

SPECIAL NEW CAR ISSUE

OCTOBER 1993 • \$2.50 PRINTED IN U.S.A.

Popular Mechanics

DETROIT '94

Drive Reports
On Motown's
Hottest Cars

TRACKING THE KILLER ICEBERGS

Another *Titanic* Disaster?
A Deadly Explosion Of
Icebergs Now Threatens
Ships On The High Seas.
Here's How A New
System Of Satellites,
Aircraft And Men
Meets The
Challenge

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New Screen Shape
Brings The Theater
Home

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This One



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OCTOBER 1993
VOLUME 170
NO. 10



39 SPECIAL REPORT

AUTOMOBILES

SPECIAL REPORT: New Cars '94

39 Detroit's New Wave The Big Three are riding a crest of new cars and trucks for 1994. Here's the lineup, plus firsthand drive reports on the Ford Mustang, Cadillac De Ville Concours, Oldsmobile Aurora, Dodge Ram T300 pickup, and more.

50 Engineering The '94s New engines spearhead Detroit's newest technology.

107 Fall Care Care

Parts and accessories for your car.

120 Motorsports

Raul Boesel continues to pace the team.

AVIATION

54 Return Of The Waco The classic YMF-5 brings back flying as it used to be.

COLLECTIBLES

65 The Art Of Knifemaking

Collecting beautiful knives is in. Making your own collectible knife is even more in.

ELECTRONICS

72 Wide TV The television of the future finally comes home, bringing with it a superwide picture.

122 Computers The newest small PCs are packed with more power than ever and many new functions.

126 Electronics Computer accessories, universal remotes, and more.

128 Photography Film's new look.

HOME IMPROVEMENT

80 Home And Shop Journal

- **Home Improvement:** Installing driveway pavers
- **Comparison Test:** Reciprocating saws
- **Home Improvement:** Sink/vanity retrofit
- **Tool Test:** Skil bench grinder

100 Homeowners Clinic Home maintenance Q&A.

104 Appliance Clinic Answers to fix-it questions.

SCIENCE/TECHNOLOGY

23 Tech Update

- Atlanta's drive to break up Olympic-size traffic.
- New airliner engine promises peace and quiet.
- Cameras dangle from balloons to photograph the face of Mars, and much more.

58 Kitchen Of The Future Designers are cooking up a high-tech feast for tomorrow's kitchens.

76 COVER STORY: Tracking Icebergs

One of the worst iceberg seasons on record tests the system of icehunters guarding against disaster.

118 Science Changing space stations.

OUTDOORS

114 Gear You Can Use

From 4x4 ATVs to the ultimate outdoor food preparation center, here's what's hot.

DEPARTMENTS

4 Editor's Notes

10 Letters

16 Time Machine

148 Coming Next Month

EDITOR'S NOTES

● Is it really new-car time again? If this is the October issue, yes it is. Our October issue is a tradition. It has always kicked off our new-car coverage with a rundown on all the fresh iron from Detroit. In December, we've traditionally brought you up to date on all the new imports. Then as scattered introductions take place during the model year, we use our New Cars column to bring you the latest and greatest. This year, it was harder than ever to uphold the tradition. Yes, things are changing, and the new-car issue may become a thing of the past if the auto manufacturers have anything to do with it. Just about every carmaker now brings out cars when they're ready, not arbitrarily in October. Thus, you have the '94 Mustang debuting on Dec. 27 and the '94 Firebird convertible's official introduction in January. With the late introductions, the car companies are very reluctant to give us



I sampled Mustangs at Ford's proving grounds...



...while Berendsohn sampled reciprocating saws in the shop.

any advance information for an October issue, lest they reveal their sales strategy too soon. I can tell you this: We've done our very best to bring you all the information we can, in this issue for domestic manufacturers and in the December issue for the imports. But this may be the last time you see a new-car issue, per se, from POPULAR MECHANICS. So take a look, starting on page 39. . . . When you read our comparison test of reciprocating saws in this issue, think of poor Tom Klenck and Roy Berendsohn, editors in our Home Improvement Department. The brunt of the testing fell to them right in the middle of the hottest days of last summer. Outside, the temperature soared to more than 100°F for more than a week straight. Inside the testing shop, things were even hotter as Klenck and Berendsohn separated the good from the bad and the ugly for their report, which begins on page 85. . . . There were no problems with heat for contributor Michael Dane and photographer Skip Gandy when they headed way north for our cover story on iceberg tracking, beginning on page 76. It's been a bad season for bergs but, thankfully, the U.S. Coast Guard has been up to the challenge. Way to go! . . . Kudos also to Graphics Director Bryan Canniff and Alan Andresen, Tom Kane and Kurt Novak in our Art Department for recently winning two more awards for excellence in magazine design. In the past 10 years, our art directors have garnered more than 60 such awards. Sometimes, the design of our pages, our technical art, our photography is taken for granted. It's all there to make PM a more enjoyable reading experience. It's nice to be recognized by professionals in the art field, but it's even better to be recognized by you, the reader, every time you buy a copy. Thanks. Till next time.


Joe Oldham

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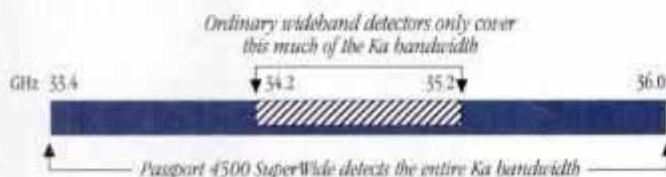
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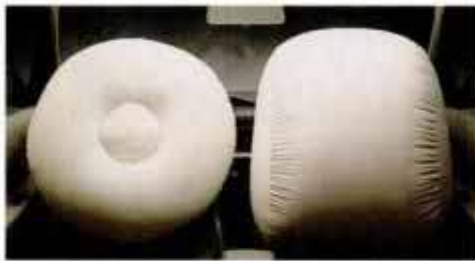
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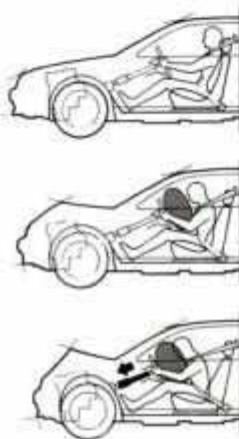
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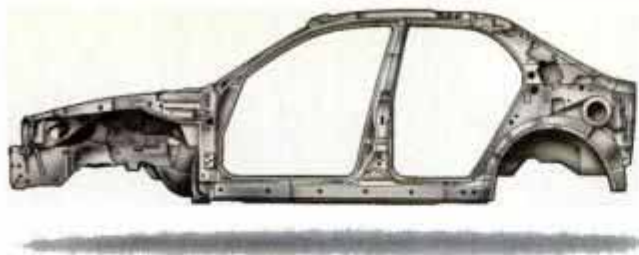
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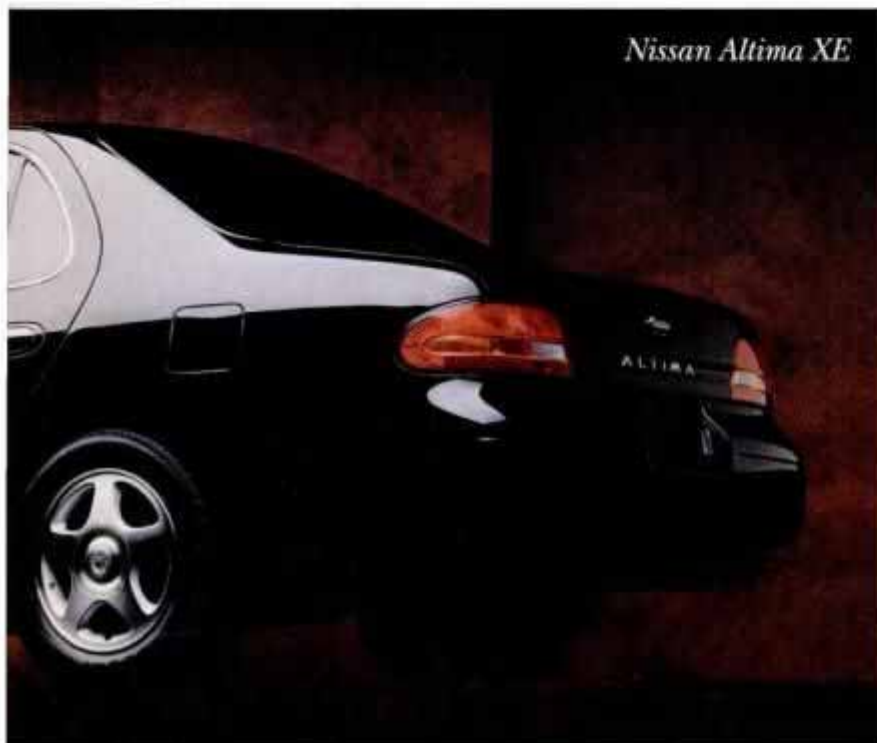




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LETTERS

Ticket To Ride



Great issue! However, I was surprised that being based in New York, you left out the most exciting train ride in the country. I'm talking about the one and only N.Y.C. subway system. Where else can you find death and drama, the smells and sounds of exotic countries, daily confrontations, close contact with your fellow man and the surge of adrenalin for only \$1.25? If not considered one of America's "great" rides, it has to rank as one of the most unique.

DAVID SMITH
HICKSVILLE, NY

I don't ordinarily read my husband's POPULAR MECHANICS, but when his last issue arrived, I couldn't resist. I love trains, but I found the article "Great Trains, Great Rides" very misleading. After 35 years, I finally convinced my husband to ride a train to Florida. The trip down was uneventful, but we were not so lucky on the return. We were removed from the train in Richmond and placed on a 7-hour bus ride to Pittsburgh, where, upon arrival, we waited another 2 hours. Needless to say,

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

my husband was furious. Later that year, I somehow managed to talk him into taking another train trip with me to Arizona. On this occasion, we were only 9 hours late. Fortunately, on the return we were just 4 hours late. In spite of it all, I still love trains and look forward to my next ride. I'm not so sure about my husband.

MRS. A.R. FREDETTE
LIVONIA, MI

Environmentally Correct

I just finished reading the August Letters column and Tom Vullo's concern about using redwood for a table and bench set. Most old-growth timber in the West is presently protected from the logger's saw in various federal setasides and wilderness areas. The chances of a consumer actually buying a conifer old growth are slight. The vast majority of U.S.-produced lumber is second growth, harvested from managed stands.

