. Roll the first coat in one direction and the final coat in the opposite direction (Photo 4).

Making a paper template

Before applying the embossing leveler, put down the template paper and mark all cuts. The object is to cover the entire floor, keeping the paper 1/4 to 1/2 in. away from the baseboard and fixtures. Overlap the individual sheets and tape them together with masking tape (Photo 5). To hold the paper in place, randomly cut 1-in. triangular slots from the pa-

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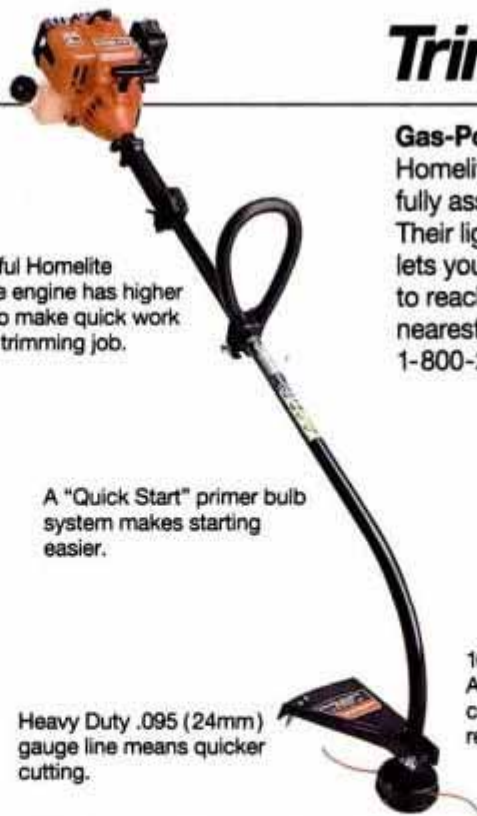
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per and tape across these openings (Photo 6). With the entire floor covered, use the kit's edging disc and ballpoint pen to trace the perimeter (Photo 7). The disc will roll along the edge, leaving a trace line on the paper that is $\frac{3}{4}$ in. in from the baseboard.

If your sheet goods must abut an irregular edge, such as a brick or stone wall, use the kit's transfer tool to transfer the exact profile of the wall. Place the pen into the center hole of the tool and draw the tool's pointed edge along the wall. When tracing around doorjamb and trim, use the transfer tool for the straight lines and draw in any sculpted features by hand. If you are unsure of this method, practice with scrap paper until you've rendered the trim's profile exactly. Then tape that paper to the larger paper.

When fitting around plumbing or heating pipes that enter through the floor, cut the appropriate holes in the paper and slice directly from that hole to the nearest wall, usually a few inches away. These cuts also will be transferred to vinyl.

With the template made and marked, loosely roll it up, leaving the

tape in place over the triangular slots. Carry the template to the waiting sheet vinyl and press it in place over the vinyl. If your vinyl has a linear pattern, be sure to align the trace lines with this pattern.

With the inside edge of the transfer tool on the trace line of the paper, use the ballpoint pen to transfer the line to the vinyl on the opposite side of the tool (Photo 8).

Cutting to fit

This kit's transfer tool also doubles as a vinyl cutter. Just insert the hook-shaped blade into one end of the tool. Pierce the vinyl on the transfer line at a convenient corner, then, very carefully, draw the blade along the transfer line (Photo 9). Cut the entire perimeter of the vinyl in this manner. Finish by trimming out the pipe openings.

Applying leveler

The embossing leveler you use should have the consistency of tile grout. Just mix the powdered leveler with a compatible bonding agent until it has the consistency of toothpaste. Using a straightedged trowel,

spread it over the old floor (Photo 10). The object is to leave compound in the recessed areas only. Use the edge of the trowel to scrape away all excess. Because embossing leveler dries quickly, you may wish to mix and apply small amounts at a time.

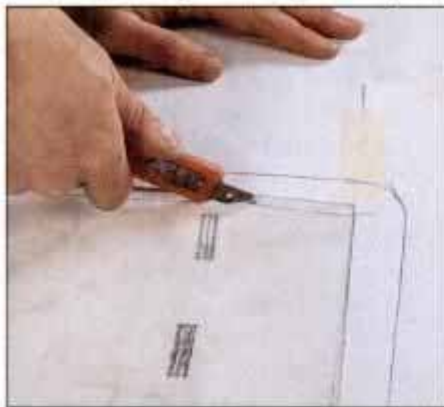
This done, carry the sheet vinyl into the room and dry-fit it. Carefully roll back one-half of the sheet and spread adhesive on the floor, using the kit's plastic applicator (Photo 11). With the adhesive spread evenly, roll the vinyl back in place, pressing it down along the edges. Then, glue the remaining half in like fashion.

All new vinyl must be rolled with a weighted roller to properly seat it in the adhesive. You might rent a 100-pound flooring roller, but a home remedy can work about as well. Just borrow the rolling pin from your kitchen and roll the floor with it (Photo 12). Because weight is important, exert as much downward pressure as you can on the rolling pin. Roll the entire floor in this way.

If there are areas abutting fixtures or cabinets, which will not be covered by base shoe, caulk those right after rolling the floor. The pros often use silicone caulk, but silicone requires a practiced hand. Instead, choose a latex tub-and-tile caulk, which is available in a variety of colors.

Trim the applicator tip to its smallest opening and dampen the seam to be caulked. Then apply a clean, continuous bead, doing your best to maintain even pressure (Photo 13). If you don't like your first attempt, wipe away the caulk with a wet rag and start over.

If you've installed a seam between plumbing pipes and walls, there are two ways to create an invisible seal between pieces. You might try a commercial seam seal, which is fed into the joint with an applicator, or you



9 Install a hook-shaped blade in the transfer tool and then cut the vinyl by drawing the blade along the cutline.



10 To smooth out embossed flooring, apply leveler to the surface. Once recesses are filled, scrape away excess.



11 Apply vinyl adhesive to the floor with the kit's notched applicator. Cover only half the room at a time.



12 Lower vinyl sheet onto adhesive, then roll surface smooth using a flooring roller or kitchen rolling pin.



13 Seal around the entire perimeter of the room—and around any plumbing fixtures—with latex tub-and-tile caulk.

can use the less expensive tub-and-tile caulk. Press the two halves together and apply the caulk over the seam. Then, with a damp cloth, wipe cleanly across the joint. The caulk remaining in the seam will shrink to a water-tight, nearly invisible line.

Joining other flooring materials

Flooring supply stores should offer splicing options for laying vinyl next to other flooring materials. While these options may include marble thresholds, most are pretty basic.

When adjoining carpeting, use a metal tack strip. Simply nail the strip over the vinyl and lock the carpet onto the strip's spikes (Photo 14). Then bend the edge over the carpet with a rubber mallet.

When meeting hardwood floors, a variety of hardwood reducing strips are available. We used grooved, 3/8-in. oak reducer to fit our tongued parquet squares (Photo 15).

For more information on this installation kit, contact Armstrong Customer Response Center, P.O. Box 3001, Lancaster, PA 17604; (800) 233-3823. **FM**



14 When laying vinyl next to carpet, use a metal tack strip. Nail the strip onto the vinyl and bend it over the carpet.



15 When laying vinyl next to hardwood flooring, buy a hardwood reducing strip and glue or nail it in place.

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Simple Sidewalk Repair

TEXT AND PHOTOS BY MERLE HENKENIUS



Sidewalks take a beating, from the very beginning. While a house is under construction, a new sidewalk often floats high on a bed of fill-sand, which eventually erodes from the sides and is swallowed by utility trenches. Then, before the expectant family moves in, their new sidewalk will bear the weight of countless delivery trucks and the grating assault of landscape

tractors, usually before the concrete is fully cured. As the years go by, all this is exacerbated by the ire of preschoolers with hammers and adults with ice hoes. Meanwhile, the soil beneath the hapless sidewalk heaves and settles. It's no wonder so many sidewalks look the way they do.

Of course, a damaged sidewalk can be more than an eyesore. It can be a barrier to the physically impaired

and a hazard to everyone, especially when adjoining sections settle unevenly. Questions of legal liability also arise. More often, though, a damaged sidewalk simply invites more damage. As such, a little care can prolong the life of a walk considerably.

Dealing with cracks

Sidewalk cracks range from minor fissures to gaping faults. Left unattended, most cracks will continue to spread. The severity and location of a crack will dictate how you deal with it. The goal is to seal out water because wet soil beneath a sidewalk only exacerbates the problems of frost heave and settling.

Narrow cracks, in the less than 1/2-in. range, should be caulked shut with a liquid-polymer crack filler. We used a product called Sure-Fix Pour-n-Patch, which is manufactured by the W.R. Bonsal Co. in Charlotte, North Carolina.

Most concrete crack fillers will not cure properly when applied more than 1/2 in. deep. If the crack you hope to repair is deeper, you can either pack the joint with some form of backing, such as foam-plastic backing rod, or pour the filler in two or more applications, each 3/8 in. deep.

In any case, clean the joint with a stiff-bristle brush and water, if necessary, then let it dry and pour the joint full with crack filler (Photo 1). Cover the joint for a day or so to keep foot traffic from damaging filler.

Repairing surface problems

Several conditions will cause the portland-rich surface of a sidewalk to



1 Brush away debris from any cracks, then pour in liquid-polymer crack filler to a level just below the surface.



2 On edge cracks or breaks, undercut the edge of the concrete with a cold chisel to increase the bonding surface.



3 Install a form board against the side of the slab. Then cover the board with masking tape to keep patch from sticking.

pop loose. The problem may be caused by a poor concrete mix, an aggregate that was not sufficiently clean or the failure to protect the surface from certain extremes in weather.

Of course, cold weather can damage a fresh concrete surface, because the surface is the most susceptible to frost. More often, however, the problem is caused by heat. When concrete is poured on hot days, the surface dehydrates faster than the cement below it, causing the slab to weaken and separate just below the surface. Fresh concrete should always be covered on hot days.

Material options

Standard masonry mortar has little bonding strength when applied in such thin layers. If you intend to use standard mortar, mix a prescribed amount of acrylic bonding agent into it for greater adhesion.

We opted for a product that does this for us. We used Sure-Fix Super Concrete Patcher, also from Bonsal, but other formulations also work. The Sure-Fix patching material is a dry mortar mix with a granular vinyl

resin as a bonding agent. Add water, and the bonding agent is activated.

Our surface pops appeared at the edges of the walk, which is quite common. To maintain a uniform appearance, we decided to form the edge of the walk, as if for new concrete. First, we chiseled a shallow trough, or keyway, into the concrete to give the patch a compound surface to cling to (Photo 2). And, to keep the patch from sticking to the rough lumber, we lined the edge of the form with masking tape (Photo 3). We then swept the area clean and wet it thoroughly (Photo 4).

To mix the mortar patch, pour a small amount into a container and add cold water. Stir the mix to a working consistency, then allow it to rest for 10 minutes. Without adding more water, stir it into a working consistency again. Then press the patch material firmly into the recesses of the surface pop and keyway groove (Photo 5). Once the surface is smooth, form the edge with an edging tool and finish up by smoothing the surface with a small trowel, feathering the edges where the patch meets the surrounding concrete.

Wait a day or two for the patch to dry, then remove the form.

Replacing a section

When a sidewalk is too badly cracked or when settled sections of sidewalk create a trip hazard, no amount of patching will help. In these cases, it's best to replace the entire section.

While replacing concrete can be hard work, there's nothing particularly complicated about it. Start by breaking up the old section with a sledgehammer. When you've reduced the old concrete to manageable pieces, haul them off. Don't even be tempted to use some of the broken pieces as filler.

With the removal complete, form both sides with 1 × 4 or 2 × 4 lumber and wooden stakes (Photo 6). Let the adjacent sidewalk sections determine grade, and drive in at least three stakes on each side, nailing the stakes into the form lumber. Then, level the bed by excavating high spots and adding fill-sand to the low spots. Avoid using soil as fill, as you'll only encourage your new section to settle like its predecessor.

With the form ready, you'll need a



4 Thoroughly remove any debris from the damaged area. Make sure to dampen the surface with water prior to patching.



5 Apply the patching material to the crack using a small trowel. Feather the patch to match the surrounding surface.



6 To install a new sidewalk section, first break up and remove the old concrete, then build rough 1 × 4 forms.



7 Pour the concrete between forms and level the surface by moving a screed board back and forth across the forms.



8 When the concrete stiffens, work the surface with a float. Smooth the top until puddles just start to form, then stop.



9 Use an edging tool to round off all edges. Then gently retrowel the surface and brush lightly with a broom.

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After

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float, a finishing trowel, an edging tool and a straight piece of lumber to use as a screed board.

As for the concrete, the best you can buy will be that mixed in a batch plant and trucked to the site. Specify a 6-bag, or 3000-psi, mix. When pouring only a single section, order ¼ yd. from a cash-and-carry plant and tow it home in one of the small trailers these firms provide. The less you buy, of course, the more you can expect to pay per yard.

If you decide to mix your own concrete on site, go for a rich mix. One shovel of portland cement to five shovels of aggregate material—or if sold separately in your area, one part portland to two parts sand and three parts gravel—will do nicely. One final caution: Don't add water to your concrete to make it easier to work with. Wet concrete is weak concrete.

Pouring and finishing

Pour your mix into the form and smooth it out with the screed board (Photo 7). On the first pass, simply drag off the excess. Then, make a second and third pass, sawing from side to side as you move forward.

Now for the hard part: Just wait. Don't work the concrete until the pour has had time to stiffen substantially. Then, dress the surface with a wooden or magnesium float, pressing firmly through each arc (Photo 8). A float is not a finishing trowel, so don't try for a finished look. The float's only jobs are to bring water and cement to the surface and level any high spots or voids. If water puddles behind the float, however, you haven't waited long enough.

With the floating complete, use an edging tool to round the edges on all four sides (Photo 9). If the edger leaves a distinct ridge, stop and let the concrete set up a bit more, then try again.

Before smoothing the surface with a finishing trowel, press your fingertips into the concrete. As long as they sink in easily, the mix is too wet. When your fingers leave only a slight impression, it's ready to finish.

Hold the trowel nearly flat and sweep in wide, overlapping arcs. If the trowel leaves chatter marks, flatten it even more. Two trowelings, 15 to 30 minutes apart, may be needed for a perfectly smooth finish. After another brief wait, drag a soft-bristle broom across the section to make a slip-resistant surface. Then, cover it with plastic and wait two days before disturbing it or the forms. **PM**

Fixing Broken Windows

TEXT AND PHOTOS BY MERLE HENKENIUS



Have you looked at the glazing putty around your windows lately? If so, chances are you noticed some cracked, broken or entirely missing strips of putty. The fact of the matter is, all single-pane windows need reglazing periodically. Replacing cracked putty when it appears will save energy and prevent rot from invading your windows.

Of course, your maintenance job

will be hastened if you happen to have a broken window or two. But take heart, reglazing is not difficult or expensive. All it takes is a few dollars worth of glazing compound and the most common of household tools.

Glazing compounds

Today's glazing compounds are wonderfully smooth and easy to apply when fresh. With time on the shelf,

however, the oils in them can settle, leaving a drier, less workable putty at the top of the container. To correct this problem, have your salesperson put the can on a vibrating paint mixer for a few minutes before you leave the store. The putty can be reconstituted in this way.

While the old pros used to add a splash of linseed oil to putty to achieve the same effect, most manufacturers now recommend against the use of thinning agents.

Preparation

Our window is typical. It's 30 years old and fitted with an aluminum, combination window. In our case, we also needed to replace a broken pane.

Start your glazing project by removing any screen, storm or combination window that might be in place. Then look to the most deteriorated strip of putty and start chipping it away with a rigid, chisel-edge putty knife (Photo 1). Putty that is cracked and has begun to lift off will usually break away easily. If the putty you encounter is rock-hard and solidly in place, as it sometimes is on very old windows, you may need to use heat to soften it. (In these cases, you'll only be removing putty to access a cracked or broken pane.)

While some sources suggest taking a propane torch to hardened putty, a good deal of caution is in order. Old window sashes can be as dry as tinder, and a smoldering ember can work its revenge hours later. If you must use heat, opt for an electric heat gun and concentrate the heat on the glass side of the glazing. Use no more heat than is necessary.

After prying all the old putty from the window, look for the half-dozen glazer's points that lock the pane against the sash frame (Photo 2). These points will either be diamond-shaped metal points, usually shot into the wood with a spring-loaded gun, or formed metal clips that were pressed into the wood with a flat-blade screwdriver or a putty knife. In either case, these points must be removed to free the glass. Needle-nose pliers or a screwdriver will easily unseat them.

With the putty and glazer's points removed, go indoors and press even-



1 Remove the storm window, if necessary, then use a putty knife to pry the old putty from around the broken glass.



2 Once the putty is out, find the glazer's points and remove them with needle-nose pliers or a screwdriver.

HOME IMPROVEMENT GUIDE

ly against the bottom of the glass pane. When the glass pushes just past the bottom rail of the sash, go back outside, grasp the pane (with gloves) and pull down steadily. Because the glass is usually seated firmly in a slot in the top rail of the sash, you may need to twist and tweak it a bit until it breaks free.

Of course, if the window pane is badly broken, you'll want to remove the loose pieces of glass first, starting with the smallest and proceeding to the largest pieces (Photo 3). Again, wear gloves and use caution. This is no time to hurry.

When the glass pulls free, brush the L-shaped recess with a wire brush and whisk away the debris (Photo 4). Then use a utility knife to pry the remaining putty from the top slot of the sash (Photo 5). If your window is quite old and the wood supporting the glass is soft and ragged, paint the putty recess with a top-quality primer. If you find the wood to be in good shape, priming won't be necessary.

Installing new glass

With the broken pane removed and the joint cleaned, ease the new glass

pane into the top slot of the sash and press the bottom of the pane against the bottom sash member (Photo 6). If the pane won't slide into its recess at the bottom, slip a putty knife into the recess and gently pry the glass up until it clears the recess edge. Remove the knife and press the glass firmly into the recess. Then, secure the pane with glazer's points. Two points per side and bottom will do. As noted, press the points into the frame with a screwdriver or a putty knife.

Applying glazing compound

If the putty you buy is soft and creamy, simply dip into the container with the knife and press a measure of putty firmly into the recess (Photo 7). If the putty seems stiff, or clings to the knife as you pull it away, try kneading it first. Simply dig out a glob of putty and roll it into a 1/2-in. rope between your hands. The resulting friction, and the heat from your hands, will soften the putty and make it more manageable.

In any case, install a bead of putty all around the window, including the small gap in the top slot. Then, with a clean putty knife, smooth the putty at

a uniform angle (Photo 8). The finished depth should not be higher than the recess, as viewed from inside the house.

In most cases, you'll want to paint the glazing when it's had a few hours to skin over (Photo 9). There's no need to be too careful about getting paint on the glass. When the paint dries in a few hours, just scrape it off with a single-edge razor blade (Photo 10). Not only is overpainting the glass easier, but it also helps seal the joint and picks up the oily film left on the glass by the putty. If you don't overpaint, you'll need to wait a few days and remove the film with mineral spirits. All and all, painting is a better choice.

Double-glazed windows

What if yours are double- or triple-glazed insulated windows? You won't need to reglaze this type of window, as the sash members are assembled around the sandwiched glass at the factory. The glazing, such as it is, simply doesn't break down the way it does on single-pane windows. For one thing, there's less of it.