PAUL MORTENSON
STARKER FORESTS INC.
CORVALLIS, OR

I am writing to cheer you on. Your Tech Update article "Convection Towers

To Rinse Out Urban Smog" really opened my eyes. I am neither a city dweller nor a U.S. resident, but I am still deeply concerned about our environment. It would be terrific if this idea eventually spread to all major cities.

SHAWNA SOPER
CRESTON B.C., CANADA

Man In Blue

Having been directly involved in baseball for more than 35 years, I greatly appreciated Stephen Booth's article "Tools Of Ignorance." However, I must take issue with the expression "the game's toughest position" when referring to the catcher. The game's toughest position is that of the plate umpire. The catcher has two advantages over the umpire. First, the catcher generally knows where the pitched ball is going to be delivered, and second, he has a mitt to protect him. The umpire, however, must stand his ground even if the catcher moves. This makes the umpire a fixed target. Assuming the catcher plays the entire game, he stands behind the plate for 27 outs. The umpire stands behind the plate for 54 outs. Now who

do you think runs a higher risk of being hit?

JAMES JACKSON
COLLIERVILLE, TN

Possible Dreams

I have always been amazed at the foresight of PM editors in the reporting of inventions that once seemed ridiculous and absurd, but are now mainstream items.

CATHERINE GLEASON
BERKLEY, MI

In the '50s, I was a regular reader of PM. Now at 65, you have managed to bring it all back. Your Possible Dreams exhibit really pushed me into another phase of my life, some may call it the "Impossible Dreams" phase.

HARRY WHITE
QUEENSLAND, AUSTRALIA

The exhibit "Possible Dreams: POPULAR MECHANICS And America's Enthusiasm For Technology," will run through Jan. 2, 1994, at the Henry Ford Museum in Dearborn, Michigan. For complete information about museum hours, admission fees, nearby accommodations and attractions, call (800) 343-1929.

Traditional Porch

My wife and I have always longed for a house with a front porch, but relocating seemed a little too drastic. I never considered adding a porch to our house until I read your article. The descriptive text, pictures and well-prepared drawings covered all aspects of the design and construction. This addition has turned our typical subdivision tract house into a traditional home with a lot of character.

BERTRAM KRIEBEL
FALLS CHURCH, VA



Reader Bertram Kriebel displays his porch built from PM plans.

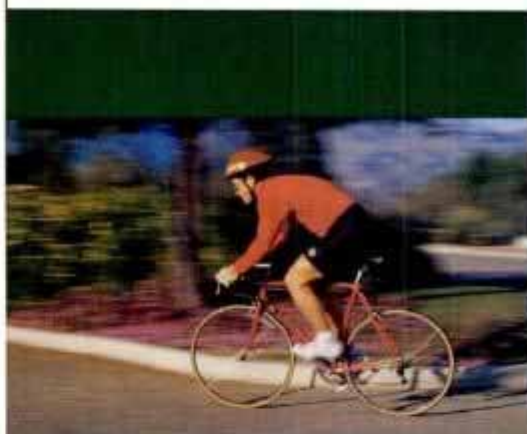
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THE NATIONAL AUTO QUIZ

1. What car manufacturer offered this radiator cap for models that it built in the 1920s?



A) Chrysler. B) Pierce-Arrow. C) Cadillac. D) Packard.

2. Henry Ford produced his first 4-wheeled motorcar in:

A) 1887. B) 1896. C) 1903. D) 1909.

3. What model nameplate from the muscle car era has been reintroduced for 1994?

A) Z0-6 Corvette. B) Shelby Mustang. C) Impala SS. D) Cobra.

4. When the Indianapolis Motor Speedway opened for its first race on August 19, 1909, the track surface was:

A) Concrete. B) Brick. C) Macadam. D) Dirt

5. Synthetic and conventional motor oils should never be mixed.

A) True. B) False.

6. General Motors last used the LaSalle nameplate in:

A) 1934. B) 1937. C) 1940. D) 1955.

7. The nickname for drag racing's greatest legendary driver is:

A) "Big Daddy." B) "The Snake." C) "Mongoose." D) "Dyno."

8. Compared to straight-through mufflers, an important feature of reverse-flow mufflers is that they:

A) Produce more power. B) Reduce emissions. C) Prevent cold air from reaching and damaging hot exhaust valves after the engine is turned off. D) None of the above.

9. The average time it takes a NASCAR pit crew to change four tires and add 22 gallons of fuel is:

A) 18 seconds. B) 38 seconds. C) 90 seconds. D) Three minutes.

10. Valve duration is the number of:

A) Camshaft degrees the valve is closed. B) Crankshaft degrees the valve is closed. C) Camshaft degrees the valve is open. D) Crankshaft degrees the valve is open.

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ANSWERS
1. A 2. B 3. C 4. D 5. B 6. D (two 'LaSalle' ls were created for the 1955 Motorola car show) 7. A (Don Garlits) 8. C 9. A 10. D.

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And get better performance, performance, performance from your car's engine.



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Replace Your Cordless Phone With One That Works




The Escort 9000 Series is the next generation of cordless phones. The first consumer phones to use Digital Spread Spectrum technology (patent pending), they set a new standard for range, clarity and security.


RANGE – the farthest

 With up to four times the range of ordinary cordless phones, Escort's 9000 Series gives you unprecedented freedom and mobility. Just pick up the handset and go – room to room, around the yard – even around the block.

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TIME MACHINE

90 YEARS AGO: OCTOBER 1903



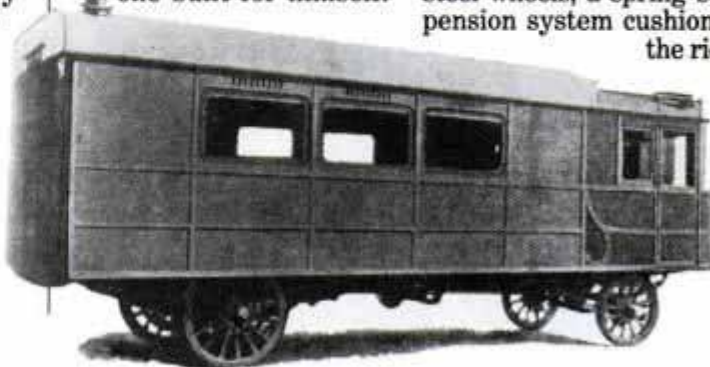
Couch Buggy

The automotive seat of power was threatening to shift from the car to the motor-sofa. The rage of the St. Louis World's Fair, the auto-chair was a battery-powered 2-seater, upholstered in cane, with four wheels and two separate levers for power and steering. Perfect for sightseeing, touted its manufacturers, the vehicle was destined to put bikes and cars out to pasture with the horses.

Wheel House

Meanwhile, the recreational vehicle hit the road—in Bordeaux, France, of all places, where the secretary of an auto club had one built for himself.

Accouterments included hot and cold running water, a gasoline-fired cooking range, icebox and—*bien sur*—a wine closet. Although the 4-ton vehicle ran on steel wheels, a spring suspension system cushioned the ride.



60 YEARS AGO: OCTOBER 1933



Lighter Than Air

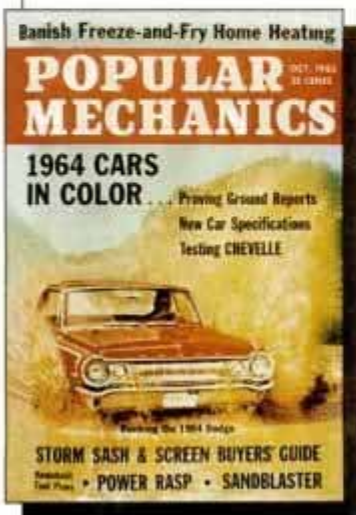
What's the best way to clue student aviators in to the caprices of air currents? Sit them in classrooms and rap out lessons? Put them in planes and let them figure it out for themselves? Or release grotesque balloons, shaped like cartoon birds and cigar-chewing turtles, and allow them to drift in and out of a propeller's backwash? Pilot trainers with the British army air corps chose the animal-balloon method.

Wet Film

Subsea photography was keeping pace with developments in underwater exploration. Moviegoers reeled over the new cinematography, and soon a question was on everyone's lips: If a shark clashed with a giant octopus, who'd win? To quell the debate, a cameraman dove off the Dutch East Indies and lured the two combatants with bait. Inside his glass-and-steel diving bell, he filmed a 20-minute battle. The shark won.



30 YEARS AGO: OCTOBER 1963



Cars '64

After a brief flirtation with petite economy cars, American drivers were returning to full-bodied performers. Even compacts were bigger: The new Chevilles matched '55 Chevys in bumper-to-bumper length. And 200-hp engine options could turn these demure pussycats into tigers. Inside, retro-engineering set the trend: separate frame and body, cast-iron engines, 3-speed gearing coupled to torque converters.

Splendid Splinter

Lockheed's Kelly Johnson whittled the F-104 Starfighter for raw speed and altitude. But by the '60s, the jet had been backburnered to Tactical

rode with a Starfighter jockey, pilots loved this fast, agile but unforgiving needle-nose. Wheeling over the California deserts near George AFB, TAC airmen practiced pinpoint strafing and dive-bombing.



Air Command low-level fighter-bomber duty. Even so, as we learned when we

Perhaps their most hair-raising move was a nuclear-bomb delivery technique that started with a level approach 50 ft. above the sands—at 700 mph. **FM**

December '92

“Test an
Oldsmobile
against a Lexus
and an Acura?
Are you guys
nuts?”



June '93

“Hello, Oldsmobile?
for ever questioning
and ask, if it's not too
please send
me some
information
on the LSS.”



I'd like to apologize
your judgment
much trouble, if you'd





Sure. Don't mention it.

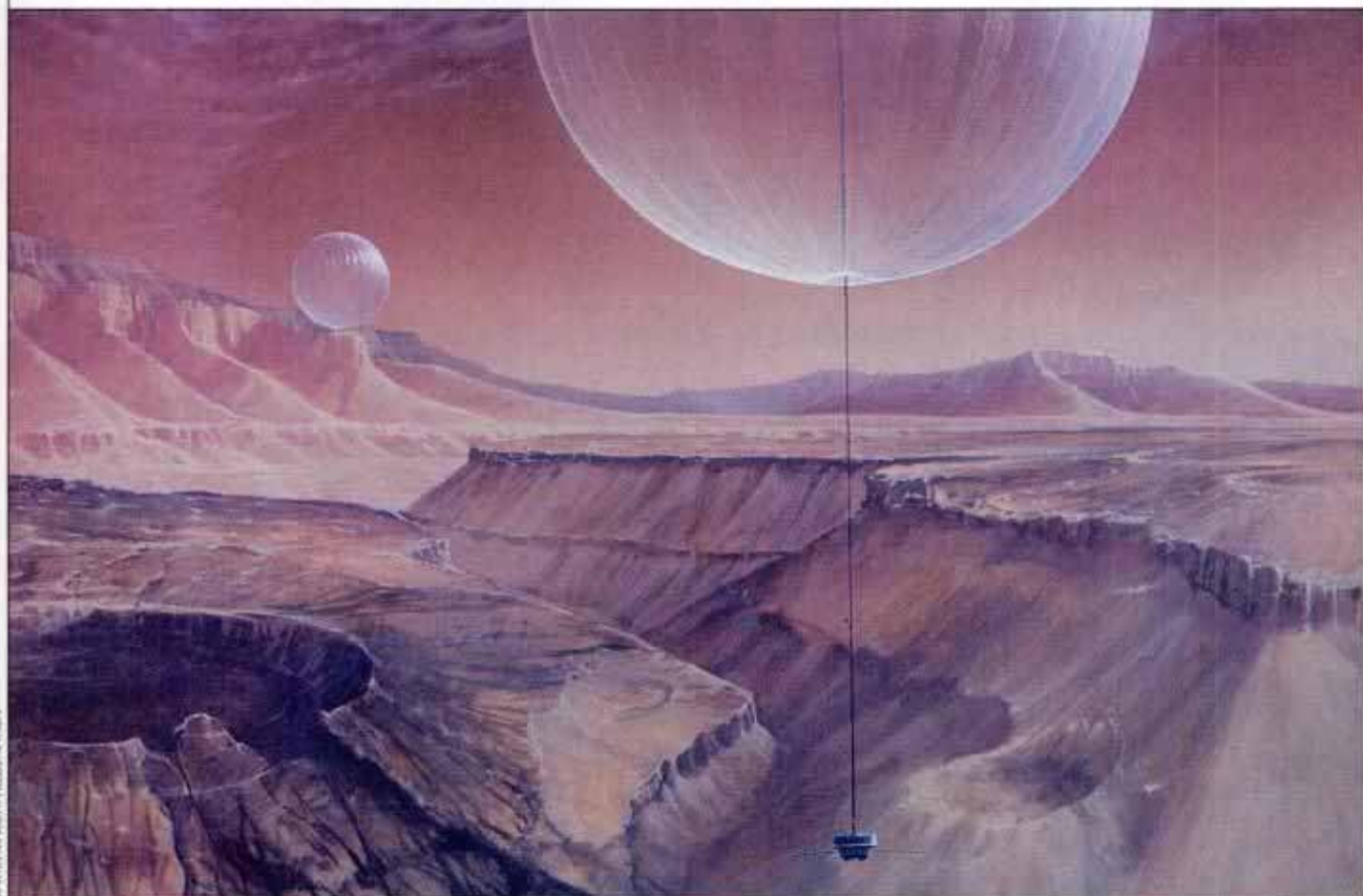
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So well in fact, particularly for a car costing thousands less, that you'll be tempted to disbelieve it—or to buy one. Either way, call 1-800-LSS-1235 or send in the attached reply card. And spend a few minutes on us, deciding how best to spend your money.

Demand Better. Eighty Eight LSS By Oldsmobile 

TECH UPDATE

News Of Tomorrow's Technology Today



MARTIN MARIETTA ILLUSTRATION

The Winds Are The Highways Of Mars

DENVER, CO—What better way to explore Mars than by breezing through its thin atmosphere in a balloon?

That's the thought behind a proposal to launch a flotilla of camera-toting balloons across the red planet. Called Mars Aerial Platform (MAP) by its creators at Martin Marietta Astronautics, the mission would follow up on the *Mars Observer* spacecraft now in orbit.

The balloons would circle Mars at an average altitude of a mere 23,000 ft. The payoff? High-resolution photography—in abundance. While *Mars Observer's* camera can resolve details the size of cars, the MAP cameras could discern cat-size ob-

jects. What's more, the camera could pan up to get horizontal shots of towering martian topography.

To put each photo in context, the high-resolution camera would be bore-sighted with a medium-resolution, wide-angle camera. An 8-balloon fleet could send home 32,000 photos every 100 days.

The balloons themselves would inflate out of capsules scattered from a Delta-launched spacecraft, which would also serve as a data relay.

A smaller balloon fleet—two or four, say—could also

Editor: Abe Dane
Writer: Greg Pope
Reporters: Philip Chien, Mike Fillon,
Charles Fox, Scott Gourley

piggyback on the upcoming Mars Environmental Survey mission, planned for 1996 or 1997.

Dangling from superpressure balloons, cameras photograph the face of Mars from low altitude.

Highlights This Month

- **Peach Jam Crumble**—Atlanta's drive to break up Olympic-size traffic.
- **Turning The Tide**—Japan considers shielding coastline with unique breakwater.
- **Friendly Skies**—New airliner engine promises peace and quiet.
- **Magnetic Pickup**—Electric catapult to launch naval aircraft.
- **Three On A Match**—Detroit rivals may make carbon-copy electric cars.
- **Stealth Bridge**—Aerospace materials cross into civil engineering.



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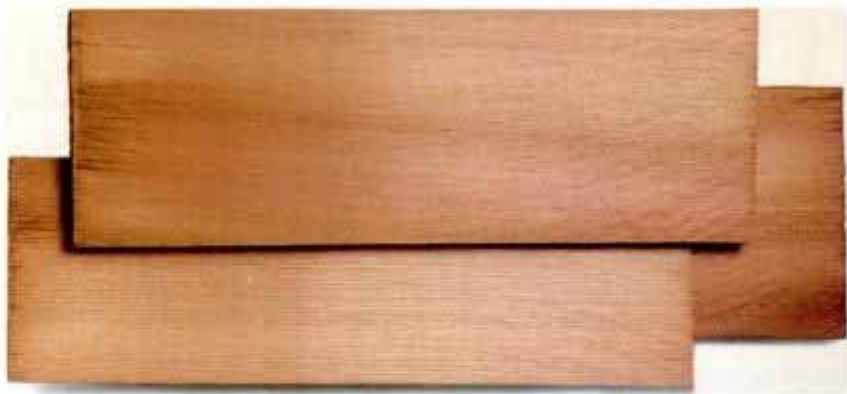


▲ Coming this October, the authoritative guide to home improvement and repairs.

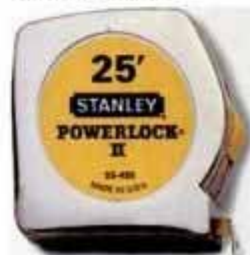
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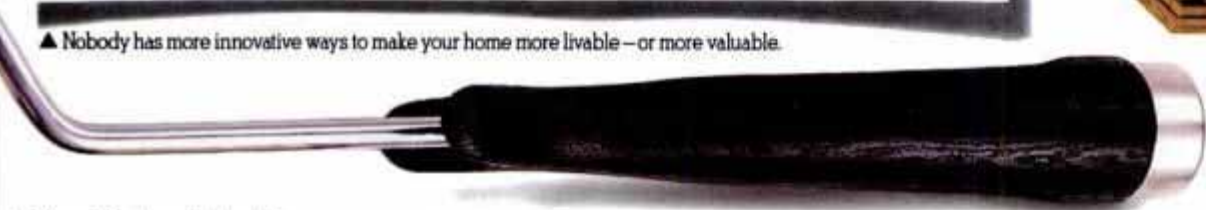
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Imagine thousands of different products, inspired by that same simple definition of quality and you can see the wisdom of asking for Stanley by name.

After all, it's not just a house. It's your home. And if you want to make it better, start with better tools.





Traffic Management Center will coordinate data flow among local traffic-control centers.

sible for the freeways.

The control centers will take in video feed from roadside cameras and traffic sensors buried under the pavement. They'll then dictate the timing of traffic lights and coordinate with public services such as police and ambulance vehicles.

Meanwhile, the TMC will soak up data from these control centers and manage the big picture. Among other things, it'll divert jammed freeway traffic onto local roads, supervise high-speed police chases across jurisdictions and clear routes for VIP visitors.

This effort will put in place the infrastructure for a full-fledged intelligent vehicle-highway system.

Atlanta's Street Smarts

ATLANTA, GA—Planning to attend the Olympics in 1996? Plan on Olympic-scale traffic. To prepare for the onslaught, the Georgia De-

partment of Transportation is installing the most intelligent road network in the country. TRW leads the team that's designing the system.

The Atlanta Regional Advanced Transportation Management System will tie together local traffic-control centers with a new state-run Transportation Management Center (TMC) respon-

Automated Army Ants

BLACKSBURG, VA—The hot topic in robotics right now is inter-robot coordination (see *Science*, page 88, Aug. '93). While computer scientists work out communications protocols, the hardware people are already building prototypes of cooperating, teaming robots.

At Virginia Tech, for example, engineers are developing army-ant robots—small tracked machines that would swarm to lift and move heavy payloads.

Each of these robots would dig under its share of the load with a pneumatic lift device and carry it with a Lazy-Susan platform. A

force sensor would lie where the platform contacts the load. This device would allow a robot to monitor the behavior of its brethren by sensing the changes in load force as other robots joined the lifting effort.

A lead robot could synchronize the lifting and align the workers along a common axis of travel through the use of radio or ultrasound signals.

Army-ant robots would cooperate to lift and transport heavy loads.



Four cables run from Skycrane to a lifting ring in the statue's base.

struggle. The 19-ft. statue weighs more than 7 tons and can only be lifted from its base.

The solution came from structural engineers Cagley & Associates: a jacking mechanism of steel tubes pressing upward from within the hollow statue. Once the statue was elevated 16 in., engineers could weld a steel lifting ring into its base.

A Sikorsky S-64F Skycrane then hooked the ring with cables and plucked Freedom from the dome.

Restorers waterjetted, repaired and recoated the aging statue.