If one of these windows breaks, or its seal is broken, you'll have to call



3 When the putty and points are gone, gently remove the broken glass. Be sure to wear heavy gloves to prevent cuts.



4 Use a wire brush or a sharp chisel to clean off the sash. Wipe away loose particles before installing a new pane.



5 If your sash has a groove to hold the edge of the glass, be sure it's cleaned out thoroughly before proceeding.



6 Slide the new pane in place from below. Guide it into its upper slot and gently press the bottom against the sash.



7 Install the glazer's points and then start filling around the pane with compound. Soften the putty before using it.



8 Smooth the putty by drawing a clean knife firmly along the joint. Carefully trim away any excess when finished.

on a professional. Even then, a pro is not likely to rebuild the frame surrounding the glass. In many cases, an entirely new sash, with glass installed, is ordered from the factory. Sash replacement is quickly becoming the only option.

You may be able to get this repair done for less money by removing the sash yourself and taking it to a glazer's shop. This eliminates the service call which, in turn, should lower the price. Removing the sash on a double-hung window can be as simple as removing the stop piece that holds the sash in place. Just use a pry bar to pull off the strip and to remove the nails from its backside so it can be used again.

Casement and awning windows are held in place with different types of hardware. Just find the screws that hold the hardware, remove them and the sash should come free.

Regardless of the type of window you're working on, you'll need to make some provision for closing in your house while the sash is being repaired. Probably your best option is to tack up a piece of polyethylene plastic over the window. Something at least 6 mils thick is best. **PM**



9 After the putty sets, apply fresh paint to the putty and the sash. Slightly overpainting the glass is recommended.



10 Once the paint has partially dried, use a single-edge razor blade to scrape away excess paint and other blemishes.

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Warm Water Outdoor Faucet

TEXT AND PHOTOS BY MERLE HENKENIUS



Have you ever wondered, maybe while washing the car, filling the kid's pool or handling any of a dozen other outdoor water chores, why someone hasn't designed a hot-and-cold-water outdoor faucet? And because day-dreaming costs so little, wouldn't it be nice if that faucet allowed you to dial in just the right mixture of hot and cold water for each job? Of

course, your dream faucet would also be designed to resist a freeze and prevent a contaminating backflow.

By now you've guessed that such faucets already exist. In fact, they've been used at the commercial level for years, but for some reason they've seldom made the trip to the residential side of the street.

It could be because they're a bit pricey (\$225 to \$250), but more likely,

it's because few of us know that they exist. We don't ask, and the plumber doesn't think to suggest.

In fact, installing one of these faucets in a typically framed home is relatively easy. For our installation, we chose a Woodford model No. HC65 hot-and-cold mixer (Woodford Mfg. Co., Colorado Springs, Colorado). This faucet has all the features mentioned above, plus two check valves that keep hot and cold water from cross-migrating through the valve. The HC65 consists of a faceplate which supports the mixing-valve adjustment, a keyed ON/OFF stem and a spout fitted with a vacuum breaker. The vacuum breaker, in turn, is equipped with standard hose threads.

Installation

We began our installation by choosing a joist space convenient to both outdoor watering tasks and indoor plumbing lines. As the body of the valve must fit through a sizable opening in the rim joist, you'll need to cut (not drill), the siding and joist. We used a tape measure and level to mark the siding for the cut (Photo 1). Taking our measurement from the back of the faucet's faceplate, we marked for an opening 2 $\frac{3}{4}$ in. high and 9 $\frac{1}{2}$ in. wide. This opening, and ultimately the faucet faceplate, must be kept level.

With the cutout marked on the siding, bore the four corners with a $\frac{3}{4}$ -in. bit (Photo 2). Then, use a reciprocating saw to cut between the holes (Photo 3). With the opening made, lay a bead of caulk around its edge



1 Position the faucet in a convenient location, then mark the siding for the faucet body cutout using a level.



2 Once the cutout is marked, bore saw-blade entry holes at the four corners. Use a $\frac{3}{4}$ -in. bit for good clearance.



3 Use a reciprocating saw, or a sabre saw, to cut between the holes. Working slowly will yield the straightest cut.

HOME IMPROVEMENT GUIDE

(Photo 4). Then press the faucet into the opening (Photo 5). To hold the faucet in position until the piping is connected, support the valve body above the sill plate with a block of wood. As with all frost-proof, self-draining faucets, you'll want the drain chambers (pipes) behind the faceplate to pitch down slightly. A slope of $\frac{1}{8}$ to $\frac{1}{4}$ in. will be plenty.

Before fitting any piping to the faucet, you'll need to install the check valves in the hot and cold mixing-valve ports. But because the nylon and neoprene parts within the check valves can be damaged by heat, it's a good idea to make up and solder the 90° turns and let them cool before threading them into the check valves.

You'll need two $\frac{3}{4}$ -in. copper male adapters, two short stubs of pipe and two 90° street ells. Street fittings have one male end and one female end, and in this case, their use allowed critically short turns into the vertically aligned valve ports. Because both sides of a fitting should be soldered at the same time to avoid leaks, we installed 4-in. pipe stubs in the female ends of the street ells. The supply piping could then be soldered

to these stubs, using sweat couplings, or in our case, 45° fittings.

With the 90° turns made, soldered and cooled, thread the adapters into the check valves (Photo 6). Be sure to use Teflon tape on the threads to prevent leaks. Then, thread the check valves into the valve ports, again using Teflon tape (Photo 7). You'll find this prefitting preferable to spending undo time inside the cramped confines of a joist space.

Tapping into the plumbing system

Because the faceplate of our Woodford faucet has no mounting screw-holes, it was clearly designed to be mortared into a masonry wall. On a framed home, the faucet must be held in place by the tightness of the joist cut, the caulk seal and the tension and support of the plumbing pipes. With this in mind, go outside and press the faucet firmly against the siding once more before cutting into the plumbing system.

With the water shut off at the meter and the piping system drained, cut into your home's hot and cold water supply lines. In our case, these

lines were made of copper, as they are in most homes built after 1950. To make the connection between the water supply lines and the new faucet, simply splice copper tees into the trunk lines and continue piping toward the faucet. With connections made, solder all fittings with lead-free solder and support the piping at least every 6 ft. with pipe hangers (Photos 8 and 9).

Soldering tips

Like many chores, sweat soldering plumbing fittings looks more complicated than it is. The basic requirements are simple: Cut the tubing cleanly and squarely, and clean all mating surfaces so they are free of dirt and other contaminants. To get a good clean cut, use a high-quality tubing cutter to perform all the cuts. And to make sure everything is clean, rigorously rub all mating surfaces with steel wool, and then coat them with flux before joining them. Also keep in mind that lead-free solder requires more heat to melt than older solders. So just hold your propane torch on each joint longer before applying the solder. **FM**



4 Once the opening is cut, check the faucet for fit. When satisfied, apply a bead of caulk to the rim of the opening.



5 Carefully press the faucet into the opening until it seats completely in the caulk. Then brace it in place.



6 Solder copper street ells to stubs and male adapters. Let assemblies cool, then thread them into the check valves.



7 Once the soldered turns are joined to the check valves, thread these assemblies into the faucet's valve body.



8 Join the supply tubing to the valve with lead-free solder. Protect any nearby framing members with sheetmetal.



9 Cut into the hot and cold supply lines, and solder tees in place. Then connect the faucet tubing to the tees.

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Basic Basement Waterproofing

TEXT AND PHOTOS BY MERLE HENKENIUS



Finding the water source

While this story is about repairing leaky walls, it's important to keep in mind that basement walls don't cause leaks. Water causes leaks, and the presence of water is almost always the result of poor drainage and poorly maintained gutters. Without first correcting these problems, basic wall repair is a losing battle.

Here's why: The backfilled soil around a basement will always be more porous and more absorbent than the soil outside the excavation line. Moreover, fill-soil will always settle, and keep settling for years. If this band of fill is not brought back to grade periodically, or if rainwater is not diverted at least 3 ft. beyond the foundation, the relatively loose soil next to the foundation will absorb a disproportionate volume of water. Some of this water will be forced, laterally, through the basement walls.

In Northern states, this scenario carries an additional penalty. Wet soil expands more than dry soil when it freezes. When wet backfill is sandwiched between virgin soil and a basement wall, the wall will always be the first to yield. With enough of these freeze/thaw cycles, the wall can collapse inward.

You should bring all backfill around your foundation back to grade (Photo 1). If window wells have settled, raise them (Photo 2). An ideal grade will slope steadily away from the foundation for at least 3 ft., at a rate of at least 1 in. per foot.

If you have an area defined by landscape timbers, make sure this area slopes outward as well. Downspouts should extend 3 ft. beyond the house, and where landscaped areas abut the foundation, downspouts should extend past them. Gutters should also be cleaned frequently.

Material choices

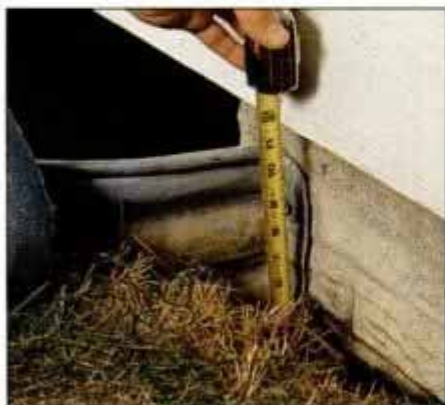
There are two basic kinds of basement waterproofing materials. The first are masonry patch items. They range from mortar caulk to pre-mixed mortar to hydraulic putty. Because our basement was not leaking

(Please turn to page 104)

As we all know, a wet basement can be a very costly thing. It not only robs the homeowner of valuable living space, the dampness also plays host to a variety of molds, which are common allergens. And of course, wet soil against a basement wall can eventually destroy that wall.

What many homeowners don't re-

alize is that wet basements can often be corrected easily and inexpensively. The obvious exception is when the culprit is ground water. In that case, the only sure solution is to install drainage tile around the outside of the wall and sump pumps inside. Still, the vast majority of wet basements can be attributed to simple neglect.



1 Check the perimeter of your foundation for depressions in the fill-soil, like this 12-in. recess at a window well.



2 Add soil to any depressions around your foundation. Then tamp the soil firmly into place and plant grass seed.

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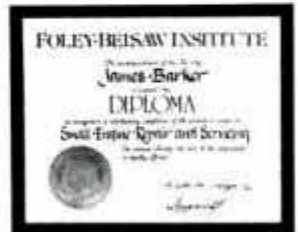
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at the time of repair, we chose standard masonry mix and added a latex bonding agent to improve adherence. (We used Elmer's Concrete Bonder from Borden Inc., Columbus, Ohio.) Had we faced a continuously seeping hole in the wall, we would have chosen hydraulic putty. Hydraulic putty bonds extremely well and cures quickly, even when wet and under pressure.

The second category includes a variety of rubberized coatings, which usually contain Portland cement. As these products are expensive (more than \$20 per gallon), cover only 75 to 125 sq. ft. per gallon and produce noxious fumes while they cure, they should only be used when drainage improvements and wall repair come up short. (Manufacturers say that nontoxic, latex coatings will be on the market soon.) In the right situations, however, they work well.

Wall preparation

Before coating a masonry wall with waterproofing compound or paint, you'll need to patch all holes and eliminate all forms of surface degradation. Surface problems can take

the form of blistered paint, molds embedded in existing paint, waterborne iron stains and efflorescence.

To remove blistered paint, use a wire brush (Photo 3). Sand any remaining hard edges with coarse sandpaper before repainting. Rust and hard-water stains may also be removed in this fashion. Efflorescence, on the other hand, appears as a white, chalky substance on masonry surfaces. The substance is actually crystallized mineral salts that have leached from the concrete or mortar. To remove efflorescence, scrub the area with an abrasive pad and muriatic acid. Then rinse with water.

As for mildew and mold growths, you'll need to kill them before sealing. The simplest approach is to scrub all visible mildew spots with a solution of household bleach and water (Photo 4).

Patching

Water migrates through walls where holes and cracks appear. Most mid-wall cracks are stress cracks, caused by the freeze/thaw cycle described before. These cracks are usually horizontal, but may step diagonally

along mortar joints. Water may also seep through the structural seam between the walls and floor.

If these cracks are small, in the 1/8-in. range, then a good, silicone-mortar caulk forced deep into the crack will work. (The caulk we used was from Macklanburg-Duncan, Oklahoma City, Oklahoma.) Cut the applicator tip at a 45° angle and apply enough pressure to force the caulk into the joint (Photo 5). Then, smooth the bead with a putty knife dipped in mineral spirits.

If the cracks are larger, or if there's loose mortar, then the best approach is to enlarge the joint with a chisel and tuck-point new mortar into the gap. To remove loose mortar, or to enlarge a crack so that it will accept enough new mortar, use a mason's chisel (Photo 6). Start at the largest point in the opening and remove all cracked and crumbling mortar. Then, brush the masonry dust from the crack and wet the joint with a mix of water and latex bonding agent.

Next, blend the premixed mortar with water and bonding agent until the mortar will stand up when you slice through it with a trowel (Photo



3 Remove any blistered paint from the interior of your foundation wall with a wire brush and coarse sandpaper.



4 Scrub mildew with an abrasive pad and a mix of household bleach and water. Use muriatic acid on efflorescence.



5 Caulk small, leaky cracks with a silicone-mortar caulk. Smooth with a putty knife dipped in mineral spirits.



6 Remove loose or cracked mortar between blocks with a tapered mason's chisel, and clean the joint thoroughly.



7 Fill any gaps in the foundation's mortar joints with a mixture of premixed mortar, water and a latex bonding agent.



8 Pack fortified mortar into the wall joints using small mason's trowels. Make sure the entire space is filled.

7). Then, stack a little mortar on the back of a small trowel, place the trowel against the crack and push the mortar into the joint with a pointing trowel (Photo 8). Pack the entire joint, then scrape away the excess and smooth the joint with a joint-striking tool (Photo 9). Use the same methods to fill any gaps or cracks around utility pipe holes (Photo 10).

Waterproofing coatings

Before deciding to paint a wall with waterproofing, wait a few weeks. If it rains and your basement stays dry, chances are you won't need it. If you don't see any obvious leaks, but the masonry surface is damp, then a sealant is a good idea.

The masonry waterproofing product we used was UGL's Drylok (made by United Gilsonite Laboratories, Scranton, Pennsylvania). Like others, it's a high-solvent specialty coating that requires plenty of ventilation. Be sure to open some windows and use fans to circulate the air in your basement. You'll also want to shut off the furnace and any other pilot lights and open flames. **PM**



9 Finish the new mortar with a joint-striking tool. Once the mortar has set, brush off the joint to remove any burrs.



10 Use the same mortar mix to fill gaps around utility pipe entrances. Pack and smooth the mortar with a brick trowel.

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ered and better lit, you'll need a grounded extension cord and a trouble light. An extension cord in the 30- to 50-ft.-long range will serve most needs, but don't skimp on its wire size. A lightweight cord will allow too much voltage drop, which will in turn shorten the life of the tool or appliance it serves. Generally speaking, the longer the cord, the heavier it will need to be.

We chose a grounded 30-footer with 16-gauge wire and a carrying capacity of 13 amps, which was priced at just under \$10.

As for trouble lights, look for the

same features. If the light you fancy does not have a receptacle, an ungrounded cord will do. We paid just under \$11 for this 25-ft. model with a plastic cage.

Chisels and sharpening stone—Every household should have a chisel or two for roughing out wood that can't be reached with a larger, more precise tool. Wood chisels are handy for setting door hinges, and if they are sharp they can be extremely versatile, removing small amounts of wood in a variety of situations. And, because many of us can blunt the edges of chisels just by picking them

up, you'll also want a double-sided (fine/coarse) sharpening stone. When used with honing oil, a sharpening stone will return the sharp edge to all but the most abused chisels and knives.

You'll need to decide which sizes best suit your purposes, but two will often do. We chose 1/4- and 3/4-in. chisels and a 2 x 5-in. combination sharpening stone. We paid \$7 apiece for the chisels and \$12 for the stone.

And finally, you may want a cold chisel in your toolbox for those materials not made of wood. A cold chisel can be used to chip concrete or split light-gauge metal. It's especially handy in cutting bricks, blocks and paving stones. We paid \$6 for this hefty 1-in. model.

Framing square—A framing square in the hands of a pro can work wonders, but even the beginner will find this a useful tool, if only as a straightedge and angle finder. It can be used to check the squareness of a room before laying floor coverings or to ensure a square cut in plywood and dimensional lumber. You'll find them in steel and aluminum for around \$10.

Caulk gun—With everything from caulk, to glue, to grout and roofing tar packaged in tubes these days, a good caulk gun is a must. Expect to find two or three levels of quality in caulk guns. Cruise right past the 99-cent bargain basket on your way to those in the \$4-to-\$5 range. These mid-price guns will accommodate all 1/10-gallon tubes and are sturdy enough for years of casual use.

Pry bar—A pry bar is another useful tool, with more real-life uses than its manufacturer probably intended. A pry bar is designed to pry things apart, primarily pieces of wood that have been nailed together. It also provides an alternate means of removing nails, aside from your claw hammer. It is equipped with beveled nail claws at each end and has a curved shank ending in a sharp right-angle. When a block of wood is placed under one end, it makes a great lever and fulcrum. Invest \$8 or \$9 in one of these and we'll just about guarantee that you'll find a way to use it.

Knives—Everyone is familiar with the uses of a putty knife, but when headed out to buy one, consider up-sizing to a 4-in. drywall knife for greater versatility. A flexible drywall knife can be used to apply spackling, scrape paint, strip furniture or press wallpaper into corners. Make sure that the model you choose has a chrome-plated blade to resist the corrosiveness of drywall compounds. Beyond that, the choice is yours. We

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paid \$8 for our drywall knife.

You'll also want a sturdy utility knife for cutting open cartons, trimming wallpaper and floor coverings and a dozen other chores. We suggest a knife with retractable blades for easier and safer storage. The better models have a cavity inside to store fresh blades. If your knife doesn't come with extra blades, pick up a pack. You'll find plenty of good utility knives in the \$5-to-\$7 range.

Four-in-one rasp/file—You might also consider a combination wood rasp and file in your toolkit. With a coarse and fine rasp and a coarse and fine file on each tool, you'll be able to shape wood and sharpen garden tools whenever the need arises, and for less than \$9.

Locking pliers—Locking pliers first became popular in shipyards during WWII. Before long, they found their way into every mechanic's toolbox and have lately turned up in a good many kitchen drawers. This tool is so popular because it can do so much. It's a makeshift wrench, a wire cutter, pliers and a sturdy clamp, which is about all you can ask of a tool costing \$10 to \$12.

Tongue-and-groove and needle-nose pliers—Tongue-and-groove pliers make a good choice because the jaws are able to expand to meet the job requirements. Their offset jaw configuration also provides a little more leverage than standard pliers. We decided on two sizes, a 6½- and a 10-in. model. The smaller tool is good for many simple projects, while the larger version will easily handle the chrome or plastic trap nuts on plumbing fixtures. With new home construction going to almost all plastic pipes and fittings, this size makes a good substitute for a pipe wrench. We paid \$9 for the smaller tool and \$11 for the larger one.

The 8-in. needle-nose tool shown on page 73 has a long reach for getting into cramped spaces, which is where needle-nose models work best. This one also has a wire cutter built into the jaws. Expect a good tool to cost between \$8 and \$9.

Drain auger and plunger—There's a perverse physical law that has drains clogging only when plumbers and drain services are hard to reach or frightfully expensive. Drain clogs like holidays best.

For those times and others, plan ahead and invest in an inexpensive drain auger. The one shown on page 73 costs a mere \$15 (a fraction of the typical daytime service call), and will work in most situations. Avoid the simple, bare-cable type augers, they won't give enough cranking power in

problem situations.

A plunger is the other half of the drain clog solution. Most clogs can be broken free with a good plunger, almost to the complete exclusion of drain chemicals. Look for one that has a large cup with a folding funnel. With the funnel folded in, this plunger will work well on sinks and tubs. Folded out, it's perfect for toilet clogs, and all for a mere \$5.

Hot-glue gun—A hot-glue gun used to be thought of as a hobby tool, but more and more of us are finding it useful around the house. It works very well in repairing small fittings

on toys and other household items, especially plastics. Best of all, hot glue sets as soon as it cools, which speeds things up substantially. You'll find inexpensive versions that are fed simply by pushing the glue stick through the gun. Others, like the model shown on page 73, feature a trigger-feed mechanism that offers better control when applying the glue. Expect to pay \$17 to \$19 for a trigger-fed model.

Level—A good 2-ft. level is another tool you'll find yourself using over and over again. It can level picture

(Please turn to page 108)

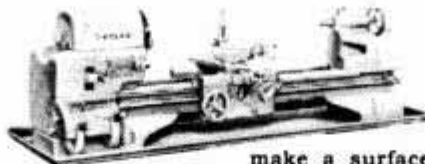


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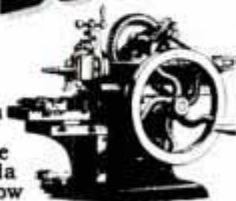
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HOME IMPROVEMENT GUIDE *(Continued from page 107)*

frames, start wallpaper, align appliances and provide a straightedge for a knife or pencil. You'll find them made of steel, aluminum, plastic and wood in a wide range of prices. The metal versions offer the most versatility for the money, which in our case was just under \$14.

Propane torch—When making plumbing improvements, you will need a propane torch. You'll find two varieties in home centers. One will require that you light it with a striker or match. The other is self-starting. We chose the substantially more expensive model simply because the self-starting feature is so handy. Just turn it on and pull the trigger for a clean blue flame. The price for our self-starter was just under \$28.

Tin snips—Tin snips may seem at the outer edge of a household tool selection, but when you need them there's no substitute. Try cutting in an extra heat register in an unfinished basement without them. If the need arises, choose one designed to cut along a straight line. These can be made to cut wide, sweeping curves as well. Our choice cost \$17.

And while you're at it, buy a roll of

quality duct tape. You may never need it for ductwork, but you'll find a use for it just about everywhere else. Expect to pay \$5 to \$6 for a 2-in. roll 60 yd. long.

Paintbrush—When it comes to paintbrushes, don't skimp. Cheap throw-aways have a way of finding their own revenge. A 2½-in. natural-bristle or high-quality synthetic-fiber brush will do the best job and endure the most cleanings. Buy a natural-bristle brush if you are working with oil-based paint and stains, but buy only synthetic brushes for work with water-based paint and stains. Brushes are available with tapered or straight bristles. The straight cuts work best on large areas, while the tapered versions work better as trim brushes. You may need both, but a straight-bristle brush is a good start. We paid \$8 for this 2½-incher.

Adjustable wrenches—We recommend two adjustable wrenches for projects around the house and garage. A 6-in. wrench will work well in tightening furniture bolts, toilet bolts, appliance leveling legs and the like. A 10-in. spanner will handle

many plumbing repairs and do double duty in automotive work. Adjustable wrenches are available at several price levels. Avoid the low-end imports like the plague, but the mid-price versions should serve you quite well. We paid \$20 for the larger wrench and \$14 for the smaller.

Screwdrivers—Screwdrivers are typically the most abused tools going. As such, steer clear of bargain screwdrivers. Look for handles that are large enough to be comfortable and shanks that are long enough to let you see your work. The better brands will have hardened steel tips and some may be magnetized. We recommend two Phillips and two flat-blade screwdrivers in small and medium sizes. All four should cost about \$10 to \$12.

Multi-tester—A multi-tester is a good choice if you plan to handle your own electrical problems. With it, you'll be able to test for voltage, continuity and ohm levels. It can be used in checking out your home's electrical system—both wiring and devices—as well as the appliances within your home. Simple multi-testers start at around \$25. **PM**

CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Fuelish

My pickup has always used a quart or so of oil every 1000 miles—normal for towing the heavy horse trailer I have. Last fall it stopped using oil, which I thought was a little odd—at 60,000 miles it's a little late for the rings to be seating. Then when the weather got colder, the oil level started going up steadily. My mechanic said the oil was contaminated with fuel and charged me what seemed like a very large amount of money to rebuild the carburetor.

Of course, the mileage is way down now and the truck makes oil to the tune of about 1 quart/1000 miles. Any ideas?

LEONARD GLASSTON
LEXINGTON, KY

Replace the fuel pump.

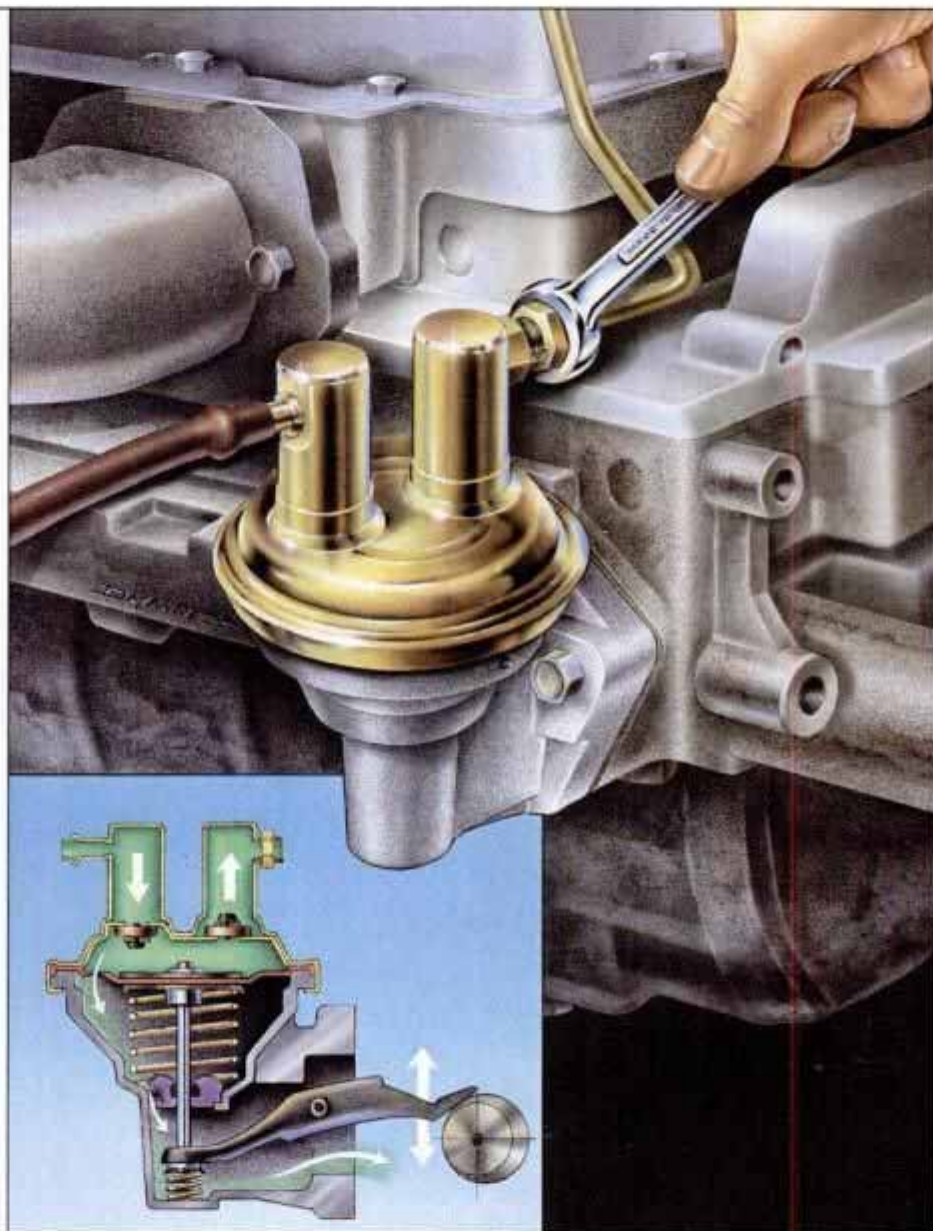
Mechanical fuel pumps are actuated by a rocker that rides against a special lobe on the camshaft. This rocker pumps a rubber diaphragm up and down, displacing fuel past a pair of check valves. The rubber diaphragm has cracked and is leaking. You may see a little fuel leaking from a small hole in the pump housing—but a good portion of the fuel is leaking directly into the crankcase.

Smoke On The Water

I have a 1982 Toyota Cressida that blows smoke when the accelerator is pressed after idling for 15 seconds or more (longer when the engine is cold). When cruising and the accelerator is pressed to the floor, no smoke blows at all. I did a compression test and all the cylinders check okay. This engine has 88,000 miles on it—will it be necessary to fix it, or can I just drive it the way it is?

WILLIE SALMINEN
ROCHESTER, NY

You've got bad valve-stem seals. The high vacuum during idle is pulling oil from the camshaft area



down the valve guides, which then burns off when you accelerate. The seals are probably bad because the guides are worn. It's not fatal—but it's not doing your catalytic converter any good. And if the guides are bad, you're not getting good sealing at the valve seat either. That's costing you mileage and performance.

You might try replacing the seals without pulling the head by blowing compressed air into the spark plug hole to hold the valves shut. Then you can use a spring compressor to remove the valve springs and

slide a new seal over the valve stem.

But if the guides are very bad, this won't last long. I'd start saving up for a valve job pretty soon if I intended to keep the car.

Tick, Tock

My 1992 Buick Century has a most annoying ticking sound at low speed. The service manager says it's the electronic pulse injection. Is there any cure for this? I'm a senior, so perhaps it's more noticeable at my age.

DICK ARTER
POINT ROBERTS, WA

CAR CARE

Your noise is caused by the electronic fuel injectors. These small solenoid-operated valves spray fuel into your engine. Sometimes the noise can be obtrusive at idle, and many manufacturers build small dampers into the fuel rail to control it. The fuel rail is the pipe that connects the three injectors on each bank, carrying fuel along its length.

You might check that the fuel rail isn't in contact with any brackets or other components that would amplify the sound. If not, then you could wrap the rail with some foam tape for insulation—which might not help much.

Don't blame this on your age, either—this high-frequency ticking is in the range of tones that people tend to lose first as they grow older.

The Man With The Golden Arm

I own an Acura Integra with approximately 40,000 miles on it. I've always been a fanatic about scheduled maintenance—and much to my dismay my car has no grease fittings.

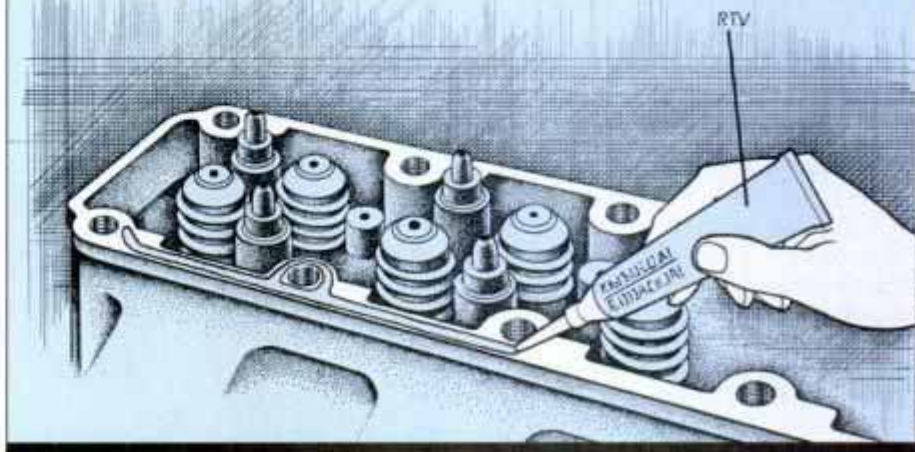
I noticed a gadget in the auto parts

The Higher-Priced Spread

• I walked into the auto parts store the other day to pick up a head gasket set and, upon inspecting the package, immediately complained that there had to be several major gaskets missing.

Wrong. Nowadays some gaskets are formed in place from RTV (Room Temperature Vulcanizing) silicone rubber.

To do this, start by cleaning the surface of old RTV, oil and grease. Spread a 3 to 4mm bead of RTV along the sealing surface, outlining any bolt holes. Excess RTV will squeeze out and may plug your oil pump, so be careful. Don't stop to answer the phone—don't let the RTV harden. It needs to be assembled before it skins over so it sticks to both sealing surfaces.



PM ILLUSTRATION BY ADOLPH E. BROTHMAN



Lots of plugs can This one started a

CAR CARE

store last week. It's a fitting for a grease gun that has a pointed needle to let you inject grease right through the rubber seal.

I was wondering if this is a good idea for tie-rod ends, ball joints and/or CV joints?

TIM MEDINGER
WILSONVILLE, OR

I'd rather see you disassemble a CV joint to inspect it periodically. I do.

But I confess to having one of these gadgets and using it fairly often. Amazingly enough, the lube doesn't seem to come back out of the hole the needle leaves.

Just be sure that when you use it on a CV joint that you punch a hole in the small end of the boot where centrifugal force won't out-throw the lube.

I have one grease gun filled with molysulfide CV lube and another with wheel-bearing grease. Wheel-bearing grease? It's a little more expensive than lithium chassis grease, but seems to last longer. I also use this needle to shoot grease deep into roller bearings instead of trying to cram stiff grease in be-

tween the rollers with the palm of my hand.

Splish Splash

During a hard rain, our 1983 Mercury Lynx will choke down to 30 mph from 60 or 65. Pumping the accelerator makes it go away, but it happens again in 5 miles or so. We've replaced all of the ignition system and fuel system at enormous expense. What's wrong?

F. ELKS
MILWAUKEE, WI

It's probably carburetor icing—the air whistling through the carb is subzero even on a warm day, and enough moisture will freeze and block off most of the carb venturi.

Look for a nonfunctioning or missing carb/manifold waterline, thermostatic air-cleaner valve or manifold stove—something that's supposed to heat the intake air is not right.

FM

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 West 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.

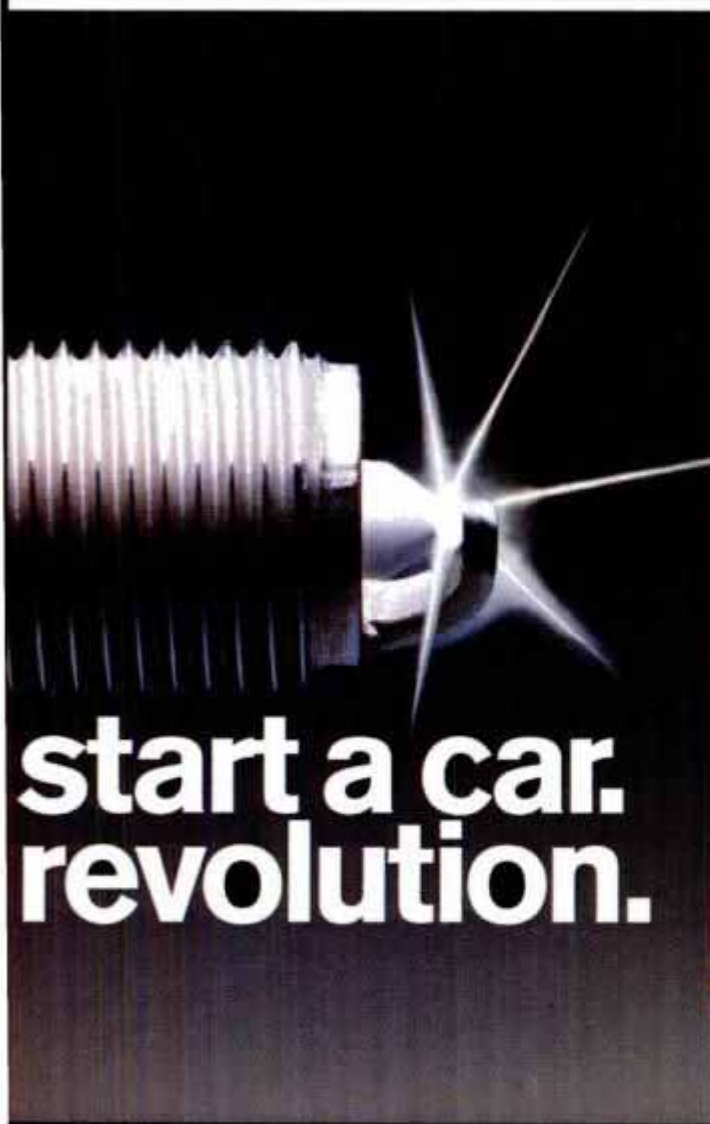
SERVICE TIPS

● Some 1992 Skylark, Acheiva and Grand Am a/c systems may have been filled with the oil intended for use with R134a—unfortunately, these systems use R12. These compressors will fail rapidly.

● Mitsubishi 3000GT, Eclipse, Galant, Mirage, Montero, Precis and pickup trucks all specify a GL4-class gear lubricant. Do not substitute a GL5-class oil.

● Jump-starting a 1989-'92 Nissan Maxima with cables may burn out the solid-state window-motor switch on the driver's side. You'll know this because the window won't go down—or up if it was down when the switch failed—and the circuit breaker will continue to click off and on. If you must jump-start this vehicle, pull the appropriate fuse.

● If you're experiencing delayed part-throttle downshifts and/or harsh engagement in your '92 or '93 Dakota, Ram truck or '93 Grand Cherokee/Wagoneer, you may need to adjust the throttle-valve cable and replace the return spring.



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MAINTENANCE BASICS

BRAKE SERVICE

BY DON CHAIKIN,
Contributing Editor

• Each time you step on the brake pedal, you count on the brake system to slow or stop your car or truck. If the brake system fails, it can be disastrous. However, some regular inspections and periodic maintenance should keep the brakes working for the life of your vehicle.

Every late-model car or light truck uses disc brakes at the front wheels. These do most of the braking and wear more quickly than the rears. They are also easy to maintain.

• Check the master cylinder for a sudden drop in fluid level and signs of leaks.

Next, place the vehicle on safety stands. Remove the front wheels.