Bath Of Freedom

WASHINGTON, D.C.—Sept. 18 marked the bicentennial of the U.S. Capitol's cornerstone-laying. The occasion demanded a facelift for the 130-year-old Statue of Freedom, which occupies D.C.'s loftiest perch.

Bringing Freedom down to Earth, however, proved a



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Japan's Open Seawall

TOKYO, JAPAN—The Japanese go through fish the way Americans go through burgers, and they tend to deplete their coastal waters of aquatic life. Their coastlines also suffer from severe erosion and get socked from time to time with tidal waves.

But a single technology could solve both problems—an offshore, reeflike breakwater with an open-faced skeletal structure.

Known as an OES Truss, the structure consists of a 3-dimensional web of open-faced pyramids. These units, made of concrete poles, snap together like Tinkertoys and can be replaced easily as the pounding surf wears them down.

Hugging the poles would



be a network of flexible circular brims that have shown outstanding wave-absorbing qualities in tests. An OES Truss breakwater would thus create a quiet zone near the shore.

Because the space within the structure is left open, however, light and oxygen can penetrate and encourage the growth of seaweed and plankton—key links in a food chain that attracts fish.

Open-skeleton breakwater protects shore and sows the seeds of aquaculture.

A Japanese consortium, led by Yamaha Motor Co., is developing the technology for fisheries.

Fail-Safe Fission, Free Fuel

IDAHO FALLS, ID—A new breed of breeder reactor could put the glow back in the nuclear-power industry. Called the Integral Fast Reactor (IFR), the plant has been under development for years (see Tech Update, page 22, Nov. '89).

The IFR has two advantages. It self-cools passively

in an emergency, avoiding meltdown, and it reuses much of its own waste.

Now two machines that drive the IFR fuel cycle have begun testing. One is the electrorefiner, which extracts reusable transuranics from spent fuel elements. The other is the cathode processor, which molds ingots of new fuel.

In addition, a small-scale prototype is testing whether the IFR can burn long-lived nuclear waste from dismantled warheads.



Electrorefiner (left) extracts transuranics, used to make ingot (above) for new fuel.



Turbofancy Airliner Engine

MOUNTAIN VIEW, CA—A turbofan engine with swiveling fan blades is going through wind-tunnel tests at NASA's Ames Research Center. The purpose: to see if the engine lives up to claims that it would muffle jet noise and trim fuel consumption by 10%.

Pratt & Whitney built the Advanced Ducted Propulsor (ADP) from a PW2000 turbofan, normally found on Boeing 757s. The ADP engine has variable-pitch fan blades that swing around backward

to slow the plane down.

The ADP also boasts a bypass ratio more than double that of a conventional turbofan. Fifteen times as much air moves through the fan as through the core. The jet's turbine connects to the fan via a gearbox, which permits lower fan speeds and hence less noise.

Pratt & Whitney may launch a production ADP by the end of this year.

New turbofan promises less noise and greater fuel efficiency for commercial airliners.

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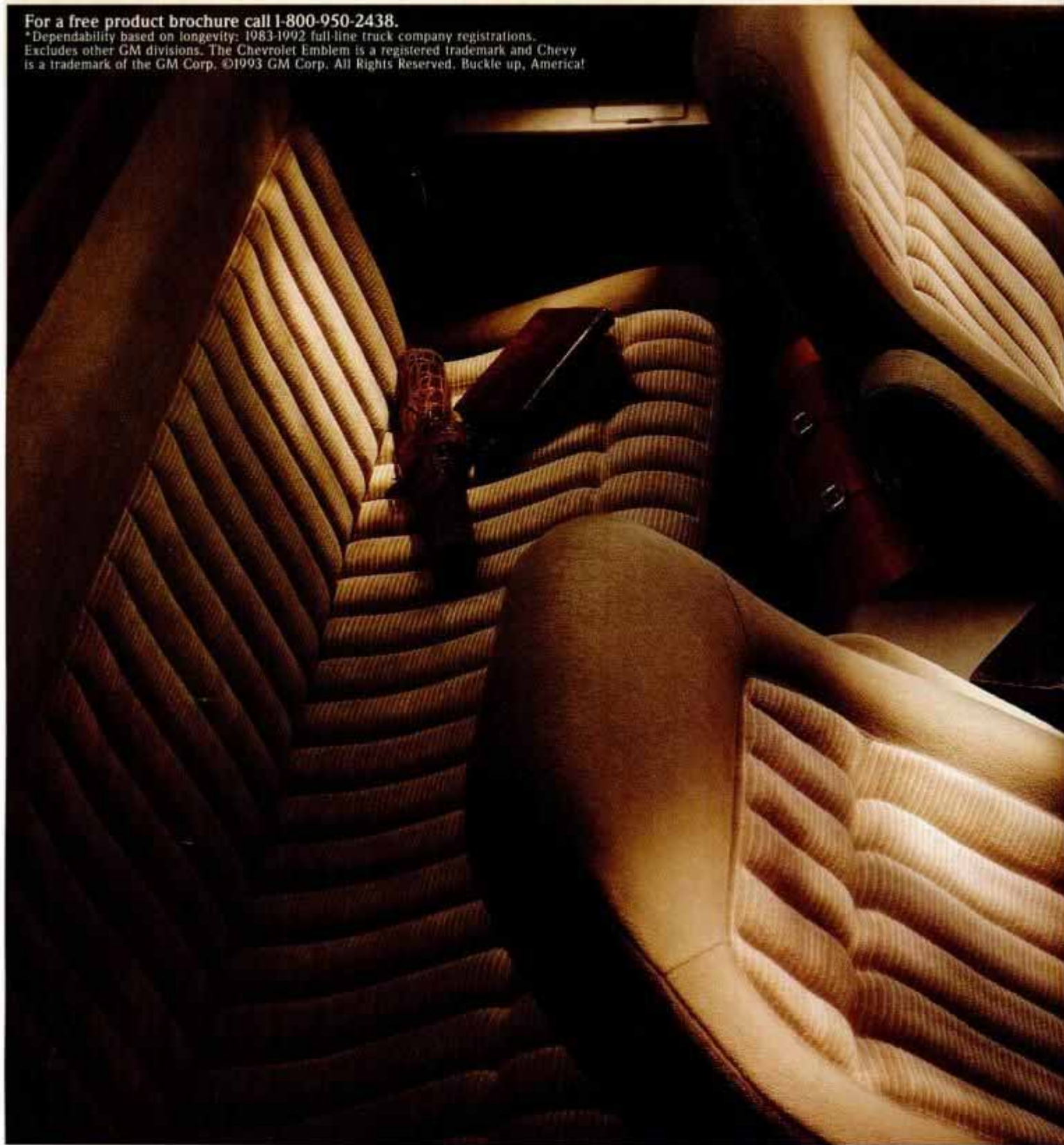


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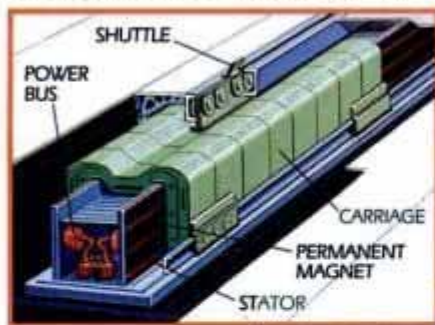
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Chevy Trucks
LIKE A ROCK



Magnetic Cat Shot



HUDSON, MA—The clunky steam catapult that slings Navy jets from a carrier deck may become a thing of the past if a new electromagnetic launch system pans out.

The device, under development at EML Research Inc., is essentially a giant brushless DC linear motor. It consists of a wheeled carriage, lined with permanent magnets, on top of which rides a shuttle that engages the aircraft nose-gear. The carriage rides a magnetic wave that shoots along a stator when jolted with electricity.

Improved rare-earth magnets are what make such a muscular system, capable of boosting a 100,000-



Electromagnetic catapult system minimizes on-deck equipment.

pound aircraft to 140 knots, more than just a pipe dream. By contrast, steam-driven catapults operate at their peak in launching today's F-14 Tomcats, which weigh nearly 80,000 pounds when fully loaded.

The electromagnetic launcher wouldn't draw power from a carrier's nuclear reactor but would run off its own generator. More important, the electrical

power fed to the stator would be precisely tailored for the aircraft's weight and wind conditions. That should extend the life of naval aircraft, which steam catapults often hammer unnecessarily off the deck.

If current component tests are successful, a small prototype will undergo land-based tests in 1995.

Parked In The Dark

LARAMIE, WY—An ideal spot for an infrared telescope? The dark side of the Moon. Pointed away from the Sun and Earth, such a probe wouldn't need to bathe its cameras in liquid helium to keep them cool.

So says an international group of scientists proposing *Edison*, an infrared facility for the European Space Agency. *Edison* would occupy the gravitationally stable Lagrange 2 point.

Because *Edison* wouldn't use short-lived liquid helium, its instruments could run for 10 years or more.



Parked a million miles from Earth, *Edison* could stay cool and gaze into space for years.

Big Three May Throw In Together On Electric Cars

DETROIT, MI—Just as American automakers were bouncing back, along comes a mandate for EVs, or electric vehicles. It's a demand sparked by California's law dictating that in 1998, one in every 20 cars sold there must be electric.

Tooling up individually to meet this demand could be another economic bonecrusher for the Big Three. So Ford, General Motors and Chrysler are considering the unprecedented step of producing a single EV for all three to sell. And even if they go their separate ways, the companies

could wind up using the same battery, motor, controller, drivetrain, steering gear and air conditioner.

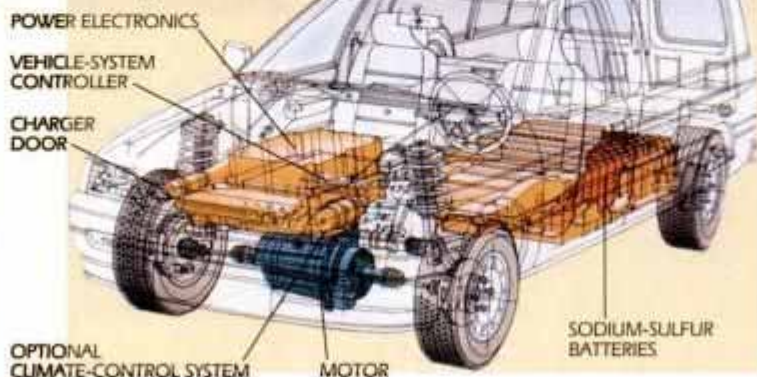
What's driving Detroit to EV collaboration? According to the head

of GM's Technical Center, the cost of producing an EV may run seven times as high as the cost of pro-

ducing a conventional car.