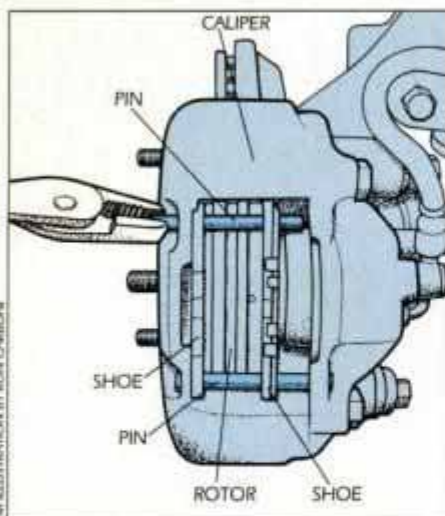
• Inspect the brake hoses for leaks, cracks, chafing or other damage.

• Check the hose fittings and connections for corrosion or leaks.

• Inspect the discs (also called rotors) for deep grooves, cracks, surface unevenness or other damage.

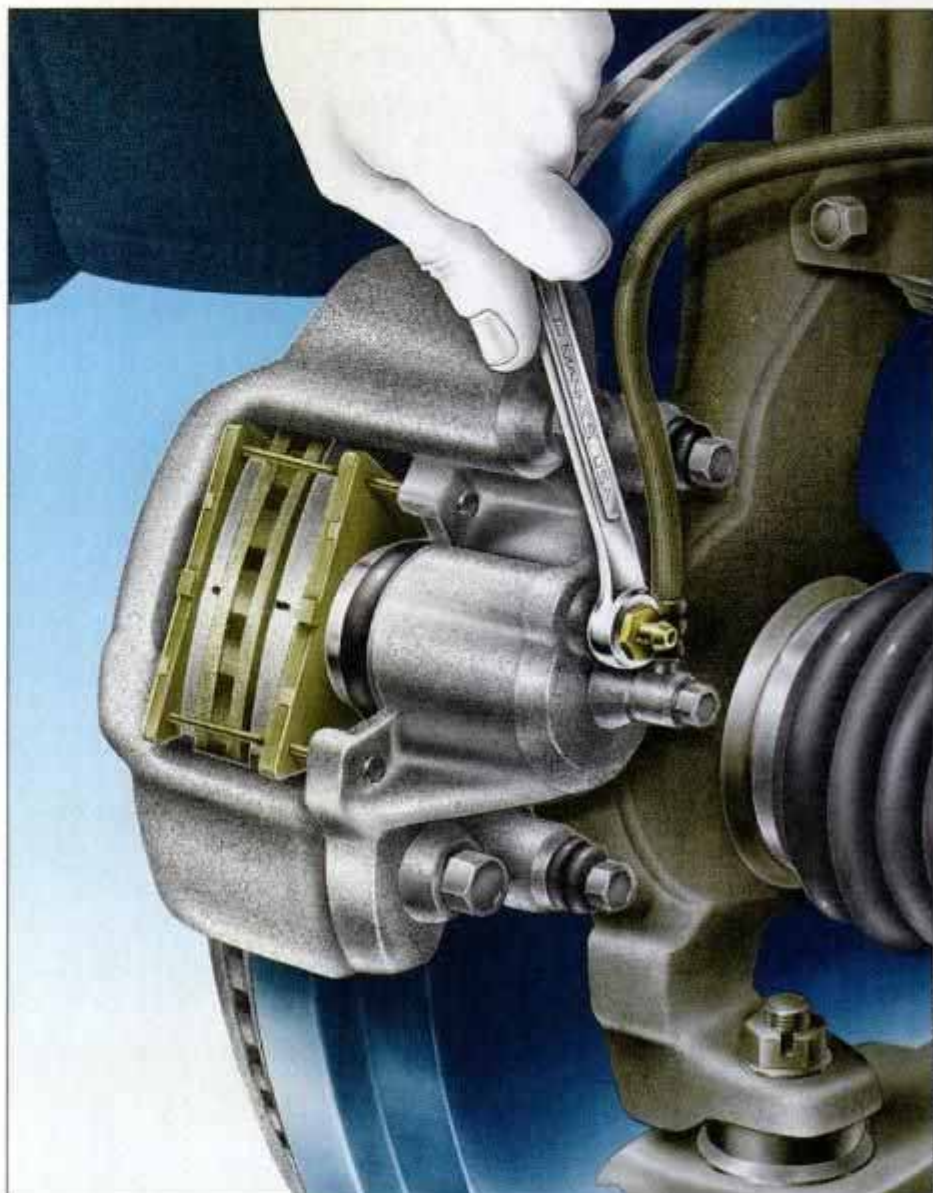
• Check how much friction material is left on the brake shoes themselves.

Most disc brake shoes have built-in wear indicators in the form of a



Shoe replacement requires undoing a couple of pins and sliding out the shoes.

deep groove down the middle of the friction material. As the material wears away, the groove disappears. Many brake systems also offer an audible brake-lining wear indicator



which shrieks if the brake shoes are dangerously worn.

If everything checks out all right, put the wheels back on. However, if it has been more than two years since the brake fluid has been flushed from the brake system, it's a good idea to replace it with fresh fluid. The fluid in the brake system collects water and impurities which can damage the system. And if the brake shoes are worn, they must be replaced.

• To flush the old brake fluid, attach a small hose to the bleeder fitting on the brake farthest from the master cylinder—the right rear. Place the other end of the hose in a container.

• Loosen the fitting nut and have a helper step on the brake pedal.

• Close the fitting while he still has the pedal down. After he releases the pedal, top up the master cylinder.

• Repeat the operation three times, or until the brake fluid becomes wa-

ter-clear. Next, do it at the left-rear brake. Then go to the front brakes.

• To replace worn disc brake shoes, undo any retaining clips holding the pins which run through the caliper.

• Remove the pins from the caliper.

• With the pins out, the only thing holding the brake shoes is the pressure from the caliper piston. Carefully push the piston back into the caliper, either using a large C-clamp or a large screwdriver or pry bar. Don't pinch the piston's boot.

• Pull the old brake shoes out of the caliper, noting which is the inner shoe as well as the presence and position of any clips or backing plates.

• Put the backing plates over the new brake shoes and apply a thin coat of anti-rattle paste to the backs of the new brake shoes or backing plates.

• Slide the new shoes in place.

• Clean and reinstall the pins.

• Reattach any retainers.

FM

SATURDAY MECHANIC

TRACKING DOWN INTERMITTENT ELECTRICAL PROBLEMS

BY PAUL WEISSLER

• You turn the ignition key to crank the engine, and it barely turns over. Visions of explaining to your spouse why you're late getting home again send a cold chill down your spine. Finally your engine catches. Bad battery? Well, maybe not.

Hit the horn button to warn a suicidal bicyclist and all you get is a click—which the biker ignores. Dead horn? That's the least-likely possibility.

Pull the headlight switch at night and faint beams barely light the road

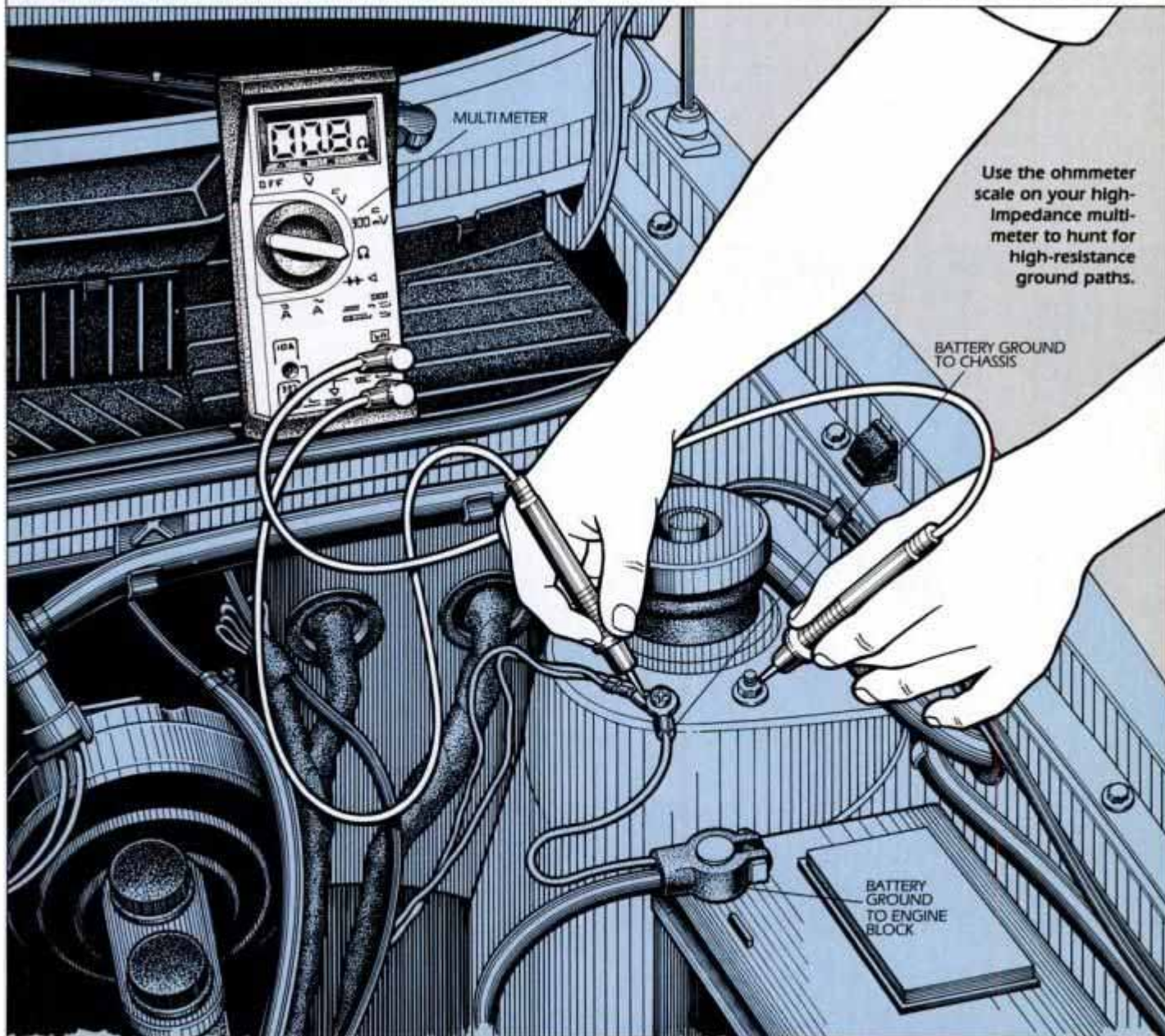
ahead. Step on the gas and the headlights brighten. Bad charging system? Not likely.

Turn on the radio and there's nothing but static. Something wrong with the radio? Good chance there's not.

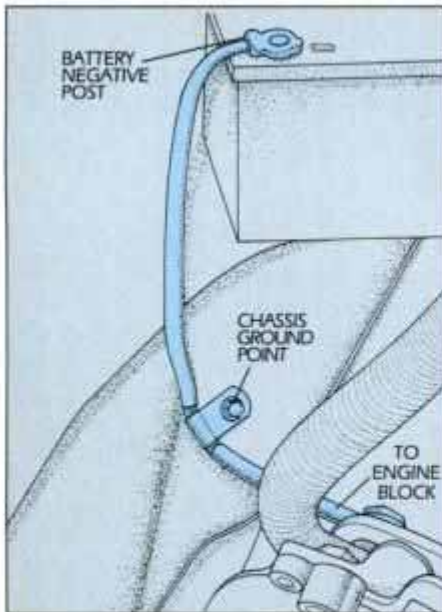
Every one of these problems could be nothing more than a corroded or poorly connected electrical ground. Virtually every electrical circuit in your car depends just as much on the ground side to complete the circuit as it does on the positive wiring.

Common doesn't mean simple

A bad ground is not only common, it's the cheapest repair you can make. Yet the failure to find and fix bad grounds leads to many unneeded parts replacements, including expensive computers and sensors. So if there's even a possibility that the ground could be responsible, it's worth looking into. However, finding a bad ground can be difficult. And the repair must be done absolutely cor-



CAR CARE



Corrosion can compromise the chassis ground in the center of this cable.

rectly in order to cure the problem.

Sometimes the bad ground will be something you can see, but more often it's something you can't. Today's electrical and electronic systems are so sensitive that an acceptable

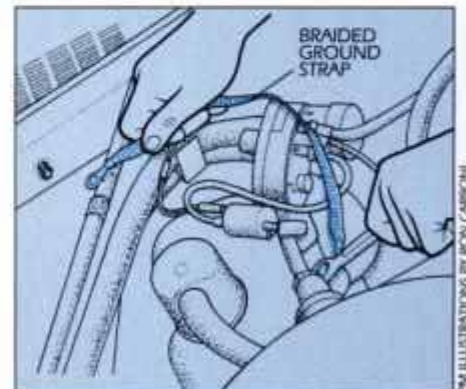
ground of yesterday is a problem of today. And when it comes to electronics, you can't rely on the old rule that a bad ground only results in poor performance. A ground may be a reference for an electronic circuit, and if the ground is bad, it can result in more current flow and the subsequent frying of transistors. This means that even if you find and replace the bad part, the problem will recur unless you trace and correct the bad ground.

Use a digital multimeter to check grounds, but be careful to select a meter with a "high-impedance" 10-megohm rating (low current flow so it's computer-safe). Suitable multimeters start at less than \$50, with professional brands costing about \$120 to \$400. The more expensive professional models are higher quality and have a lot of special features, some including rpm and plug-in thermocouples for temperature measurement. So base your decision on the overall range of work you plan to do.

If the problem is slow cranking, test the battery ground cable. Set the meter to VOLTS, connect the positive lead to the battery ground terminal

or post, and the negative lead to the engine or, if possible, to the starter housing. Have someone crank the engine and the meter will read whatever voltage isn't being used in the starter circuit. If it's more than 0.4 volt, either the connection or the cable is bad. If it's a split cable (one branch to a ground on the body, the other to a ground on the engine), a 0.5-volt drop is tolerable. If you find an excessive drop, it could be in either branch.

Look for a corroded terminal or



Check for corroded or missing ground straps between the engine and firewall.

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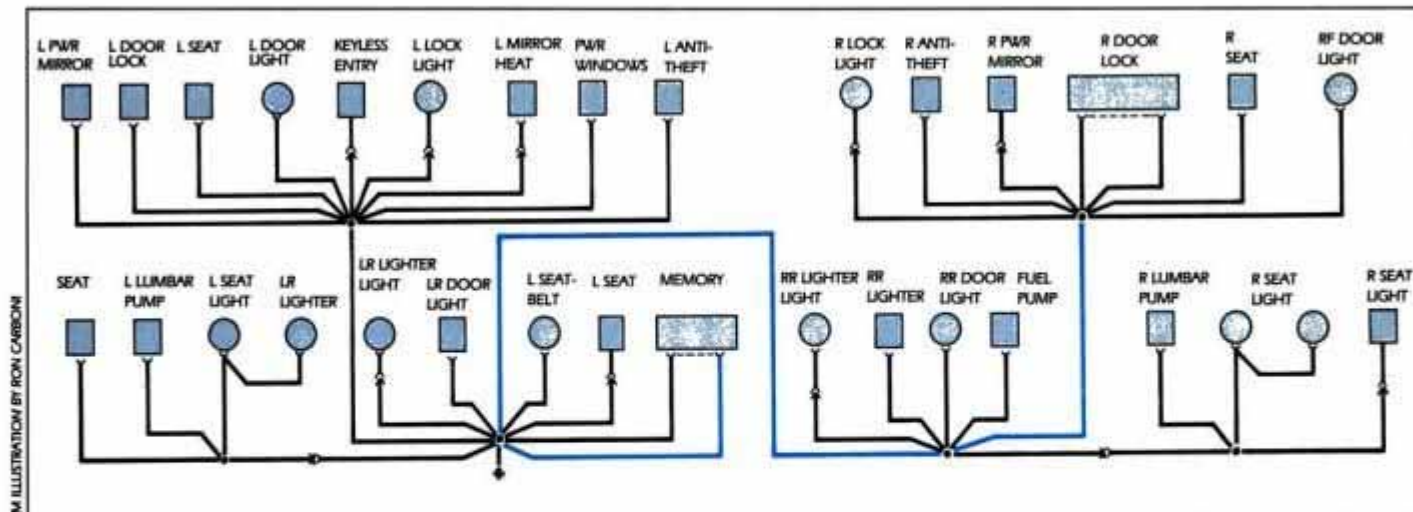
As part of the National Home Improvement Days program, the QUIKRETE Companies have placed an advertisement for its Fast-Setting Concrete product. The advertisement, which appears on page 18 of the National Home Improvement Days insert, was produced prior to the repackaging and new design of the Fast-Setting Concrete bag. The new design and specifications, now appearing on the bags, reads:

"Specifically formulated to set hard in minutes. Perfect for setting posts, slabs, sidewalks, steps, and hundreds of other jobs."

In addition, QUIKRETE has amended the description of the Fast-Setting Concrete process, which appears on page 20 of the National Home Improvement Days insert. The revised description reads as follows:

"QUIKRETE specialty concrete mixes are perfect for small needs such as setting posts. To set a post, use QUIKRETE Fast-Setting Concrete mix. Simply set the post in the hole, plumb and brace the post. Add water to the mix to achieve a plastic-like consistency, then pour into the hole. It sets in 15 minutes. Basketball backboards or other heavy objects can be hung in only four hours."

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FM ILLUSTRATION BY RON CARBON

If the fuel-pump ground is marginal, opening a rear door kills the motor because the courtesy light shares a ground point.

frayed wiring at the battery end, damaged insulation (perhaps from battery acid droppings) and/or frayed wiring on each branch. Also inspect each ground connection with the meter—positive lead to the bolt holding the cable end, negative to the adjacent metal on the body or engine. Crank the engine and the reading should be less than 0.2 volt.

On some cars, there's a single

ground cable from the battery's negative post, but it goes into a connector with two or three branches. The branch to the starter may be fine and the engine will crank normally, but one of the other branches may be bad. This can cause a variety of general electrical-circuit problems. Disengage the connector and inspect each branch terminal for a bent or damaged tab or poor connection be-

tween the wire and the terminal.

There are two grounding variations that suffer from special problems. One (used on many Fords) is a single cable from battery to engine, but with about an inch of insulation stripped away at the midpoint. A clamp is wrapped around the cable and bolted to the car body to provide the second ground. The clamp and the wiring under it may corrode and

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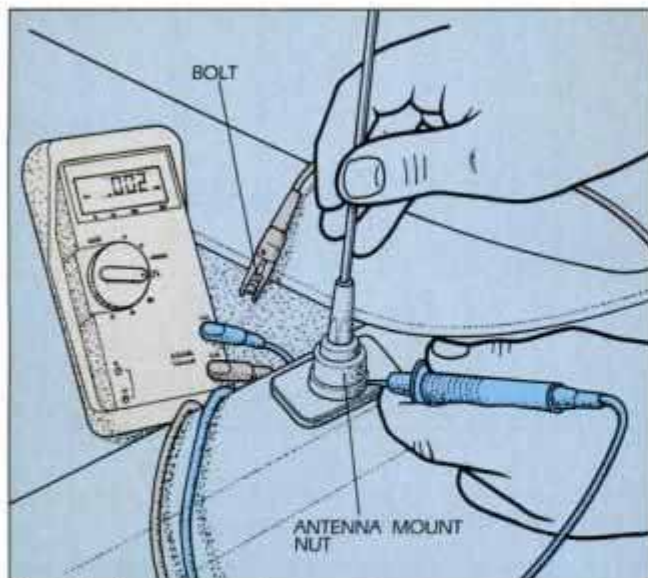
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Check for low resistance between the antenna mount and a good chassis ground, like this mounting bolt.

affect both body electrical circuits and engine cranking.