The biggest roadblock is the battery. Lead-acid batteries poop out after a limited range, and the more promising technologies also promise more expense.

But facing the 1998 deadline, the carmakers are plugging away with the most mature battery technologies available. Ford, for example, is preparing a fleet of European Escort vans powered by peppy sodium-sulfur batteries, which date back to the '60s. Since both materials are hazardous, and the battery runs hotter than 600° F, a crashproof outer shell is a key research focus.



Ford's electric Escort van, dubbed Ecostar, will roam about 100 miles.

I JUST BOUGHT THESE GREAT
SOUNDING SURROUND-SOUND
SPEAKERS.

THESE ARE THE SATELLITES,
THAT'S THE SUBWOOFER...
AND *THAT'S MY*
KNOW-IT-ALL BROTHER-IN-LAW.

HE THINKS I WENT TO SOME
EXPENSIVE AUDIO STORE.
HE THINKS I PAID TOO MUCH.

SHOULD I TELL HIM ABOUT
THE GREAT DEAL I GOT?

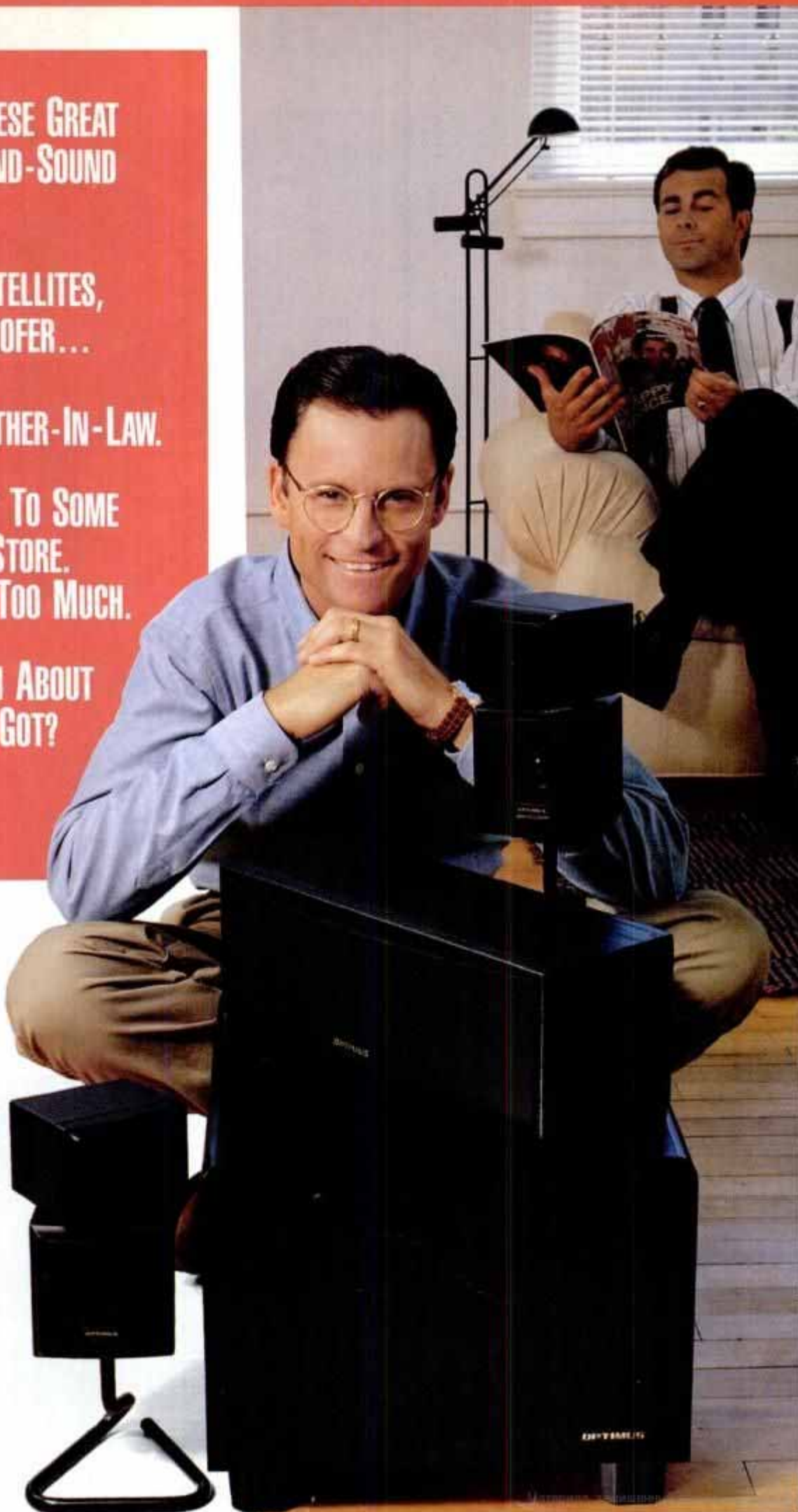
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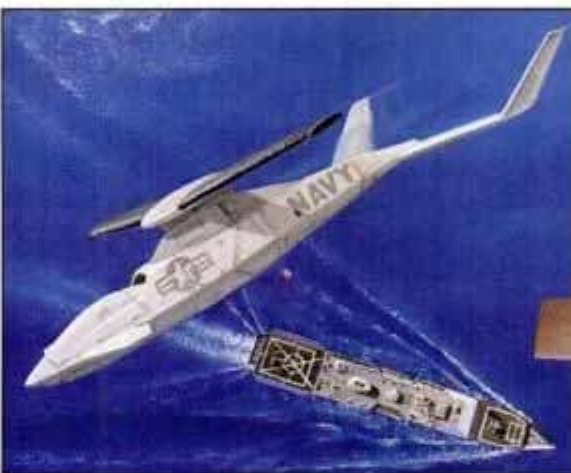


Rotor-Stopper Robo-Chopper

MESA, AZ—What the Pentagon wants in an unmanned air vehicle is a machine that could lift off and land in a confined area, such as a warship's deck. McDonnell Douglas thinks its canard rotor/wing concept (see Tech Update, page 26, Oct. '92) would work nicely.

In theory, the vehicle takes off on a 2-blade rotor, which spins as exhaust from a turbojet engine blows from blade-tip nozzles. Once in the air, it noses forward like a helicopter until it reaches a conversion speed between 120 and 150 miles per hour.

The rotor then stops and locks into fixed-wing mode. The turbofan exhaust is redirected to supply conventional jet thrust. Forward



Canard rotor/wing 75%-scale model (right) undergoes testing in NASA-Langley's wind tunnel.

canards, stopped rotor and tail surfaces take over responsibility for lift.

The vehicle could dash forward at 375 knots or revert to rotorcraft mode and loiter in the air for 3 hours. The 16-ft.-long

machine would weigh roughly 1600 pounds and could carry a 200-pound payload.

A full-scale demonstrator, now under construction, is scheduled

to fly—in rotorcraft mode—next June.



MCDONNELL DOUGLAS PHOTO AND ILLUSTRATION

Crossover Materials

SAN DIEGO, CA—The world's first vehicular-traffic bridge built from composite materials is being designed for Interstate 5, where the freeway crosses the University of California campus.

Two universities and a handful of chemical, engineering and defense companies have joined forces to blueprint the 450-ft. cable-stayed bridge.

Composite materials boast many advantages over steel and concrete for bridge construction. For one thing, glass, plastic and carbon re-

sist corrosion. For another, composite bridges can be made from prefabricated segments, making unnecessary the lengthy cast-in-place process. And because composites are far lighter than conventional materials, bridge construction can proceed more rapidly.

The consortium is hoping to win money from federal defense-technology redirection efforts to complete construction of the bridge. **TU**

San Diego bridge will feature materials derived from aerospace composites.



UNIVERSITY OF CALIFORNIA PHOTO



Fluid-cooled garment lowers body temp, relieving symptoms of multiple-sclerosis.

NASA's Ames Research Center for moonwalking astronauts and jungle-flying helicopter pilots.

The application of the cool suit as a multiple-sclerosis therapy surfaced after patients reported that cold-water immersion relieved symptoms such as paralysis. A drop in body temperature, rather than exposure to cold, proved to be the salutary factor. The garment also helps these patients throw off the heat that builds during their exercise therapy.

Other medical applications are emerging.

Medical Cool Suit

MOUNTAIN VIEW, CA—Multiple-sclerosis patients can achieve a marked improvement in quality of life, thanks to a technology with roots in the Apollo Moon program.

The device, made by Life Support Systems, is a garment veined with tubes through which an icepack-cooled water/alcohol solution circulates. This personal cooling system originated at

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A FORD LATELY?

Why We Race

POPULAR MECHANICS
DETROIT '94

AUTOMOBILES

Popular
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OCTOBER 1993



FORD MUSTANG GT

DETROIT'S NEW WAVE

The Big Three are riding a crest of new cars and trucks.

BY JIM DUNNE, Detroit Editor; PM Photos by G Photo

● A leaner, stronger Detroit is poised to launch its new models this year. And that's a change. Fueled by aggressive domestic pricing strategies and a favorable relationship (for U.S. manufacturers) between the dollar and the Japanese yen, America's Big Three automakers are riding a mini-boom in car and truck sales for the first time in several years. So, beyond the traditional optimism you see and hear at new-car previews, the marketing people at Chrysler, Ford and General Motors believe the recent sales surge proves American products can match the competition from overseas in quality, performance, content and, most important, price.

Their confidence seems justified. Older models are selling surprisingly well. And sales prospects for Detroit's new 1994 models, which offer a wide variety

of major improvements, look particularly bright.

In fact, each of Detroit's major players has potential home runs in its 1994 lineup. Here's the pregame rundown.

Ford Motor Co.

The Mustang will celebrate its 30th birthday in 1994. So it's fitting that Ford has a new design ready to roll out for its ponycar faithful. A completely redesigned Mustang will be ready for sale at the end of this year, available as both a coupe and a convertible.

One look at Mustang's exterior tells a big part of the '94 story. Under the all-new sheetmetal, the Mustang's chassis is basically the same, though there have been dozens of refinements, including a much-improved braking system. Ford's designers wanted to give the

POPULAR MECHANICS
DETROIT '94

Mustang a contemporary look, but also wanted to hold on to some of the car's older styling cues. Carried over are the slightly rounded roof profile, the quarter panel scoops and the galloping Mustang in the grille. That takes care of visual ties to previous generations.

Under the hood, Ford will continue to offer the 5.0-liter V8 as the Mustang's performance option. The



MERCURY COUGAR XR7



LINCOLN CONTINENTAL

5.0-liter engine has been a prime feature in the Mustang for many years, and Ford has developed a broad range of power-enhancing goodies for it. Ford's new dohc 32-valve version of the 4.6-liter modular V8 engine—the standard powerplant for the new Lincoln Mark VIII, with a robust 280 horsepower on tap—will

eventually become a Mustang performance option, but not for another year or so.

The tried-and-true 5.0-liter delivers 215 hp and 285 ft.-lb. of torque to the rear wheels through a new electronically controlled 4-speed automatic transmission (optional) or the standard 5-speed manual. The Mus-

tang has gained about 100 pounds in the redesign, so performance numbers will probably be about the same as in '93.

However, look for the entry-level Mustang to be considerably peppier than before. A 145-hp V6 with 215 ft.-lb. of torque will be the new base engine, replacing the old 2.4-liter Four. Besides offering much better performance, the V6 mated to a 5-speed manual transmission is also rated at 38 mpg on the EPA highway fuel-economy cycle.

The new Mustang's body dimensions are slightly larger than the previous car. It gains about 2 in. in overall length at 181.5 in., while the wheelbase is almost an inch longer at 101.3 in. The biggest dimensional change is in the front/rear track—60.4/59.5 in. for '94 versus 56.6/57.0 for '93. The wider stance contributes to better handling at high speed, as well as improved straight-line stability. New optional 17-in. alloy wheels should help handling, too. And, like GM's new Chevy Camaro and Pontiac Firebird, the suspension tuning will be aimed at providing driver and passengers with a more civilized blend of ride and handling.

On the safety front, the Mustang will have dual airbags as standard equipment. Antilock brakes are optional on both the basic Mustang and the GT edition.

Other Ford vehicle lines emphasize safety this year. Passive restraints—either driver's or dual airbags—have been installed in almost every line as standard equipment. That includes the captive import Mercury Capri, the Mercury Villager minivan, members of the F-series pickup line and the Bronco full-size sport/utility. In addition, side-impact-protection door beams have been added to the Ranger compact pickup, the full-size Econoline and Club Wagon vans, the F-series trucks and the Bronco.

On the environmental front, Ford, like most manufacturers, is almost across-the-board with non-CFC air-conditioning systems. The new sys-



DRIVE REPORT

FORD MUSTANG

● If you've ever driven a 1979-'93 Mustang, the '94 will be an astonishing experience. Yes, the old Mustang was a fun car. But the body flopped around and twisted and shook and squeaked. Now all that is gone. Instead, you get the feeling you're driving a small bank safe on wheels.

The new Mustang is solid, quiet, stable and thoroughly locked to the road. Ford engineers focused on making the new car's body structure very rigid. From that rigidity comes a quiet cabin, great ride and handling and precision steering. So the new Mustang is still fun to drive, but now there's a new dimension of stability that was previously missing. The same can be said for brakes, which weren't the strongest part of the previous Mustang's performance.

The newly available 3.8-liter V6 makes the standard coupe and convert-

ible much more lively than the old 4-cylinder base car, but true Mustang enthusiasts will still look to the GT coupe and convertible powered by old pal 5.0-liter V8 rated at 215 hp. It's still there under the hood, and it still kicks butt whenever your right foot is so inclined. And there's still no American muscle car that gets better rubber in Second gear.

—Joe Oldham

SPECIFICATIONS

Layout	Front-engine, rear-drive
Body style	Coupe, convertible
Engines	145-hp ohv 3.8-liter V6 215-hp ohv 5.0-liter V8
Transmissions	5M, 4A
Wheelbase	101.3 in.
Track, f/r	60.4/59.5 in.
Length	181.5 in.
Width	71.8 in.
Height, cpe./conv.	52.9 in./52.8 in.
Curb weight, cpe./conv.	3055 lb./3193 lb.
Brakes, f/r	Disc/disc ABS (opt.)

tems are present in all Ford cars and almost all 1994 light-duty Ford trucks.

Modest facelifts are styling highlights in the 1994 Thunderbird and Mercury Cougar. Both cars sport new front-end motifs that include bumpers, grilles and associated trim. Inside, Cougar and Thunderbird have new instrument panels that house dual airbags.

Ford's 4.6-liter modular V8 engine replaces the 5.0-liter V8 as a performance upgrade in the two coupes.



FORD RANGER SPLASH

MERCURY CAPRI XR2



A 4-speed automatic transmission is standard with all engines, including the base 3.8-liter V6 and the 3.8-liter supercharged V6, which powers the Thunderbird Super Coupe.

Displayed at the New York Auto Show as a 1994 model, the Lincoln Continental carries new grillwork and minor exterior trim changes into the new year.

Two other all-new cars—the Ford Contour and Mercury Mystique—are also scheduled for introduction early next year. Slightly larger than the current Ford Tempo and Mer-

cury Topaz, the new compacts will be based on Ford's new European best seller, the Mondeo.

Festiva, Ford's captive import subcompact from Korean manufacturer Kia, has been dropped, but a slightly larger replacement—the Aspire—will be introduced shortly after the first of the year.

General Motors

A blend of old and new vehicles is rapidly restoring vitality to America's anemic automotive giant. Older models, like Chevy Cavalier and

Oldsmobile Ciera, have paced the resurgence, while recent redesigns like the Chevy Camaro and Pontiac Firebird are expected to post huge sales increases in the heart of the muscle-car market. Optimistic GM leaders say the added sales from new '94 models, plus GM's emphasis on competitive pricing, should put the General in its strongest market position in years.

Cadillac

Cadillac has revised the De Ville lineup with two new models, the Sedan De Ville and De Ville Concours. Take a close look at these two cars. The styling is new from bumper to bumper, even though the cars look a lot like the '93s.

The Sedan De Ville is Cadillac's mainline 6-passenger sedan, while the De Ville Concours, a new nameplate for the line, is an upscale version. The Coupe De Ville, one of Cadillac's grand old standards, has disappeared from the lineup.

The two new sedans share most

DRIVE REPORT

FORD THUNDERBIRD

● For some time now, T-Birds have been the embodiment of the Gentlemen's Express. That means big, comfortable and—at the same time—athletic and competent.

The new interior manages to be much more ergonomically effective, control-placement-wise, but at the expense of looking like the bridge of the Starship Enterprise.

Best thing, however, is the transplant of the 4.6-liter sohc V8 from the Crown Vic. The base V6 is adequate, and the supercharged version is downright quick—but neither is exactly smooth. The



V8 is quick—especially at lower revs—and very smooth indeed, much more in keeping with the character of the rest of the car.

The 4.6-liter has slightly less torque and horsepower than the 5.0-liter pushrod engine it replaces—but not noticeably less (190 hp versus 200 hp). Its

top-end breathing is much better, as the sohc engine seems eager to wind up right to the fuel cutoff point.

—Mike Allen

SPECIFICATIONS

Layout	Front-engine, rear-drive
Body style	Coupe
Engines	140-hp ohv 3.8-liter V6 190-hp sohc 4.6-liter V8 210-hp ohv 3.8-liter supercharged V6
Transmission	4A
Wheelbase	113.0 in.
Track, f/r	61.6/60.2 in.
Length	200.3 in.
Width	72.7 in.
Height	52.5 in.
Curb weight	3570 lb.
Brakes, f/r	Disc/drum, disc/disc ABS



POPULAR MECHANICS
DETROIT '94



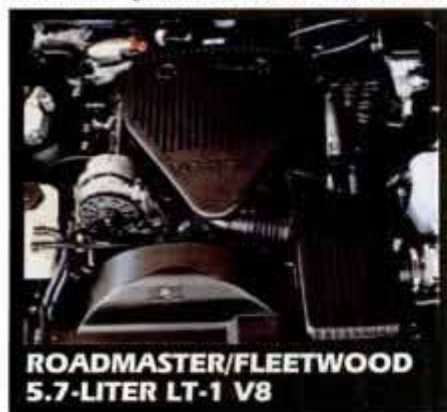
**CADILLAC
SEDAN De VILLE**



**CADILLAC De VILLE
CONCOURS**

exterior sheetmetal and interior features, and are both substantially bigger than the previous Sedan De Ville. The wheelbase is 3 in. longer at 113.8 in., and overall length—measuring 209.7 in.—has been increased by just over a foot.

Concours (the s is silent) has Cadillac's 4.6-liter dohc 32-valve Northstar V8 engine, tuned for 270 horsepower in this application. This is the major distinction from the



**ROADMASTER/FLEETWOOD
5.7-LITER LT-1 V8**

Sedan De Ville. The latter continues to offer the same 200-horsepower 4.9-liter pushrod V8 engine as the previous model. Both Sedan De Ville and De Ville Concours have speed-sensitive power steering and computer-controlled smart suspension systems, and both are equipped with dual airbags.

A major improvement in Cadillac's big Fleetwood series is the addition of the 5.7-liter LT-1 V8 engine, delivering 260 hp and 335 ft.-lb. of torque. Teamed with GM's latest 4-speed automatic, the engine is expected to deliver 0-to-60 acceleration in the mid-8-second range. That's pretty frisky getaway for a sedan stretching close to 19 ft. and weighing almost 4500 pounds.

Cadillac has also made two minor name changes. The base Seville is now called the Seville Luxury Sedan, and the Eldorado Touring Coupe is the Eldorado ETC.



DRIVE REPORT

CADILLAC De VILLE CONCOURS

● The power, performance and handling of the lithe Seville STS. The luxury and roominess of the huge Fleetwood. That's the promise of Cadillac's new De Ville-based Concours, and it delivers. Well, pretty much. The Concours carries the 270-hp version of the Northstar engine and a slightly softer suspension setup, so it's not quite up to Seville in overall performance and handling. And the De Ville, while a very roomy package, is no Fleetwood in size.

The end result, though, is still a big, roomy, fast (Cadillac forecasts 0 to 60 in 8.2 seconds) car with excellent handling that will suck up and spit out interstate with aplomb. And all the while, it will coddle you with leather appointments, Cadillac's trademark Zebrano wood trim and a killer stereo system—11 amplifiers totaling 160 watts driving 11 speakers—which will make you forget all the rave

reviews you've heard about European luxury performance sedans. This is American luxury performance.