There may be a second grounding cable—often a braided metal strap—far from the battery, that goes from the engine or transmission to the body, a setup used by both Chrysler and General Motors. This type of cable may be at the firewall, perhaps partly under the air-cleaner housing or elsewhere nearly out of sight, even underneath the car. Frayed, corroded, even damaged by rocks, it can hang by strands for a while, until there aren't enough strands to complete the circuit with a minimum voltage drop. The result is similar to the bad branch problem. Or, it may be that a mechanic removed a secondary strap or cable to gain access to a part for a repair job, then forgot to put it back in place. Everything may seem okay, but you soon discover otherwise.

Sensitive grounds

Electronic circuits are sensitive to poor grounds, but so may be garden-variety electrical circuits. Example: The power windows, power seats, power mirrors and interior lights don't work, and the engine stalls when you open any door. This actually happened on a 1990 Lincoln Continental, and the single, simple cause of all this misery was a bad ground. All these systems—and the in-tank electric fuel pump—share the same ground.

Occasionally we see cases where turning on one accessory affects the operation of another, because they share the same weak ground. Result: The electrical current finds another

way to complete the circuit—through the circuit—through the other accessory.

When the car is suffering from a problem that involves just one or a few circuits, you really need a manual with charts that show all the components that share the same ground (or if a circuit has a single "dedicated" ground) and where the ground is located. Sometimes the regular shop manual has the diagnostic diagrams. In other cases (such as Ford), it's in a separate manual. The charts also show the ground wiring that is part of a common splice and where that splice is located. That's important because several splices may use just one ground, and that's exactly what occurred in this case.

If only the systems or components with ground wiring up to a splice are affected, you know you have to check only the splice. If failed systems share a common ground but different splices, you know the splices are good and you only have to check the ground.

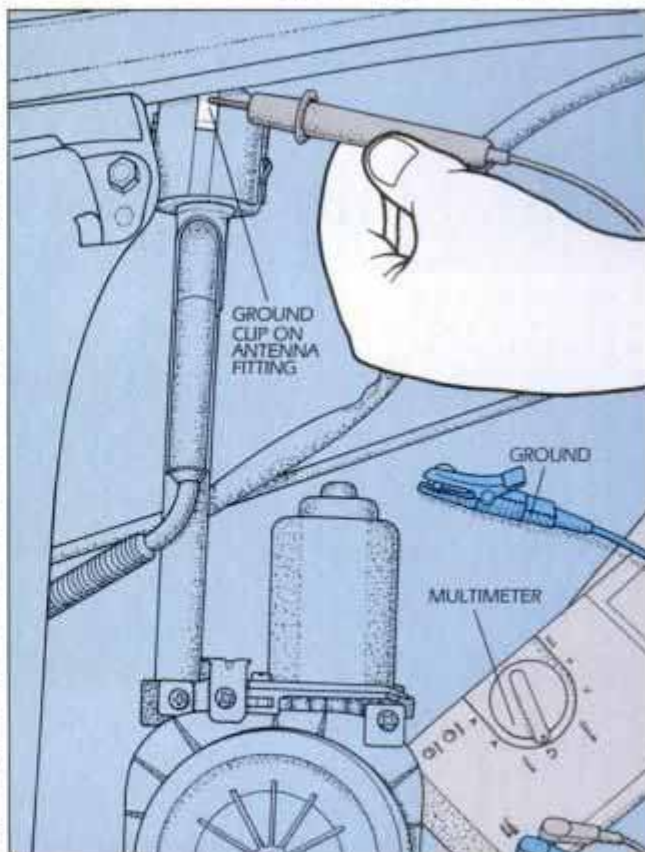
However, the locator lists or illustrations are important because you can't guess. In the case of the '90 Continental, the ground is partly under the front seat, not exactly the place you would think to look for the end of a fuel-pump circuit.

It's true, however, that some electronic circuits are considered so sensitive that they have two grounds—a setup called redundant grounding. It would seem unlikely that a problem could result if one fails, but there are problems all the time where all that's wrong is a single ground weakness (not even a complete break).

You can test an electronic circuit ground with an accurate multimeter set for VOLTS. If there's a choice (as opposed to an auto-ranging meter that picks the appropriate range for the reading), set it on the 0-2 volt scale, activate the circuit and you should get a zero reading. Even 0.1 volt is too much.

Using an ohmmeter to take a resistance reading at the ground connection is a good alternate method, and it can be done with the circuit off, which takes the variability of voltage out of the picture. With many circuits, a voltage-drop reading is difficult or impractical, so resistance is the way. But it also can be difficult to get an accurate resistance reading unless you're careful. Repeat a check several times to verify a reading. Make sure you test at the same spots and use a needle probe you can dig in, instead of a clip that may make inconsistent contact. You can buy meters with leads that convert from an alligator clip to a needle probe.

Unless the meter is auto-ranging, begin by selecting a medium ohms scale (0-100 or 0-200) and touching the lead clips or probes together. If you have to set the range, be careful not to pick 0-100K or 0-200K, which is simply too high to give you an ac-



Some antennas rely on spring-loaded lugs to ensure contact with the sheetmetal fender.

CAR CARE

curate reading. You should get a resistance reading of no more than 0.2 ohm, and preferably less (hopefully zero). If you can't get this reading, and the meter uses a dry-cell battery, the battery probably is weak. Any resistance meter will have an internal battery.

Touch the ground terminal and the adjacent metal and you also should get a similarly low reading. If you're checking an electronic system ground wire from its origin to the adjacent sheet-metal, the reading should be no more than 5 ohms.

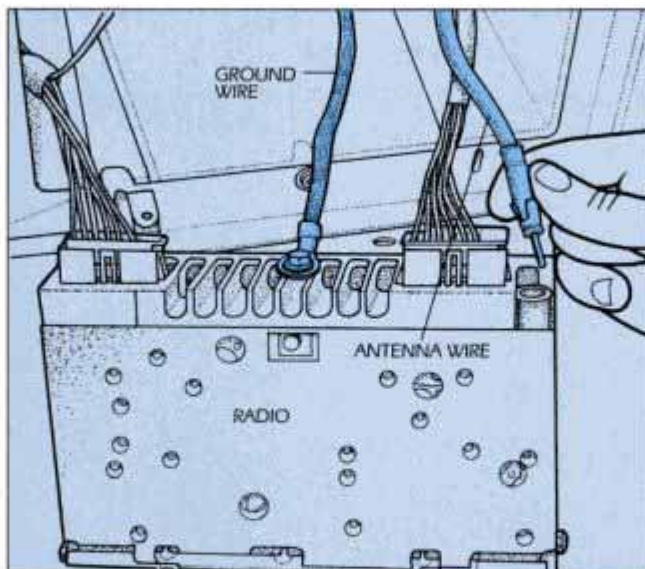
Radio grounds

Although a blown fuse is the most common cause, many no-reception problems can be traced to a bad ground, either for the radio itself or for the antenna. Many people change spark plugs and wires to get rid of ignition noise or static when a weak antenna ground is the problem.

Access to the radio ground often requires removing the radio itself, but with today's front-service dashboards, that's rarely a problem. Typically, you pry out a plastic trim piece held by spring clips, then remove a few screws and pull the radio forward. On some, there's a clearly separate ground wire to a nearby bolt. On others, the radio's plug-in harness includes one ground wire (usually black). Probe the ground wire terminal with one ohmmeter lead, and touch the other to a nearby body ground to make the test.

Testing an antenna ground often is very straightforward and the fixed antenna mast is the easiest. Check resistance from the shield around the bottom of the mast to the engine compartment sheetmetal while gently trying to rock the mast side to side. There should be no more than a half-ohm reading. Be careful not to measure resistance from the trim that rests against the fender. It usually has a rubber gasket under it and is insulated, not grounded.

If the car has a retracting antenna mast (power or manual) in the rear quarter panel or front fender, locate the motor/gear mechanism or

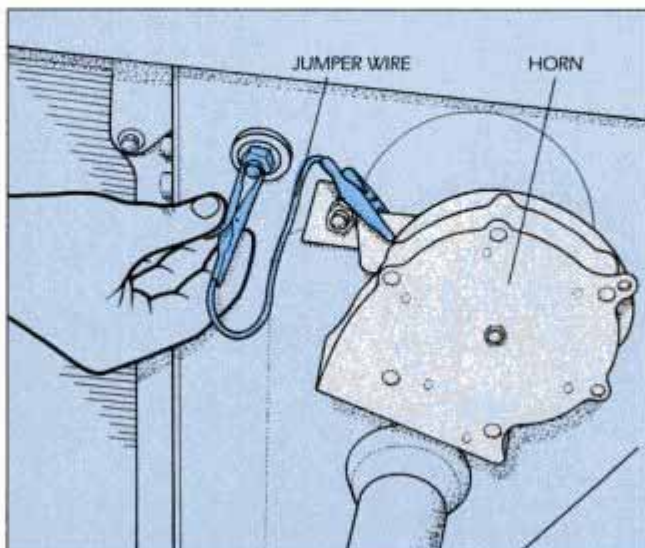


It's amazing how many poorly performing radios are grounded only by the antenna cable, rather than a proper ground strap.

housing and look for either a ground cable (typically used with plastic body panels) or grounding/retaining clip or tab. Make a resistance check looking for no more than 0.5 ohm. With a rear quarter panel antenna, the access is in the trunk. With a front fender antenna, you have to remove a few screws from the wheel-well liner to reach the ground.

On cars with an antenna that retracts into a roof pillar, and no external grounding shield, remove the trim piece for access to the antenna holder that provides the ground.

When the static is intermittent and the resistance reading is good, recheck while you try to wiggle or push on each section of the antenna assembly. If the resistance reading suddenly shoots up, the ground is not secure.



You can use a jumper wire to diagnose a poor ground connection on a high-current device like the horn.

If the external parts of the antenna assembly have a protective coating, it may insulate the metal from the ohmmeter leads. You'll have to dig in with a pin probe.

Problem with the antenna ground? There may be rust on the body hole. Clean it with a wire brush, then delay a recurrence by applying a coat of nonhardening sealer to the underside of the trim.

If there is no AM reception and the FM is very weak and noisy, the problem is likely to be a break in the center wire of the antenna cable. If you check resistance between this and the cable housing, it should be infinite. Gentle wiggling of the center wire tip and flexing the cable may suddenly produce a low reading, indicating that the center wire is intermittently making contact.

Fixing 'em

Repairing other weak grounds often requires no more than just tightening a loose screw or wire-brushing away some corrosion from the threads. However, even clean threads that feel tight actually may be making loose contact, particularly if a bolt isn't threaded all the way up. A missing washer may be the problem.

Or if a ground connection originally came with a star washer that has been lost, get another one. It will dig in and restore the low-resistance contact that's necessary.

And just to prove that high tech can throw you another curve, don't use a star washer on a bolt or nut that didn't originally come with one. It may have a special protective/conductive coating that the washer—or even wire-brushing—will destroy, and the bolt or nut soon will corrode and the grounding problem will return.

Grounds—or for that matter any electrical connections—that are exposed to the elements probably could benefit from a shot of protective grease, but plain old white lithium grease or even Vaseline work just as well.

We used to be satisfied with good grounds. Now they have to be great, and if you give them the attention that matches their importance, you can make them that way. **FM**

HOW IT WORKS

AUTOMATIC TRANSMISSION

BY DON CHAIKIN, Contributing Editor

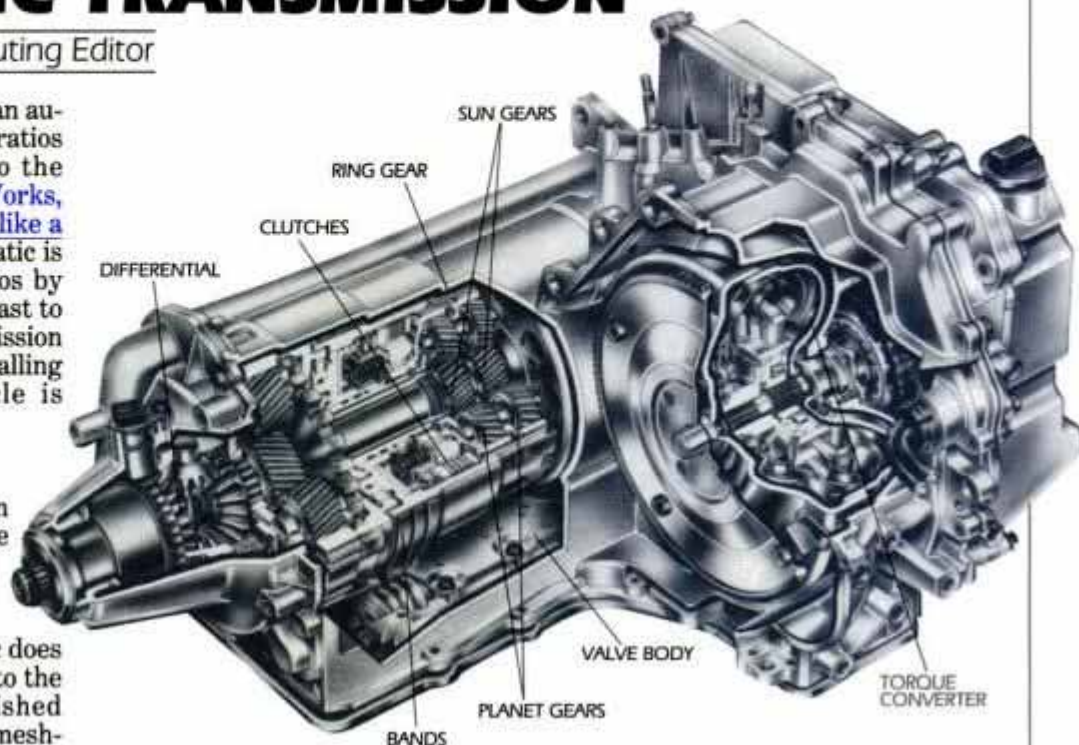
• Like a manual transmission, an automatic provides various gear ratios to match the engine speed to the vehicle's speed. (See *How It Works*, page 93, Mar. '93.) However, unlike a manual transmission, an automatic is able to shift between gear ratios by itself. And also in marked contrast to a manual, an automatic transmission can remain engaged without stalling the engine while the vehicle is stopped.

No clutch, no clash

While a manual transmission must be disconnected from the engine briefly each time the gears are shifted to avoid grinding the gears (by disengaging the clutch), an automatic does its gear shifting while engaged to the engine. This feat is accomplished through the use of constantly meshing planetary gears.

A planetary gearset consists of a ring gear, a sun gear and several planet gears all mounted in the same plane. The ring gear has its teeth on its inner surface and the sun gear, concentric with the ring gear, has its teeth on its outer surface. The planet gears are spaced evenly around the sun gear, and they mesh with the ring and sun gears. In addition, the ring, sun and planet gears each have their own carrier or driveshaft.

Brake bands or clutch packs attached to the individual gear carriers and shafts are hydraulically activated to direct power flow from the en-



GM's Hydra-matic 4T80-E represents state-of-the-art in automatic transmission design with its electronic controls for gearsets and torque converter.

gine to any of the gears and to hold any of the gears from rotating. This manipulation allows gear ratio changes and power flow reversing while the engine is running.

An oil pump in the transmission provides the hydraulic fluid needed to activate the various clutch packs and brake bands. And a very complex series of valves—referred to as the valve body—in the transmission's oil pan controls the fluid flow. The valve body acts on inputs it receives on engine and vehicle speed and load.

Modern automatic transmissions now rely on the data from electronic sensors and a dedicated electronic control unit to operate the valve body's solenoids to shift the automatic's gears. Older units rely on vacuum signals and mechanical speed senders.

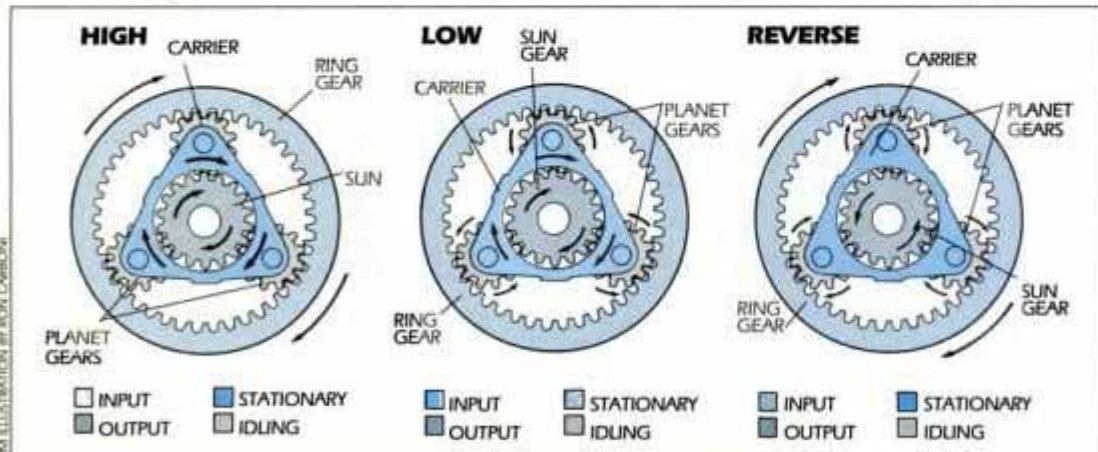
Slip a little

An automatic is connected to the engine by a fluid-filled torque converter. The converter consists of an impeller which is attached to the engine's crankshaft, a mating turbine which is attached to the transmission's input shaft and a torque-multiplying stator mounted between them.

As the engine rotates, the impeller's vanes throw hydraulic fluid at the turbine blades, causing the turbine to spin the transmission's input shaft.

When the engine is idling, the impeller doesn't throw the fluid with enough force to spin the turbine, allowing the car to sit without stalling.

PM



By controlling which elements of the planetary gearset rotate and which elements receive the engine's power, an automatic transmission can alter both drive ratios and direction.

NEW PRODUCTS

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Show-Car Shine

Getting your car or truck to gleam like new is more than a matter of cleaning and polishing the finish—you must also tend to the trim and brightwork. The task of polishing metal trim is less onerous if you have an easy-to-use polish, like Quick Shine (about \$6 plus shipping) from Concours West. The polish itself is impregnated in the applicator. Just

tear off a portion of the applicator and rub it into the metal, then wipe clean. Its maker says it works on brass, copper, silver and glass. From Concours West Inc., 5374 Via Maria, Yorba Linda, CA 92686; (714) 777-8333.



Automatic Roof Closer

Ever leave your convertible top down or electric sunroof open while you're at lunch—only to discover that while you were indoors a sudden cloud burst rinsed your car's interior? An innovative device called Wet? . . . Not! ensures that you won't get caught with your top down again. Wet? . . . Not! is an electronic sensor that automatically activates your car's electrically operated top, sunroof or power windows to close them after the first few drops of rain. The unit can also be connected to a pager if your car has a manual sunroof or T-top. The sensor is compact—3 × 1 in.—and mounts low on the windshield, out of the driver's line of sight. The suggested retail price is \$149.95. From Car Experience Inc., 400 Anthony Trail, Northbrook, IL 60062; (708) 564-0320.



Pickup Dump Bed

Emptying a standard pickup truck bed of bulk loads—like firewood, fill dirt or gravel—can be a back-breaking chore. One way to expedite the task is with the E-Z Lift, which converts the pickup bed into a small dumptruck. The E-Z Lift bolts to the frame of any domestic pickup be-

neath the cargo bed. The hydraulicaly driven unit weighs 140 pounds and can lift 4000 pounds up to a 45° angle in 20 seconds. It comes with everything needed for installation and costs \$1595, plus shipping. From G. Sneddon Co. Importers & Exporters, Site 9, RR2 Box 33, Stony Plain, Alberta, Canada T0E 2G0; (403) 963-4513.



Dust And Grit Collector

Buffing parts cleans them and brings back that original luster. Unfortunately, in the process, it also covers you with grit and dust. Eastwood has a solution, however, in the form of a dust and dirt collecting system which works with its line of buffing motors. (Both the 1/2- and 3/4-hp buffer motors.) The system—designed to meet OSHA standards—consists of large, heavy-gauge metal shrouds for the buffing wheel, a 1/2-hp vacuum that draws the dirt from the wheel through a 3-in.-dia. hose and a large filter bag which collects the dirt. The complete debris collection system costs \$499. The shroud assembly alone costs \$199. From The Eastwood Co., 580 Lancaster Ave., Malvern, PA 19355; (800) 345-1178.

New Impact Wrench

As Tim Allen likes to point out, when it comes to power tools, there's nothing like more power. Enter Ingersoll-Rand's new model IR2131 1/2-in.-drive impact wrench (\$249.95), with 450 ft.-lb. of torque for tightening and 600 ft.-lb. for loosening nuts and bolts. A multistage control allows you to limit output to 50 ft.-lb., 100 ft.-lb. or 225 ft.-lb. and maximum to prevent damage from overtightening. Another feature is an integral 360° swivel air-hose connection sleeve. From Ingersoll-Rand Co., Power Tool Div., Dept. NR-482, P.O. Box 1776, Liberty Corner, NJ 07938; (908) 647-6000.





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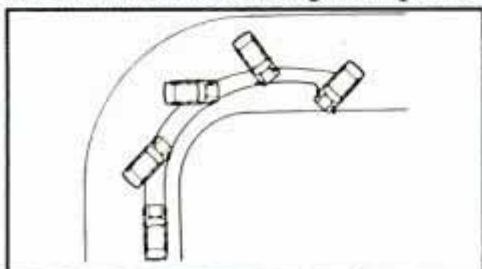
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1. Which most accurately describes the state of this automobile as it travels through a right-hand corner?



A) Skid. B) Understeer. C) Oversteer. D) 4-wheel drift.

2. The production passenger car laden with most chrome trim of all time is the:

A) 1955 Cadillac Eldorado. B) 1957 Oldsmobile 98. C) 1958 Buick Limited. D) 1959 Chrysler Imperial.

3. Which automobile had a third headlight centrally mounted in the front of its hood?

A) Cord. B) Duesenberg. C) Pierce Arrow. D) Tucker.

4. If your car suddenly stops running on the highway, the first thing to check is:

A) Battery condition. B) Fuel supply. C) Ignition wire connections. D) Engine oil level.

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5. Which car could be ordered with an aluminum V8 engine?

A) 1961 Buick Special. B) 1969 Camaro. C) 1992 Cadillac. D) All of the preceding.

6. The 1992 NASCAR Winston Cup stock car racing champ is:

A) Alan Kulwicki. B) Kyle Petty. C) Richard Petty. D) Darrell Waltrip.

7. One of the handiest simple tools to determine the general overall condition of your engine and pinpoint specific problems is a:

A) Compression gauge. B) Timing light. C) Vacuum gauge balance. D) Ohmmeter.

8. The term "flat-four" refers to what type of engine?

A) 4-cylinder inline. B) 4-valve head. C) Transverse 4-cylinder. D) Horizontally-opposed 4-cylinder.

9. Which of these is the main change adopted by auto manufacturers to allow for the use of lead-free gasoline?

A) Hardened exhaust valve seats. B) Increased compression ratio. C) Catalytic converters. D) Electronic fuel injection.

10. Increasing positive caster when aligning the front end tends to:

A) Increase steering effort. B) Increase self-centering. C) Both A and B. D) Neither A nor B.

ANSWERS
1. C 2. C 3. D 4. B 5. D 6. A 7. C 8. D 9. A 10. C

We owe you one.

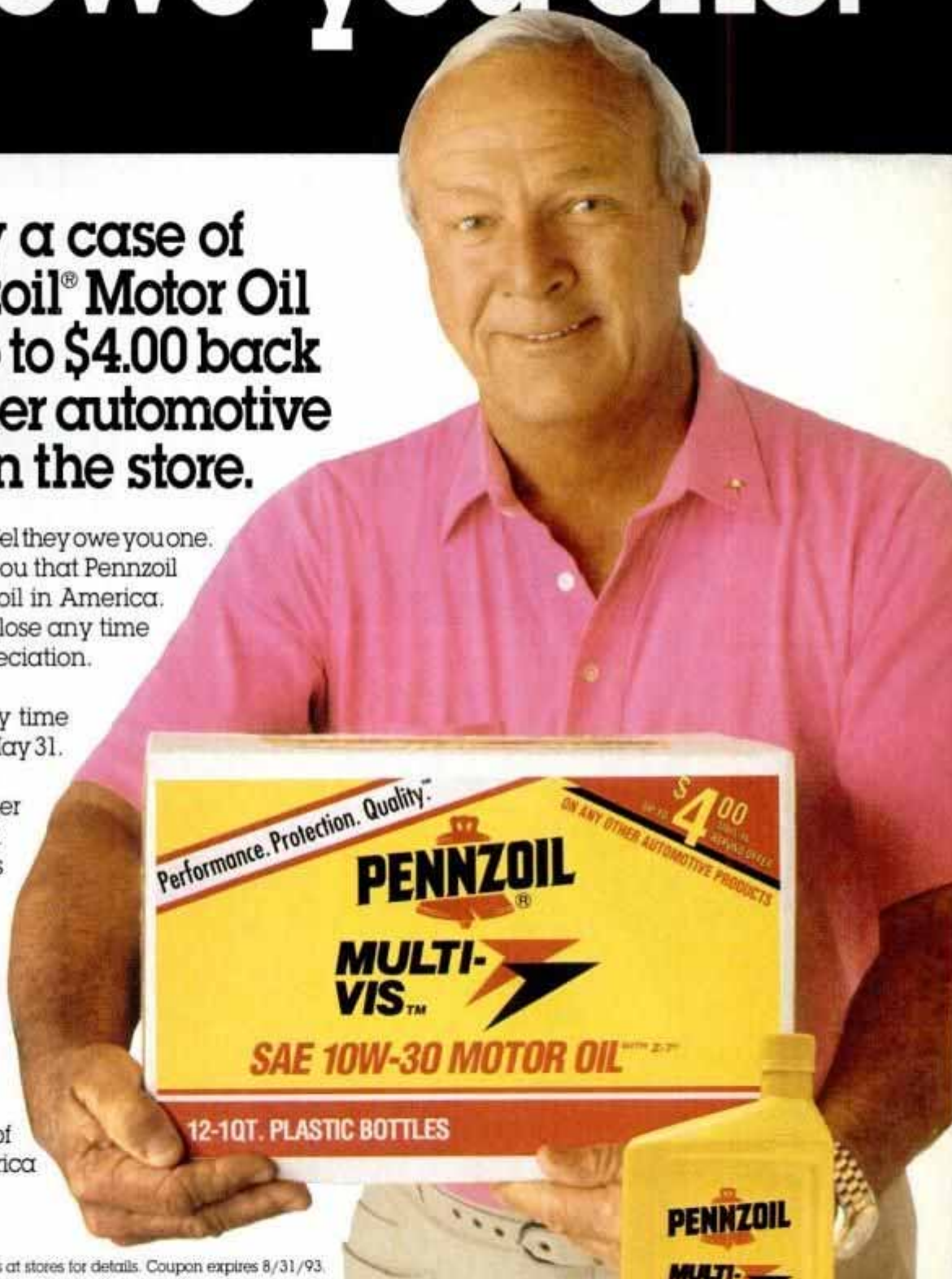
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PHOTOGRAPHY

LOW-LIGHT BLACK & WHITE

BY GEORGE SCHAUB

● Pro photographers call it "available" light. It's shooting in dim light with fast films without flash, and it's great for capturing a mood or making pictures when flash isn't allowed or would be inconsiderate. Though there are special films as well as shooting and processing techniques that come into play, the payoff is in capturing a gritty realism or an ethereal mood that just can't be matched by photos made with flash. News photographers earn their livings by understanding these techniques, whether they be used in gathering hard news, capturing the action of indoor sports or grabbing shots of



In low-light situations, color film may not record the scene accurately. Black-and-white film may be the better choice for capturing realism or ethereal moods.

speed color films can certainly record the scene, but the colors are generally off and the results are usually overwhelmed by an orange/red cast. That's because the fastest color films are made to be shot in daylight or with electronic flash and simply can't deliver true colors under incandescent light. The thinking is that if you can't get true colors, it's better to have no color at all, and that's where black-and-white films come in.

One of the main keys to getting the best results is film choice. A super-fast film, such as Fuji's Neopan 1600 or Kodak's T-Max P3200 will do the job. The next step is working with the right lens, so pick the "fastest" lens in your camera bag. What is a fast lens? One that has the widest maximum aperture, or f-stop. For example, let's say you have a choice between a 50mm f/1.4 lens (standard with many 35mm SLR cameras) and a 70-210mm f/4.5 zoom. The 50mm is faster by two stops. This not only allows you to focus easier, but, when wide open, lets in more light by a factor of four. That can be crucial in very low light, when even a stop can make the difference between getting the picture and having no details recorded on the film.

Though it's not essential, an autofocus camera can make your shooting so much easier. Most autofocus SLRs can find the right focus in light as low as EV1—about the amount of light shed on a 1-year-old by the candle of a birthday cake in a darkened room. With manual focus, you may have to guesstimate focus—finding focus through the viewfinder might be difficult at best. When you're shooting at wide-open apertures the depth of

field, or zone of sharpness, is very narrow, so proper focusing is key.

Another thing you'll need for these shots is a steady hand. You may be shooting at a speed as slow as $\frac{1}{2}$ of a second, or slower.

If you want to be sure of having a shake-free shot, use the time-tested rule of setting your shutter speed at the inverse of the focal length of the lens on the camera. For example, if you're working with a 135mm lens, shoot at



stars at concerts.

Though there are color films with speeds that fill the bill, such as Konica's super-fast ISO 3200, the overwhelming choice for this type of picture-taking is black and white. Why? When the light's really low, high-





Veteran jazz pianist Red Richards poses in low-light club conditions.

about $\frac{1}{250}$ th of a second. If the focal length is 50mm, you can get away with about $\frac{1}{60}$ th of a second, and so forth. This really comes into play if you're using a long-range telephoto, such as a 210mm lens, which is necessary if you're back in the bleachers. Here, a minimum of $\frac{1}{250}$ th of a second, or faster, is your best bet.

What about using a tripod for steadiness? This is fine for landscapes when the tripod legs won't get in the way. But try using a tripod in an arena or a crowded room and you'll be causing more trouble than it's worth. Monopods—single-leg steadiers—may be a better choice.

Now that we have all the elements together, let's go through an actual shoot. The assignment was to photograph veteran jazz pianist Red Richards in a club where the lighting was low and indirect—no spotlights there. My film choice was Fuji Neopan 1600, and I worked with a 35mm f/2 lens on my Nikon N8008 autofocus camera. I had already decided that flash was out of the question, as I knew it would disturb the musicians.

After I took a light reading through the camera, I decided to rate my film speed at EI 3200. To find the rating you need in a similar situation, set your shutter speed to whatever speed is best (again, following the inverse focal-length rule described above) and, with the lens wide open (set to its maximum aperture), take a reading in manual exposure mode. Note the degree of underexposure indicated by the camera, and however many stops that may be, that's the amount at which you should change the rating of the film when it's processed. Changing the speed rating of film, and compensating for that change when the film is

processed, is called "pushing."

Experience has taught me that the true speed of Neopan is about ISO 800. Since my readings told me that if I used that speed at $\frac{1}{60}$ th of a second my exposure would be two stops underexposed, I rated the film at ISO 3200—a 2-stop gain (ISO 800-1600-3200). You may not need that much of a gain. Work with as little a gain in pushing as possible, because quality does go down when higher ratings are used. Also, most films have a limit as to how far they can be pushed, with anything more than two to three stops being the absolute limit. Neopan 1600 and the Kodak T-Max P3200 films, are made for this work, so they can take pushing to high speeds.

I worked in and around the close quarters of the music stage, concentrating on Red, his facial expressions and the other members of the band. I shot a few slow speed pictures of his hands on the keyboard. By exposing at $\frac{1}{4}$ second I knew that his hands would blur, but I was going for a visual effect that matched the music.

The next day I consulted the film charts supplied by the manufacturer, and when I developed the film I "pushed" it to the speed at which I had it rated—EI 3200. Pushing means that you extend the develop-

ment time to compensate for underexposure. Neopan 1600 and T-Max P3200 allow you to push to any number of speeds—if you need more speed, you just develop it longer. I know some photographers who've rated Kodak film as high as ISO 12,000 with success. (Note that the whole roll must be developed for the same speed.) If you're not into developing film yourself, a custom lab that handles pro work can do it for you.

Can you do this type of work with a lens/shutter camera? Though you can't change the ISO setting as you can with an SLR, you may be able to use a fast film and have it pushed to get close to the speed you need. However, your camera must have the following:

- A DX-code system that can handle fast films.
- The ability to expose at shutter speeds slower than $\frac{1}{60}$ th of a second.
- An override that allows you to defeat the auto-flash mechanism.

I've worked with fast black-and-white films in many concert situations, and have even photographed fast-moving sports such as basketball using the techniques described above. Give it a try, and you may become hooked on low-light shooting. It delivers moods and effects bright-light photography just can't match. **FM**

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AUTOMOBILES

THE ALTERNATE FUEL REPORT:

FLEX-FUEL DODGE SPIRIT

BY CLIFF GROMER



• Mix alcohol and gasoline? Certainly—as long as it's in your gas tank. The Dodge Spirit shown here has an appetite that can be satisfied on a blend of methanol and gasoline ranging from M85 (85% methanol/15% gas) to 100% gasoline. Methanol can be produced from crude oil, natural gas, coal and, though not very economically, even garbage.

A conventional engine needs special hardware in order to automatically adjust its operation for fuel blends ranging up to 85% methanol. But a peek at the Spirit's 2.5-liter 4-cylinder engine shows it to be nearly identical to its gas-fueled counterpart. The key element in the system is a "smart" sensor in the fuel line that measures the dielectric constant of the blend and adjusts spark timing, fuel injection and other engine controls, via the vehicle's computer, for optimum efficiency.

While it's an easier task to calibrate an engine to run on 100% methanol than a varying blend, straight methanol presents two basic problems. First, methanol does not

like to vaporize at lower temperatures, which causes hard starting. Adding a minimum of 15% gasoline is the fix here.

The second problem is that methanol is highly corrosive to most materials in a conventional fuel system, so upgrading from carbon steel to stainless, for example, is required.

There are, however, added operating costs associated with running on M85. Even if an engine has good piston rings, methanol will still manage to get past them and down into the oil where it degrades the oil's lubricating qualities. A special premium oil with specific additives is recommended, and the change interval drops from 7500 to 5000 miles.

Since methanol contains fewer BTUs of energy per gallon than gasoline (it's about 50% as energy capable), it takes 1.6 times as much M85 to travel the same distance as it would on 100% gas.

We had a chance to drive the flex-fuel Spirit on both 100% gasoline and with the M85 cocktail. On gas, the Spirit felt totally normal with no dis-

cernible driveability differences compared to a stock vehicle. With M85, we felt we had a real tiger in our tank. The engine was more responsive all around and had more zip for a given amount of throttle travel.

This isn't surprising when you consider the 100-plus octane rating of M85, which allows for a bit more aggressive performance curve, plus M85's more efficient combustion characteristics. As a matter of fact, the same engine makes five more horsepower and four more ft.-lb. of torque on M85.

Track tests demonstrated the difference with the normally aspirated Spirit clocking 0-to-60-mph runs at 14 seconds even and a quarter-mile time of 17.8 seconds at 73 mph on 100% gas. Switching to the M85 pump, the 0-to-60-mph time fell by a half-second, while quarter-mile times showed 17.4 seconds at 75 mph.

The big drawback to flex-fuel is the relatively few service stations that now serve up the M85 brew. And it will take legislation or a crimp in the oil supply line to change this. **PM**

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ECONOLINE



THE BEST-BUILT, BEST-SELLING AMERICAN TRUCKS ARE BUILT FORD TOUGH.

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Continental Expansion

● Ford will move the new 1994½ Lincoln Continental up in size and power next year in an effort to compete more directly with Cadillac's De Ville. You can look for a V8 engine under the hood and major changes in the front suspension, as well.

Continental will offer the sohc version of the 4.6-liter modular V8, the same engine used in the Town Car, the Ford Crown Victoria and the Mercury Marquis. This will boost horsepower into the 200-plus range. The current 3.8-liter V6 will be dropped from the lineup.

The front suspension will be revised from the strut type now used, to upper and lower control arms. Ford engineers believe that the change to the suspension system will reduce impact harshness to a world-class level.

1994 Cadillac De Ville

A bigger De Ville is planned for Cadillac's 1994 model lineup. This prototype is slightly disguised by red, yellow and black paint patterns, but the details of the new design are easily seen.

The new De Ville will have Cadillac's overhead-cam 4.6-liter Northstar engine under its hood as a

replacement for today's 4.9-liter pushrod V8. Look for this engine to be phased into the De Ville lineup, starting with the Touring Sedan.



Cadillac Northstar V8 trickles down to the De Ville for 1994.

1995 Ford Explorer

Not quite. Yes, that is a Ranger front end on an Explorer body. But this prototype is not a new Ford sport/utility vehicle. It is really a test mule for Ford's 1995 Explorer. Under the sloping hood is a redesigned suspension system. Gone is the famed Ford Twin I-Beam front suspension. In its place is a system with upper and lower control arms. The change will allow Ford to

lower the hoodline about 2 in. That's the clearance gained by removing the front differential from one of the I-beams. A fleet of mules like the one shown here will prove the roadworthiness of the new suspension in tests during the next two years.

Dodge Ram

Dodge designers reached way back into history to find the styling theme of the 1994 Ram pickup truck. What they zeroed in on was the 1949 Dodge Power Wagon, a military design held over from World War II. Power Wagon hood, radiator opening and front fenders are the lines that Ram designers crafted into the new vehicle. "We wanted our truck to stand out," says Tom Gale, Chrysler's design chief. "And we wanted to give it a traditional Dodge flavor." It's clear Dodge succeeded on both counts.