The Concours is a thoroughly American road car in the finest sense of the term. It's big, fast, comfortable and stable. We'll leave the styling critique up to you.

—Joe Oldham

SPECIFICATIONS

Layout	Front-engine, front-drive
Body style	Sedan
Engine	270-hp dohc 32V 4.6-liter V8
Transmission	4A
Wheelbase	113.8 in.
Track, f/r	60.9/60.9 in.
Length	209.7 in.
Width	76.6 in.
Height	56.0 in.
Curb weight	3984 lb.
Brakes, f/r	Disc/disc ABS

Chevrolet

The biggest news at Chevy this year is the division's popular compact pickup truck, the S-Series—a redesign of the S-10. Although most exterior dimensions of the redesigned

trucks are nearly identical to the previous S-10, the cabs are more spacious, with 3 in. of additional shoulder-room and almost an inch more hip- and headroom.

Wheelbases range from 108.3 in. to



CHEVROLET BERETTA Z26



GMC SONOMA PICKUP



DRIVE REPORT

CHEVROLET S-10 PICKUP

● Like most redesigns, the new S-10 pickup doesn't represent a totally fresh sheet of paper. But it would be easy to believe it does. This truck has quantum improvements in ride, handling, noise and vibration over the old. Chassis stiffness is up 40%, allowing the use of springs and bushings that can control unwanted ride motions because the frame won't flex first. And the added structural integrity wards off squeaks and rattles.

The aerodynamic bodywork and flush glass help keep interior noise down to a new low. And somehow, the interior seems much larger than the 3/4 in. of extra hiproom would lead you to believe.

The standard 2.2-liter Four is new as well, and more than adequate to the tasks of general running around. Plenty of midrange torque makes for strong acceleration and less gear changing. But there are also two versions of GM's 4.3-

liter V6 available, depending on the job. The 195-hp version, with 260 ft.-lb. of torque, puts the Chevy S-10 on a competitive footing with the Dodge Dakota V8 when it comes to powering a 4wd system or towing a full-size load.

—Mike Allen

SPECIFICATIONS

Layout	Front-engine, rear-drive
Body style	Regular cab/standard box
Engines	118-hp ohv 2.2-liter I4 195-hp ohv 4.3-liter V6
Transmission	5M
Wheelbase	108.3 in.
Track, f/r	54.5/54.6 in.
Length	188.8 in.
Width	67.9 in.
Height	63.0 in.
Curb weight	6000 lb.
Brakes, f/r	Disc/drum rear ABS

117.9 to 122.9 in., while cargo boxes are 71.7 in. (standard) and 87.6 in. long. The S-10—along with its GMC Truck twin, the Sonoma—is built in five different versions, including 2- and 4-wheel-drive options, standard cab and extended cab, with two cargo cab bed length options available in the standard cab editions.

Three engines are available. The new base engine is a 2.2-liter Four that puts out 118 hp. Optional upgrades include two variations on GM's corporate 4.3-liter pushrod V6, one rated at 165 hp, the other—GM calls it the "enhanced" V6—rated at 195 hp. Transmission choices are a 5-

speed manual or a 4-speed automatic.

A couple of sport pickups are offered for the first time in this compact series, the Super Sport (2wd) and ZR2 (4wd). The sport trucks are distin-

guished by heavy-duty suspension packages, more aggressive axle ratios and special trim packages, and a choice of one of the two V6 engines. In addition, the ZR2 package features taller (by 3 in.) ride height, wider (by 4 in.) track, skid plates, fender flares, a heavy-duty rear axle, 46mm Bilstein shocks and 31x10.5R15 off-road tires. This one is clearly designed to keep going when the pavement ends.

Chevy's Lumina minivan, along with the Pontiac Trans Sport and Oldsmobile Silhouette, will have a somewhat more snub-nosed look for '94. The designers lopped 2.7 in. off the front to modify the often-criticized "Dust-Buster" look. Changes to the front end include a new bumper, hood and grille.

Inside, the Lumina gets instrument panel changes and a driver's airbag—plus what Chevy calls a "layering" of the upper panel cover to cut down on its apparent expanse, a function of the steeply raked windshield.

You can order two built-in child seats in the Lumina this year. In addition, the two rows of rear seats can be folded upward and forward—as well as easily clicked out—to make room for extra cargo storage. General Motors has also gotten its power-operated side door ready for production this year on the Lumina, Trans Sport and Silhouette. The optional system can be operated from the driver's seat or by a signal from



CHEVROLET C/K PICKUP



CHEVROLET CORVETTE
ZR-1 COUPE



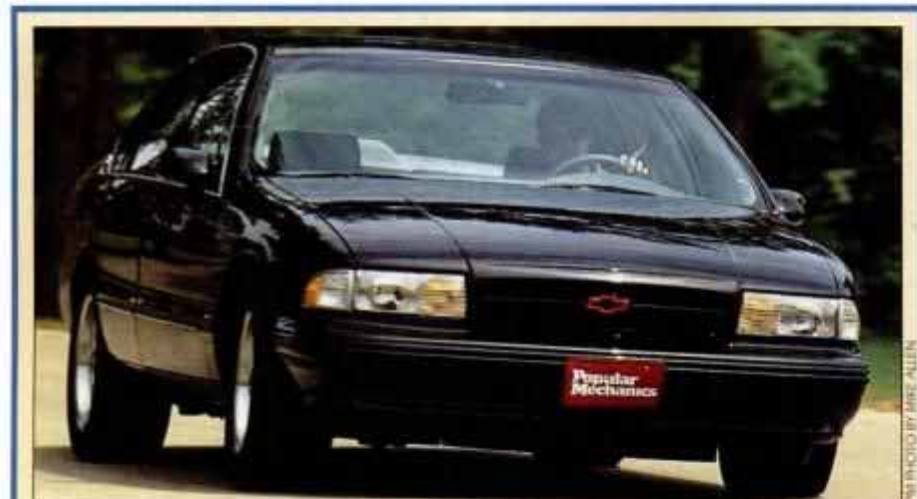
a remote, carry-along fob.

GM had expected to make this system available during the '93 model year, but in extreme temperatures the system showed some glitches, so it was held back until the supplier was able to correct the faults.

Chevy's full-size Caprice sedan series got some attention for 1994, too. The engine lineup now includes a 4.3-liter V6 that develops 30 more horse-



CHEVROLET LUMINA



DRIVE REPORT

CHEVROLET IMPALA SS

● Chevy turned back the clock when it designed the 1994 Impala SS. Like its name, the car is an idea from a time when big bodies, big V8 engines and flashy styling made American sedans the kings of the road.

Chevy heard the chorus of approval that greeted its Impala SS at auto shows earlier this year and decided to put this Caprice variant into production. The result is a sedan with sports-coupe dash and performance, plus full-size 6-passenger sedan comfort.

You can order your Impala SS in any color you want—as long as it's black. Body moldings are black, too. Big 17-in. 5-spoke alloy wheels hint at the Impala's performance. A rear deck spoiler and unique sail window, along with SS emblems, finish setting this car apart.

But the big distinction is under the hood. Derived from the basic Corvette

engine, the 5.7-liter LT-1 V8 produces 260 hp here and is mated to GM's world-class 4-speed automatic transmission.

The Impala SS also has 4-wheel disc brakes with ABS. It all adds up to a balanced sedan that can compete with fancy imported sports sedans at Caprice prices.

—Jim Dunne

SPECIFICATIONS

Layout	Front-engine, rear-drive
Body style	Sedan
Engine	260-hp ohv 5.7-liter V8
Transmission	4A
Wheelbase	115.9 in.
Track, f/r	61.8/62.3 in.
Length	214.1 in.
Width	77.0 in.
Height	55.7 in.
Curb weight	4218 lb.
Brakes, f/r	Disc/disc ABS

power than the 5.0-liter V8 it replaces. The new optional V8 is the 5.7-liter LT-1, rated at 260 horsepower, 80 more than the V8 used in the '93 model.

The LT-1 will be standard equipment in a new-for-'94 Caprice variant—the Impala SS—a famous name from Chevy's past revived as a show car earlier this year. Public reaction to the Impala SS show car was so positive that Chevy decided to bring most of its elements into production as part of the Caprice lineup. Impala SS distinctions include sporty exterior styling, a rear deck spoiler and 17-in. alloy wheels.

Geo Prizm, Chevy's joint-venture version of the Toyota Corolla, gets a passenger's airbag for '94. Thanks to Isuzu's withdrawal from passenger car manufacturing—the company will confine its efforts to trucks and sport/utilities in the future—the sporty Storm coupe has been dropped from the Geo lineup, although it's expected to reappear in the 1995 model year, with Suzuki tabbed as the likely supplier.

Buick

Unlike some, Buick has never forgotten its roots, which are firmly anchored in power and prestige. Measured against this ethic, the Roadmaster sedan could well be the sleeper of 1994. Buick has substantially improved the power part of the equation by installing the LT-1 V8 engine in this car to give it an 80-hp boost over '93 and 0-to-60 times in the low-8-second realm. At the same



OLDSMOBILE AURORA

DRIVE REPORT

OLDSMOBILE AURORA

● The European sports sedan is a concept most manufacturers are trying to add to their product lineups. But the list of cars that actually live up to this concept—a blend of plentiful power, athletic handling and subdued luxury—is relatively short.

Judging by our first drive in Oldsmobile's still-to-be-launched Aurora, that list will grow by one along about May of next year. Aurora's 4.0-liter dohc 32-valve mini-Northstar V8 provides plenty of low-end and midrange punch, the chassis has roll stiffness worthy of an Audi and the all-around handling makes you forget it's a front-drive car. Similarly, the stopping power of its disc brakes and antilock system make it hard to believe this car weighs 2 tons.

Inside, there's a tailored cockpit feel that enhances the Aurora's sense of performance capability. Major gauges are big and legible, controls are well marked and handy.

Like Cadillac's Seville STS, the Auro-



ra is a made-in-America alternative to imported sports sedans, positioned at the lower end of the luxury spectrum—the low-\$30,000 range. And like the STS, it has all the earmarks of a winner.