1995 Aurora

Oldsmobile's Aurora sports sedan will be built on the same chassis as Cadillac's De Ville. That's the conclusion from a glimpse of the major dimensions of the two cars. Aurora will have a 113.8-in. wheelbase, the same as the De Ville. Overall length will be within a quarter-inch of the De Ville at 205.4 in. Those two dimensions are critical. Drive-

train, brake balance and ride control depend on both. The dimensions tell another story. Olds will have no place for the Ninety Eight sedan in its cur-



Explorer will get lowered hoodline with revised front suspension.

rent form once the Aurora comes on stream. They both fill the same market niche, so the Ninety Eight becomes expendable. But Olds claims it is not dead. So look for the Ninety Eight badge to live on as the top model in the Eighty Eight lineup.



Front-drive Aerostar replacement is based on Taurus components.

1995 Ford Van

Ford has set this final design for its new '94½ compact van. The front end carries traditional Ford sedan styling, while the passenger compartment is shaped much like the Mercury Villager. When the van—code named Win88—makes its appearance as a '95 model, Ford will sell it alongside the Aerostar for at least one year. After that, Ford is expected to drop Aerostar from its lineup. Features of Win88 include a low, flat load floor, V6-engine power and a sedan-like instrument panel. Airbags for driver and passenger will be standard.

Green Steel

That's one way the steel industry is selling its products to the auto companies. They say that steel can be totally recycled—used again to build new cars. That's not universally true of plastics. If keeping the environment clean is important, steel has a big advantage. Studies show that more than 90% of the steel used to build new cars is recycled metal. That keeps the metal in use and out of a trash dump.

More Steel

Look for automakers to keep using steel as the prime material for cars—even if it means knocking off those plastic panels you sometimes see. Steelmakers say you can coat a steel body to keep it corrosion resistant. And, stronger steels coming on the market will replace mild steel, resulting in lighter weight and better fuel economy. Short-life dies and flexible welding jigs will cut the cost of body panels and make steel competitive with plastic for short-run body styles.

Final Steel

Put these trends together and you get the reason GM is switching back to steel body panels on the '95 APV compact van. Front fenders on some GM luxury models have already been switched to steel. Finally, look for pullbacks to steel in some body pan-

els now used on the Camaro/Firebird—and eventually Saturn.

Electric Hookup

Ford, GM and Chrysler want to cut their losses. That's the big reason the three will cooperate in electric car research. Few, if any, Detroit insiders see a market for electric cars. Sure, some electric utilities will buy several for their fleets. But that won't pay Detroit's research and development bills, let alone produce a profit. By combining the talents of GM, Ford and Chrysler, Detroit will spread the losses. It will also avoid duplication of effort. Each will take on a different part of electric car development and spend less on a final product.

Good News...

You won't have to replace mufflers on your new car as often as in the past. Automakers are building mufflers and pipes—including catalytic converters—to last for 100,000 miles. That's the good news. The bad news? When you do need exhaust-system service, it will cost more. According to Tenneco, higher prices will be charged for double-walled exhaust pipes and other emissions items in the exhaust system. Those thinner, double-wall pipes heat up faster, lighting off the catalytic converter sooner to produce cleaner exhaust. And the 100,000-mile stainless-steel systems are much more costly than the older mild-steel type.

Disappearing Windshield

GM quietly dropped its face-saving plastic liner for big-car windshields because of some problems with mist and ice. The plastic liner was a thin sheet of pliable material covering the inner surface of the glass. It acted as a cut protector if an occupant's head struck the windshield in an accident. But the plastic also insulated in cold weather. It slowed down the defroster effectiveness by 5% and hindered clearing the inside of mist and the outside of ice. **PM**

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SIXTH SENSORS

BY ABE DANE, Science/Technology Editor



● I wasn't expecting much when a derailed train left me with a day to kill in Salt Lake City, Utah. But science reporting is often as much a matter of serendipity as advance planning, so I decided to pass up the chance to see the Mormon Tabernacle and pay a surprise visit to the University of Utah.

As it happened, my visit coincided with some big news from the university's robotics researchers. Score another one for serendipity.

Dr. Stephen C. Jacobsen, robotics guru and head of the College of Engineering's Center for Engineering Design, has one of the most hyper-organized offices I've ever seen. Cabinets full of meticulously color-coded files line the walls, and his phone projects toward him on an articulated stalk. When I walk in, he seems entranced with the images on a large computer monitor.

You get the sense that this is a guy whose time is so valuable that everything around him must be structured perfectly to prevent a single moment's thought or movement from going to waste. And indeed, his efforts have been instrumental in advances ranging from the Utah Artificial Arm, which now gives renewed

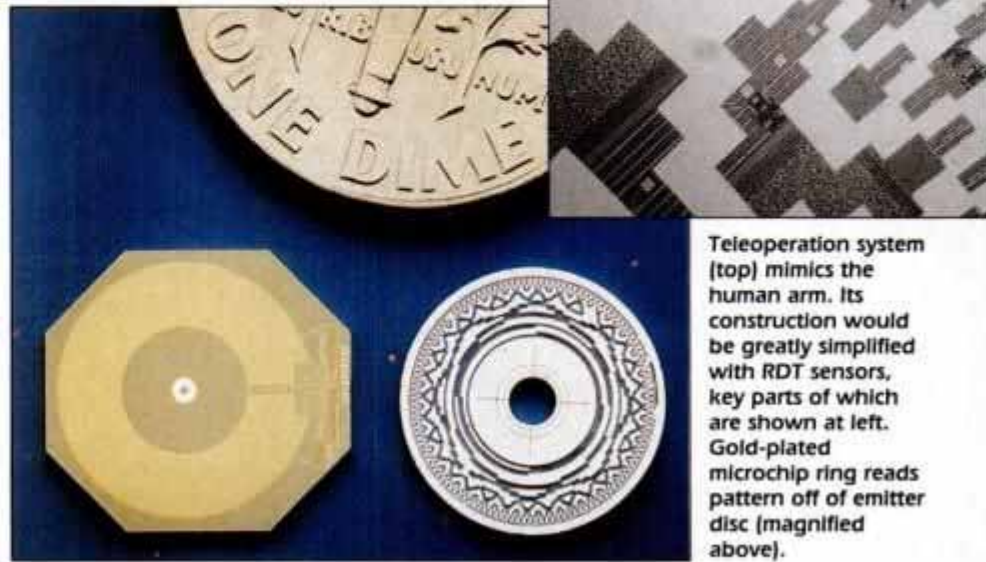
dexterity to hundreds of amputees, to manipulators for secretive Defense Department projects and beguiling animatronics figures at theme parks. After a pause, he swivels his chair slowly to face me like some James Bond supervillain.

But he is cordial and speaks with precisely measured enthusiasm. At the moment, he's particularly excited about a new class of tiny sensors that will help robots and other intelligent machines monitor their own move-

ments. "That's the biggest thing out of the lab," he says flatly.

At first, it doesn't seem like such a big deal, but with a little explanation, the implications grow clearer. "Something that has permeated this place for years is a sadness that the strategies used by biology can't be used by manmade machines," Jacobsen says. "That is, using large numbers of sensors that acquire precision from statistics, not measurement, and work in groups and networks to interpret machines such that they can function like organisms. The option of building machines that work in the same strategic ways as biological machines has been unavailable because of the cost of the sensors, and what this is going to do is change the philosophy of design for machines."

Dr. Melvin W. Siegel of the Robotics Institute at Carnegie Mellon University agrees that the sensors have great promise. It stems, he says, from their ability to provide something called proprioception, a sixth sense which we all take for granted that tells us what our own parts are up to at any given moment. "That's what robots don't have," says Siegel. "They're running blind and the existence of small, lightweight, reliable sensors will let us work with machines that know where their own



Teleoperation system (top) mimics the human arm. Its construction would be greatly simplified with RDT sensors, key parts of which are shown at left. Gold-plated microchip ring reads pattern off of emitter disc (magnified above).

parts are. You know how important that is to you."

One example is an unimpressive-looking little device called a Rotary Displacement Transducer (RDT). Consisting of a cylinder about the size of three stacked dimes with a shaft protruding from one end, its purpose is to provide data on the rotation of one part with respect to another.

It does this in a unique but simple way. Inside the cylinder, a wheel etched with electric emitters in an elaborate pattern known as a Gray code rotates on the end of the shaft. The coded electric field it produces is read by a gold-plated microchip ring fixed to the bottom of the cylinder.

This simplicity yields a \$50 unit the size of a marble that can replace lemon-size devices costing as much as \$1400. The data it produces is extremely precise, indicating movements as small as .018°. Perhaps even more important, this data comes in the form of multiplexed digital signals, so information from up to 128 sensors can travel along the same set of three wires.

The principles behind the RDT have spawned a whole class of sensors offering similar advantages. Taken together, these should dramatically reduce the complexity and cost of a wide range of machinery, which earlier relied on analog sensors, requiring great bundles of wiring for communication. Bottom line, says Jacobsen: "It'll probably take 30% off the cost of a robot."

And the dividends don't stop there.

"The encoder business is over a billion dollar market—everywhere from washing machines to airplanes," he says, adding that major automakers have already expressed interest.

So how come nobody came up with anything like this before? Probably because microchips had always been

sensor. "Nobody's ever had the stupidity or whatever to say we're going to take a device and put it right on the chip and we're going to treat the chip so it can stand it," says Jacobsen. But with the Rotary Displacement Transducer and its brethren, Jacobsen's group

has done exactly that. "The chip, instead of extracting information from wires and from optical processors and strain gages, is looking directly at the physical process and extracting information. That means lower cost, higher bandwidth and smaller size," he says.

Before my meeting with Jacobsen, I had a chance to look around the CED with Todd Johnson, the lab's senior electrical engineer. Thinking back on what he showed me, I could see the potential of the new developments. Although designed before the latest sensing technology was available, the robots populating the place already had hauntingly lifelike powers.

Yet, a reverence for the way nature does things was a theme repeated throughout the tour and an obvious source of inspiration for much of the design work. "Look at the power it takes to move an artificial arm," said Johnson at one point. "Com-

pare that to biology, where a Snickers bar is good for 2 or 3 hours on the ski slope. Then you begin to realize, well, first of all, you have to have a lot of respect for what nature has achieved. Then you have to go see how much of it you can understand and perhaps use."

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thought of as tools for processing data, rather than for generating it. For all their electronic brainpower, they were believed too fragile to interact directly with the real world, meaning that you always had to have two separate devices—one to do the sensing, and one to make sense of the

MULTIMEDIA POWERS UP

BY FRANK VIZARD, Electronics Editor

● Sometimes the shape of things to come is determined by how well a technology can handle shapes.

A case in point is a revolutionary graphics and animation processing system that processes images 50 times faster than a personal computer. This technology is scheduled to debut this fall in a compact-disc-based interactive player that connects to your television.

This new technology comes from a company called 3DO (three-dee-oh), and it's designed to be a worldwide multimedia standard, much like VHS is a standard for videotape. While the name 3DO is virtually unknown, the companies supporting 3DO bring a lot of muscle to the table. The group of partners supporting 3DO include AT&T, Time Warner, MCA, Electronic Arts (an entertainment software publisher), Matsushita (makers of the Panasonic and Technics hardware brands) and the Silicon Valley venture-capital firm of Kleiner Perkins Caufield & Byers.

What does 3DO offer? In a nutshell, 3DO gives you a lot of interactivity, a higher level of realism and multiple uses for the player. Not only will a 3DO machine play its own software, but it will play music CDs, photo CDs and motion-video CDs planned for the near future. Expansion slots allow you to do home video editing or connect a MIDI-compatible musical instrument. Other uses for the expansion slots are expected to be developed as well.

If you examine the picture at the top of the page, you can begin to understand the enormous processing power of 3DO. Imagine the cube in the picture in full motion, spinning or rotating in a variety of directions,



shrinking as it zooms into the background, enlarging as it comes to the foreground, changing its shape briefly to register a collision with another object. With every movement, whether it be a spinning or tracking motion, each image on every face of the cube has to be reconstituted in a series of seamless transitions according to scale and color. The speed in which this reconstituting is done requires a large processing capability. In a separate comparison of the same moving images made with a 486 computer, the 3DO system performed amazingly fast while the 486 seemed as slow as a turtle. A 486 is currently the personal computer with the most



Fast processing is the trademark of the innovative 3DO player due this fall.

amount of processing power.

With 3DO's kind of processing muscle, it's easy to apply Hollywood-style special effects and lighting to the software. For example, a programmer can take a photo of a mountain and then apply animation that looks like rain or fog. The Sun can move across the sky with shadows and colors changing as they would naturally. Images can be warped or bent to show impact, and solid objects can become transparent.

The key to 3DO technology is a pair of animation "engines" that display or move up to 64-million pixels, or picture elements, per second. By comparison, a 16-bit videogame manipulates about 1-million pixels per second. And unlike videogames, which manipulate individual graphic images called sprites, the 3DO engines organize graphics into animation "cels" of high-resolution full-color images. The manipulation of these cels in terms of the techniques used is analogous to Hollywood productions in which animators use layer upon layer of independent art to provide realistic visual depth. These cels can be manipulated individually or together in real time.

Additionally, 3DO offers millions of colors while 16-bit systems typically use only 256. Other system components include a 32-bit RISC (Reduced Instruction Set Computer) processor for program control, a video processor and a digital signal processor for surround-sound effects. Also helping matters along is a CD-ROM drive that spins discs at twice the speed of standard models, thereby increasing access time to data dramatically.

Panasonic plans to debut the first 3DO player for about \$700. Portable models as well as 3D glasses also are



Walk and watch TV at the same time with these special Virtual Vision Sport goggles.

promised. In '94, AT&T plans to network 3DO so programming can be delivered via telephone lines connected to a box similar to a cable converter.

How well 3DO fares may well depend upon the software developed for the system. Interactive movies, multimedia encyclopedias, educational materials, lifelike sports and flight simulations and, of course, videogames are all on the drawing board. More than 70 software developers have already signed on to the 3DO bandwagon. Assuming that 3DO technology can be put to imaginative use in software development may be assuming too much. But if the software is good, a 3DO multimedia player may move into the living room next to the VCR in a big way.

TV Glasses

Couch potatoes can now leave their seats without missing a television moment. Just put on a pair of Virtual Vision Sport glasses and you become a mobile TV watcher.

Basically, the idea is to give the wearer a view of two worlds at the same time: reality and a video image that seems to float in space. For viewers, the video image appears to be 8 to 15 ft. away and the image size can appear to be the equivalent of a 60-in. screen. Now you can do chores around the house while keeping an eye on the local sports team.

Within the eyeglasses is a miniature video display and a reflective optical system. A reflective lens, mounted slightly below your normal field of vision on your dominant-eye side, bounces the image so that it appears to be focused at a comfortable distance away. By viewing the image with your dominant eye, the image seems to be viewed by both eyes. Which eye is dominant varies from person to person so there are left- and right-eye versions of the product. Image quality is a bit variable, working best when the background is a solid, uncluttered plane.

Connected to the glasses is a belt-

pack housing a TV tuner and a rechargeable NiCad battery. An optional cordless transmitter and receiver are available for connecting the glasses to a VCR, cable box or camcorder. Range is 50 ft. indoors and 100 ft. outdoors, according to the company. The Virtual Vision Sport glasses can also be used as a viewfinder for a camcorder.

The glasses weigh just 5 ounces, while the belt pack weighs in at 2.2 pounds. List price for the Virtual Vision glasses is \$900. Video Vision Inc. is located in Redmond, Washington, and can be reached at (206) 882-7878.

Project Zoomer

Getting information anytime, anywhere via handheld electronic devices is a notion gripping the corporate minds of major electronics manufacturers. Apple precipitated the trend by announcing its as-yet-undelivered Newton personal digital assistant project, and now many companies appear set to follow suit.

Project Zoomer is a joint venture between the American Tandy Corp. and Casio Computer Co. of Japan. By pooling their resources, both companies take advantage of their respective expertise in product design, engineering and retailing.

Zoomer, due this summer, is a handheld device in which a pen is used to enter information. The operating system is being developed by GeoWorks, which means it's a graphical operating environment similar to the Windows system used in many computers. A variety of applications software targeted toward specific user requirements is also planned.

In addition, Zoomer connects to America Online so interactive communications is possible. Intuit, which makes the popular Quicken financial software package, also is supporting the product with software.

Zoomer is expected to run on alkaline batteries and battery life is expected to be about 100 hours. List price is \$600. **PM**

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IMPORT SPY REPORT

BY TONY SWAN, Automotive Editor



Mercedes In Miniature

● Although we tend to associate the offerings of Daimler-Benz AG with size and power, this doesn't mean the world's oldest car company is incapable of change. By way of proof, we offer this illustration, developed by our spies in Germany, of a possible micro-Benz.

Aimed at providing a true entry-level addition to the Mercedes line—with a price in the low \$20,000 range—the Benz urbocar would break new corporate ground in a number of areas.

Foremost on the list, of course, is size. The tiny Benz would have to grow almost a half-foot to be as long as Ford's Festiva, the smallest car sold in America. Then there's the question of which wheels will apply power to the pavement. Mercedes is a staunch advocate of rear-wheel drive, but Stuttgart sources suggest that front-wheel drive may be used for the minicar, even though it's likely to be based on the soon-to-be-launched rear-drive C-Class chassis, which replaces the current 190 series. The new platform may also be used as the basis for a proposed Mercedes minivan.

Power for the little hatchback will almost certainly be supplied by a 4-cylinder engine. Mercedes currently has two new ones in the works—a 1.8-liter and a 2.2-liter with about 120 and 150 hp, respectively.

Consistent with Mercedes' safety image, the car's standard-equipment inventory will probably include dual airbags, antilock brakes and traction control. It would also reflect M-B's extensive work in the area of side and angled front-impact protection.

What's the production likelihood? Mercedes sources are predictably vague on this question. But Dr. Dieter Zetsche, the new head of Mercedes-Benz research and development, says it is not impossible.



Mazda Mystery

Snapped in the act of fleeing from our spy-photographer's lens, this Euro-spec Mazda 323 prototype looks distinctly production-ready. However, the big 323 production question these days is when and for whom.

With its rounded lines, the 323 echoes the subcompact styling trends



Mazda may drop 323 nameplate for new 323/Protegé.

set by the Toyota Tercel and Honda Civic. It's also expected to be roomier than its predecessor.

However, recent retrenching at Mazda Motor America casts doubt on the continued presence of the 323 at the entry end of Mazda's North American model lineup. At this point, company sources suggest the 323 nameplate may be dropped, leaving only the upscale Protegé, which is based on the 323 platform.

NX Nix

Nissan's sporty NX series seems likely to become another victim of hard times. Due to sluggish sales and

too many sporty models, Nissan will probably axe the 2+2 subcompact coupes—NX 1600 and NX 2000—at the end of the '93 model year.

Kia Sportage

Although Kia will open its U.S. sales operations with the subcompact Sephia sedan, the Korean automaker has particularly high hopes for its new 4-door compact sport/utility, the Sportage.

The Sportage is expected to be a little bigger than the Isuzu Amigo, close to the size of the Nissan Pathfinder and Toyota 4Runner. Like all members of this tribe, it's expected in 2- and 4-wheel-drive editions, with manual and automatic transmission options.

Both the Sephia and the Sportage will probably have new names when they roll into the U.S. The sedan will probably make its appearance at the beginning of the 1994 model year, the Sportage a few months later.

Kia currently supplies the Festiva minicar to Ford, which has a minority stake in the company. Sources close to Ford say it's unlikely that Kia will market its own version of the Festiva here.

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New Sportage sport/ute will anchor Kia's U.S. debut in '94.

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COMPUTERS

ADDING TV TO THE PC

BY RON GOLDBERG



● In a world of technological incompatibilities, perhaps no mismatch is as misunderstood as the one between video and computers. On the surface, the two mediums look like they're from the same species. After all, you watch them both on a TV screen, and some of the best computer monitors are made by TV makers. But beyond these superficial similarities, they've traditionally had little in common outside of the broadcast studio.

All that's changing, however, as both video and computers become more involved in our everyday lives. The latest fashions for the well-dressed computer are PC-to-video bridges, in the way of computer cards and outboard devices designed to bring the two mediums together. As a result, it's getting harder these days to separate one from the other.

Why would anyone want to get video on their computer, or vice versa? For camcorder buffs, a computer can be the ideal production assistant, providing a quick and accurate way to log shots, edit footage, superimpose titles and add special effects. To do these tricks, a video input/output card is a necessity. A computer can also be used to capture still pictures fed to it from a video source. This is called frame grabbing,

and it's useful for manipulating pictures with "digital darkroom" techniques. With other kinds of output devices, you simply can dump the display of the computer screen onto videotape. This is especially convenient in business situations, where complex computerized graphics and



TelevEyes transfers images from a PC to a TV (top). IBM's PS/2 TV gives you a TV window (above).

presentations can be passed around and played on a more universal delivery system—the VCR. Beyond these reasons, another idea is gaining popularity—video cards that actually turn the computer monitor into a TV. With these cards, you can watch two very different kinds of "programs" at the same time.

This all seems like obvious stuff, but there have always been numerous roadblocks in getting video and computers to communicate. The big problem is timing. The NTSC television standard is 525 lines of picture information scanned at 30 frames per second. Depending on the hardware and the graphics mode being used, a computer might update images as quickly as 80 times per second. Then there's the problem of how the lines are scanned. The 525 lines of video picture are presented in two alternating fields of 262.5 lines, with the odd lines scanned first, followed by the even. This is called interlaced video. A typical VGA computer displays all of its lines sequentially—a technique described as non-interlaced video.

To make matters worse, there are many different computer displays in use today. While NTSC video is an established standard, there are many standards in the world of personal computers. The PC world alone offers numerous variations: VGA, super VGA, CGA, EGA and so on. Add to those the various display schemes for platforms like the Apple Macintosh and the Commodore Amiga, and it's easy to see how a universal connection might be problematic.

Finally, video is an analog medium, while computer information is always digital. That means that if the computer is to do anything more than display moving video signals, those signals first must be digitized. Several new ideas along these lines have been inching the state-of-the-art toward pure digital video. Apple Computer's QuickTime operating environment for the Macintosh is a good example. In this scheme, moving video is digi-

computer's QuickTime operating environment for the Macintosh is a good example. In this scheme, moving video is digi-

tized and the data compressed as it is input into the computer. Once it's stored there, it can be manipulated like any other digital data.

A typical (though atypical) new product for PC to video output is TelevEyes from Digital Vision, which allows you to print VGA computer graphics onto videotape. Unlike many of the solutions that allow this transfer, TelevEyes is not a card that plugs into a slot inside the computer. It's an outboard box about the size of a cigarette pack that connects in-line between the computer's VGA card and your video gear. This greatly simplifies the procedure for those who get nervous poking around inside their computer—although the open architecture of the IBM PC and its clones is designed for just such work. TelevEyes works with any PC, AT, XT or compatibles, as well as the IBM PS/2, laptops and notebooks.

Once the device is hooked up, you install the TelevEyes software on your hard drive. This consists of three programs—one actually activates TelevEyes, one allows operation under the Microsoft Windows (3.0 and up) operating environment and one displays handy test patterns for setup. This last bit of software is necessary because picture characteristics are largely dependent on which graphics mode you use. Using the ALT and SHIFT keys in tandem with the keyboard arrows, you move the picture around until it's centered. Once that's done, you simply call up the information you want to print to tape, set your video gear recording and let them fly.

IBM itself acted somewhat leisurely in getting out desktop video products to the consumer market. However, the company's "Ultimedia" series of multimedia-based products may now be the most comprehensive resource. The PS/2 family of computers was envisioned as an ideal platform for these ideas, and Big Blue has released several interesting new products for these machines. The PS/2 TV, for example, is an outboard box that puts television signals onto the computer monitor. Fitting neatly below the monitor, the PS/2 TV accepts either cable or broadcast signals into a standard 75-ohm connection point. Composite video input and output jacks are provided, as are audio jacks for connection to an external amplifier.

The PS/2 TV is activated by pressing the NUM LOCK key twice in succession. This brings up a screen that offers the viewing choices. You can use the entire monitor as a television screen or choose the picture-in-pic-

ture (PIP) mode. In the latter case, you can monitor your TV program (or input from any other video source) in a small box that can be strategically placed on the monitor. A click of the ESCAPE key brings the current software application back into active mode. Shortcuts for volume, channel selection and view mode are provided on the PS/2's numeric keypad, and preferences for all picture and sound settings can be saved. The only real drawback to the PS/2 TV is that the keyboard is temporarily deactivated when the moni-

tor is playing video information. As a result, you can view your computer data while watching TV, but you can't work with it.

Ideas like these are just the beginning in what promises to be an important relationship between video and computers. Next year's FCC decision on high-definition TV looms particularly large. If, as expected, an all-digital transmission format is selected, computer and TV signals will be integrated as never before, opening new possibilities for interactive TV and multimedia entertainment. **FM**



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OUTDOORS

NEVER TOO OLD TO SHRED

BY CHARLES PLUEDDEMAN



● Winter changed for me last summer. Like most veteran snow skiers, I noted with interest the growing number of snowboard riders on the ski slopes. And, like most veteran skiers, I created a list of reasons why I didn't like them and their sport:

1. Kids snowboard. I'm too old.
2. If I try to learn, I'll just bruise my body and my ego.
3. I already have a pile of cash invested in ski gear.
4. It looks dangerous.
5. Snowboarders talk funny and dress funny, plus they have an attitude.

Actually, I think it was No. 5—the attitude—that finally attracted me to the sport. Let's face it, snowboarders seemed to be having more fun than skiers.

Curiosity eventually got the better of me and, last summer, I went to a glacier at Whistler Resort, in the Canadian Province of British Columbia, to attend the Craig Kelly World Snowboard Camp. After four days, I discovered the following responses to my list of old excuses:

1. You're never too old to have fun.

2. It's easy to learn to snowboard.
 3. Sell your skis—you'll never use them again.
 4. Sharon Stone is dangerous. This is nothing.
 5. Every sport has its own attitude and vocabulary.
- Snowboarding has grown by more than 15% in the past two seasons,

while the number of downhill skiers has held about steady. And while the age of the first wave of snowboarders was pretty young, the kids are getting older.

In fact, the snowboard industry expects its next boom to be with crossover skiers—older, experienced alpine devotees who try the new sport and stick with it.

The snowboard concept dates back to 25 years ago when pioneer Tom Sims claims he was inspired while riding a skateboard on icy New Jersey sidewalks. He built his first 30-in. plywood snowboard in a high-school shop class in 1963. Sims built his first commercial snowboard in 1976. Current industry sales leader Jake Burton offered his first board in 1978.

Today's snowboards are much more sophisticated than these early efforts. The materials are similar to those in skis, usually a composite matrix of fiberglass or Kevlar fabric and sheets of aluminum or plastic over a core of wood. Like skis, snowboards have metal edges for carving on hard snow and a polyethylene base that can be waxed.

Modern boards can be divided into three basic types. Freestyle boards typically have a soft flex pattern, moderate sidecut and a trimmed tail that can be ridden backward or forward. Freestyle boards are designed to be used for acrobatic riding, but they're also at home on cruising slopes.

Freeriding boards are a bit longer and stiffer than freestyle models, with a more aggressive sidecut—narrow waist. These boards have more edge-holding ability than freestyle boards and are most at home carving turns on groomed slopes.

Alpine boards are very stiff and have the most radical sidecut of all the styles to give them excellent edge-holding in slalom gates or on extreme slopes. These boards are most at home on the race course and are not a good choice for beginners.

Some freeriding and all



Snowboards (l. to r.): freestyle—soft flex, moderate sidecut; freeriding—stiffer flex, more aggressive sidecut; alpine—very stiff, asymmetrical. Arrows show binding adjustments.

alpine boards have an asymmetrical sidecut. By moving the toe-side edge ahead of the heel-side edge, the sidecuts are aligned with the rider's center of gravity as he stands with his toes angled forward.

Today's snowboard bindings consist of a molded-plastic heel cup with a high back to support the ankle. Straps with adjustable buckles secure the boot in the binding. Bindings are offered in more flexible freestyle models and more supportive freeride models. Crossover skiers will like the freeride boards and bindings, which usually have two buckles over the instep and one over the ankle. Prices for a freeride board with bindings range from about \$400 to \$600.

Snowboard boots have also advanced from converted Sorel snowmobile boots to today's dedicated footwear with a ski-boot-type liner and beveled toe and heel that won't drag in the snow. Like boards and bindings, soft boots are offered in both freestyle versions and more-supportive freeride models. Prices range from \$175 to \$270. In Europe, most snowboarders ride with hard-shell boots and plate bindings, which offer superior edge control on hard snow. Hard boots present an option for aggressive crossover skiers who don't feel comfortable in soft boots.

More than 90% of the ski areas in North America now welcome snowboarders, and most offer snowboard lessons if they have a ski school. Most beginners can pick up snowboarding after a few lessons and a couple of days of practice.

The first question you'll be asked at the ski school is: "Are you regular or goofy?" A regular rider leads with his or her left foot. Those who are "goofy" place their right foot forward on the board. This has nothing to do with being left- or righthanded. To find out whether you are goofy or regular, run and slide in socks on a smooth floor. The foot you naturally lead with should go forward on the board. About 70% of the population is regular. Beginners should have the bindings set about shoulder-width—19 in. to 21 in. apart—angled about 35° forward. As you learn, you'll adjust the binding stance to fit your riding style.

I found out fast that the icy conditions on a fast-melting glacier are not conducive to quick learning. In soft snow, the board will bank over and flex naturally in turns, while hard snow or ice requires a much trickier edge technique. Turns are accomplished by changing from the toe-side edge to the heel-side edge and

back. At first I found it easy to go from the toe to the heel edge, and almost impossible to go the other way. The trick lies in learning to get all your weight on the front foot so that the tail of the board can pivot around behind you. Just as on skis, your natural instinct is to lean into the hill when you begin to feel out of control, which inevitably puts you way out of control. My instructor, champion alpine racer Kevin Delaney, finally got me out over the board and on the second day I was linking turns down the blue glacier.

If you're already a skier, why even consider snowboarding? Maybe just for variety or a new challenge. But there's really a big difference between the sports, a difference that goes beyond the equipment. In skiing, there's a right way and a wrong way to ski, there's a certain etiquette, a certain adherence to style and fashion. Snowboarding, by contrast, is an expressive activity. The goal is to have fun. Creativity is encouraged. The correct style is your own style. If that appeals to you, you'll love snowboarding. **FM**

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THE LURE OF INDY

BY TONY SWAN, Automotive Editor



● While this year's IndyCar campaign promises to be one of the best ever, 1994 may be even better yet. That's when Honda and possibly Nissan plan to join Chevy and Ford in the PPG IndyCar World Series, including racing's greatest prize—the Indianapolis 500.

While Nissan's commitment isn't linked to a specific year, Honda has made a definite campaign declaration, bolstered by the car you see pictured here.

The car was unveiled at the '93 North American International Automobile Show in Detroit, Michigan, by American Honda Executive Vice President Tom Elliott, who will ramrod the effort.

Honda's IndyCar activities will be headquartered in the United States, specifically in Valencia, California. A new American Honda subsidiary—Honda Performance Development Inc.—has been organized to handle development of the new engine, with Elliott as president.

"Challenges have always been important to the growth and success of Honda," said Elliott. "IndyCar racing is this type of challenge."

Elliott added that from a cost/benefit perspective, IndyCar racing is much more attractive than the wildly expensive world of Formula One racing. Estimates of Honda's 1992 Formula One budget range from \$50 million to \$80 million.

It's also accurate to say that at about one-third of the cost, the IndyCars put on a far better show.

Beyond announcing intent, Elliott had few specifics to offer about

the program. This year will be devoted to powertrain development, and in '94 Honda will ally itself with a "flagship" team for the actual campaign. Smart money says this will be defending champ Bobby Rahal.

The car shown here rides a Lola chassis, but the ultimate chassis choice will be up to the designated team. Asked what kind of power he expects Honda's 2.65-liter dohc 32-valve turbo V8 engine to develop, Elliott smiled and said "competitive." Competitive currently means about 750 to 775 horsepower.

One problem could derail this exciting program. With the exception of the Indy 500, current rules specify that engine manufacturers must supply more than one team. This provision is likely to be reviewed this summer but, if it stands, Honda's program could be stillborn.

Honda Minor

Meanwhile, back here on Earth, we've just returned from the first round of our own Honda racing effort, in the stirring new Prelude VTEC. In Honda-speak, VTEC is an acronym for Variable Valve Timing and Lift Electronic Control, a system that transforms the Prelude into a



Honda's 1994 IndyCar campaign will be built around a new 2.65-liter dohc 32-valve turbocharged V8.

veritable tiger when the tachometer needle gets up to 5200 rpm.

Starting from the back of the pack in the rain at Willow Springs, California, the Prelude hustled us to second in class. Although first place was in sight for a time, the downpour became torrential in the final laps, whereupon the Prelude proved to be a good deal faster than its driver.

Nevertheless, the Prelude VTEC is a promising prospect in the Sports Car Club of America Showroom Stock A class, where its major competition is the Mitsubishi Eclipse/Eagle Talon/Plymouth Laser and the formidable Nissan 300ZX.

The VTEC's 2157cc dohc 16-valve aluminum engine produces phenomenal power for its displacement—190 hp at 6800 rpm—and the car's balanced handling makes it exceptionally easy to drive quickly.

Just how quickly, compared with the competition, remains to be seen. But we think the combination of VTEC power, excellent handling, outstanding brakes and BFGoodrich R1 radials will put us in the hunt for a spot in the SCCA National Championship Runoffs next fall. **PM**



Singin' in the rain: PM's Honda Prelude VTEC made a splashy '93 debut in monsoon conditions at Willow Springs International Raceway in California.

PM PHOTO BY RON HUSBY

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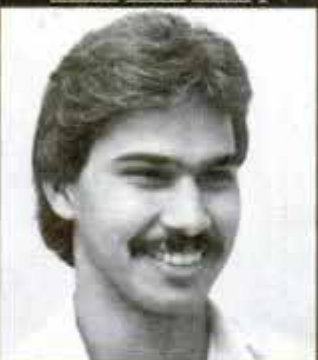
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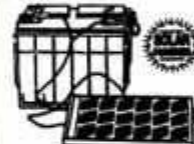
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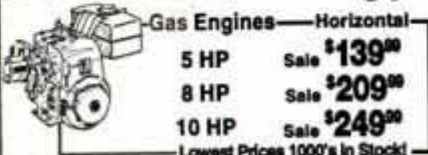
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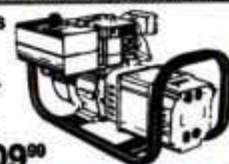
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How to test your drinking water, and what to do if the results indicate a problem. Plus, a complete rundown on water treatment and filtration systems.

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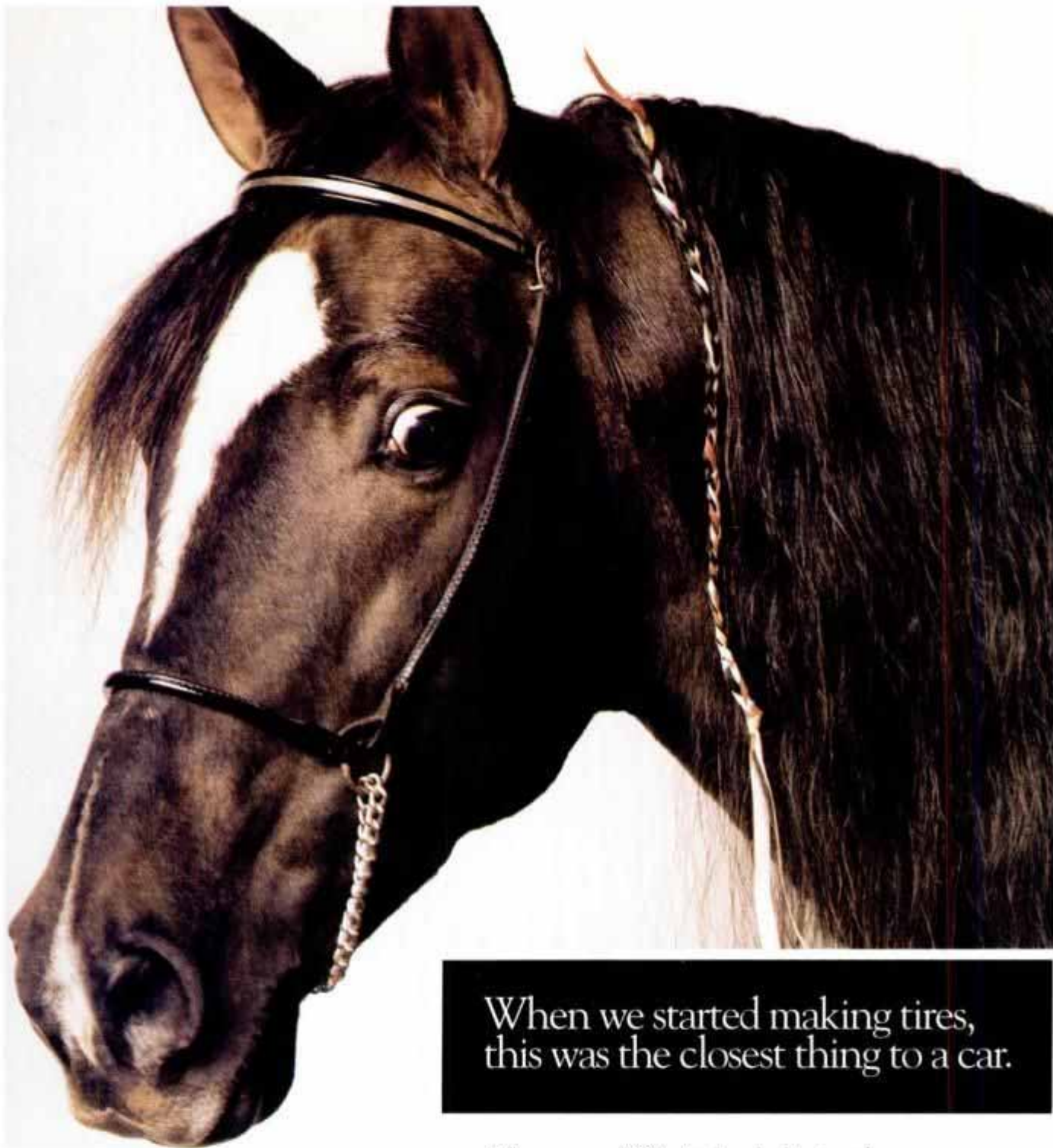
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