—Jim Dunne

SPECIFICATIONS

Layout	Front-engine, front-drive
Body style	Sedan
Engine	250-hp dohc 32V 4.0-liter V8
Transmission	4A
Wheelbase	113.8 in.
Track, f/r	62.5/62.6 in.
Length	205.4 in.
Width	74.4 in.
Height	55.4 in.
Curb weight	4000 lb.
Brakes, f/r	Disc/disc ABS

time, Buick also claims a slight fuel-economy improvement for this big rear-drive sedan.

All '94 Buicks have driver's airbags, and the bigger cars—LeSabre, Park Avenue and Roadmaster—have dual airbags.

In the Skylark, a 4-speed automatic transmission replaces the previous 3-speed, and a number of subtle revisions have been made in the base

car's 2.3-liter sohc Four to reduce engine noise.

The Riviera, meanwhile, is taking a short year off, and is scheduled to reappear as a completely restyled 1995 model (due in mid-'94). The new Riv will continue as a personal luxury coupe, but on a grander scale, sharing the same basic platform as the 4-door Olds Aurora, another '95 model due in mid-'94.

Pontiac

Refinements to current products sum up the Pontiac story for '94, with powertrains, airbags and a restyled Trans Sport minivan heading the main chapters.

Pontiac trimmed almost 3 in. off the Trans Sport's profile, and also added the long-awaited motorized sliding side door, which joins the Trans Sport's option list for 1994, along with integrated child seats. There's also a driver's airbag and a redesigned dashboard to go with it.

Grand Am sales are running stronger than ever this year. It's the sales leader among its N-Car stablemates, Skylark and Olds Achieva. Buyers seem to respond to its aggressive styling, and the new optional 4-speed automatic should produce a smoother driving experience.

Bonnevilles now have dual airbags, plus an extra inch of front-seat travel. The Pontiac flagship offers an improved traction-control system, a computer-controlled suspension system and a 10-hp boost in its optional supercharged 3.8-liter V6.

Extended front-seat travel has also found its way into the midsize Grand Prix lineup, along with dual airbags and cup holders molded into the door-mounted map pockets. The 160-hp 3.1-liter 3100 V6 engine is new to the Grand Prix, and output of the optional 3.4-liter dohc 24-valve 3400 V6 has been bumped from 200 to 210 hp for '94.



OLDSMOBILE EIGHTY EIGHT



OLDSMOBILE NINETY EIGHT

POPULAR MECHANICS
DETROIT '94



CHEVROLET
CAMARO CONVERTIBLE

Oldsmobile

You hear so much talk about the Aurora that it's easy to forget that this important new car is still some months away from its official debut as a 1995 model. Still, Olds has released Aurora technical information and presented the car for test drives, so we're presenting it here.

Conceived as a 5-place luxury performance sedan, Aurora is V8-powered, front-wheel drive and all-new. It's designed to be Oldsmobile's prestige image car, more or less replacing the old Toronado, and figures to sell in the mid-\$30,000 range.

Aurora's 4.0-liter dohc 32-valve aluminum-alloy engine is a close relative of Cadillac's Northstar V8. Rated at 250 horsepower, the engine mates up with GM's newest 4T80-E 4-speed electronically controlled transmission to create a drivetrain that is world-class in both performance and quality.

Aurora's wheelbase is exactly the



PONTIAC TRANS SPORT

same as the Cadillac De Ville at 113.8 in., but overall length is tidier—by 4 in.—at 205.4 in.

Performance is brisk, handling positive, and the styling, for all its prelaunch exposure, should still be fresh when the car rolls into Oldsmobile dealer showrooms.

Other Oldsmobile model lines reflect the division's intent to become leaner in its model mix. The Achieva lineup has been trimmed to three entries—the S and SC coupes and the SL sedan. Two coupe variations—the SL and the hot-rod SCX—have been dropped.

DRIVE REPORT

DODGE RAM T300 PICKUP

● Dodge Truck executives are euphoric about this one. It's the first big new Ram to come along in decades, and it's likely to rewrite the rules for full-size trucks. Big is back. Big as in massive. Big as in roomy.

The long hood covers an engine bay big enough to hold an 8.0-liter V10, Chrysler's cast-iron truck version of the Viper sports-car powerplant. Peak torque is the same as the aluminum edition at 450 ft.-lb., but it comes on even lower in the rpm band—perfect for heavy hauling, tough to beat for towing.

Inside, there's real stretch-out legroom, something that's been missing in full-size pickups since the beginning. No more steering-wheel hub pressing against your chest here—the new Ram boasts the biggest standard cab in the business. Besides plentiful legroom, there's also storage behind the seats—a



welcome touch if you've got tools you need to lock up. There's also a driver's airbag in the steering hub.

The T300 offers traditional 3-across pickup seating, but can be ordered with comfortable high-back buckets. That limits seating to two, but adds storage in the form of a center-console bin big enough to swallow a computer.

Finally, big is a key part of the new Ram's styling, styling that says "truck" at a glance. And at a glance, it looks like a big winner.

—Jim Dunne

SPECIFICATIONS

Layout	Front-engine, rear-drive
Body style	Regular cab/standard box
Engine	300-hp ohv 8.0-liter V10
Transmission	4A
Wheelbase	118.7 in.
Track, f/r	68.5/68.0 in.
Length	204.1 in.
Width	78.4 in.
Height	75.9 in.
Maximum tow rating	13,200 lb.
Brakes, f/r	Disc/drum ABS (opt.)



CHRYSLER LH

The Cutlass Supreme series has been simplified by dropping the optional 3400 V6 and making the 160-hp 3100 V6 standard for all versions. A driver's airbag, antilock brakes and a 4-speed electronically controlled automatic transmission are all Cutlass Supreme standard features.

Dual airbags become standard features in the Olds Eighty Eight and Ninety Eight sedans, along with new instrument panels and improved traction-control systems. The venerable Ciera sedan, Oldsmobile's oldest car line and perennial best seller, gets a driver's airbag and antilock braking as standard equipment, and the new 3.1-liter V6 with 4-speed automatic joins the option list.

Like GM's other front-drive minivans, the Silhouette got a nose job and gets the same new equipment—a driver's airbag, optional integrated child seats and the optional power sliding side door.

Saturn

Now entering its fourth year, the boom is still booming at Saturn, to the point that GM is planning to open another production facility in the not-too-distant future.

Refinements to the current lineup for '94 are aimed at improving the car's already-high initial quality ratings. Revisions include reduced interior noise, new steering ratios and minor trim changes.

GMC Truck

Like Chevrolet, the biggest news at GMC Truck for the 1994 model year comes in a compact package—the Sonoma pickup. Mechanically identical to the Chevy S-10, the Sonoma sports a fresh new face with a rounded nose and flush side glass.

Besides improved aerodynamic efficiency, the flush windows also yield more shoulder-room, while an extra click of seat travel provides improved legroom.

Chrysler Corp.

Neon, Neon, Neon. That's Chrysler's big new-car news for 1994. Unveiled at the 1994 Frankfurt Auto Show, this subcompact sedan—technically a 1995 model—will be sold wearing both Dodge and Plymouth logos, with virtually no other divisional distinctions.

More than anything else, the Dodge/Plymouth Neon has eye-catching styling. The oval headlights, rounded roof profile and perky air deflector on the rear create a special look. You won't be able to mistake this one for

any of its dozens of competitors.

Like the LH sedans, the little Neon offers exceptional interior volume for its size class. And, again like the LH sedans, the Neon appears destined for immediate and resounding success in a fiercely competitive market segment.

Neon will be about the same size as Ford's Escort, and will be built initially only as a 4-door sedan. Power will be from a 2.0-liter 4-cylinder engine built by Chrysler. Transmissions include a 3-speed automatic and

(Please turn to page 130)



DRIVE REPORT

DODGE/PLYMOUTH NEON

● One car with two brand names? Well, why not? We've been seeing the same thing from carmakers for decades—the same basic car with minor trim variations and badging for different divisions. With the Neon, Chrysler has simply dropped all the pretense. The only difference between the Dodge Neon and the Plymouth Neon will be where you buy one.

However, there will be a big difference between the Neons and the subcompact segment they'll challenge—Honda Civic, Toyota Corolla, et al. Just as it did with the LH sedans, Chrysler has created a car that's much roomier than its chosen competition. That rounded roof provides plentiful headroom, and rear-seat legroom is truly suitable for adults.

Another similarity to the LH design philosophy is an exceptionally rigid unibody, making it much easier for the chassis team to dial in the handling. For

initial production, that dial will be set at precise but not exceptionally aggressive, with ride quality that may set a new standard for the class. Add zippy response from the new 2.0-liter Four and you've got a small family 5-seater that's exceptionally spacious and also fun to drive.

—Tony Swan

SPECIFICATIONS

Layout	Front-engine, front-drive
Body style	Sedan
Engine	130-hp sohc 16V 2.0-liter I4
Transmissions	5M, 3A
Wheelbase	104.0 in.
Track, f/r	57.4/57.4 in.
Length	171.8 in.
Width	67.4 in.
Height	54.8 in.
Curb weight	2350 lb.
Brakes, f/r	Disc/drum

THE 220 HORSEPOWER



	Engine	Horsepower/Torque	Towing	Cab/Cargo Volume	Safety	Warranty
DODGE DAKOTA 4x4 CLUB CAB Dakota Superiorities	Available 5.2L V-8 MPI A V-8 compact pickups don't offer	220 @ 4400 rpm/ 295 @ 3200 rpm More available power	Max - 6400 lbs More available towing	80.6 cu ft/47.9 cu ft Larger cab & cargo bed	Sid. driver's airbag Avail. 4-wheel ABS More safety features	3/36 Bumper-to-Bumper or 7/70 Powertrain Dodge provides the only choice of warranties, our Owner's Choice Protection Plan, offering longest powertrain protection.*
TOYOTA 4x4 XTR4 CAB	Available 5.0L V-6 EFI	150 @ 4800 rpm/ 180 @ 3400 rpm	Max - 3500 lbs	72.5 cu ft/41.2 cu ft	No driver's airbag No 4-wheel ABS	3/36 Bumper-to-Bumper & 5/60 Powertrain
FORD RANGER 4x4 SUPERCAB	Available 4.0L V-6 MPI	160 @ 4000 rpm/ 225 @ 2500 rpm	Max - 5600 lbs	75.0 cu ft/50.5 cu ft	No driver's airbag No 4-wheel ABS	3/36 Bumper-to-Bumper
CHEVY S-10 4x4 MAXI CAB	Available 4.3L V-6 CPI	195 @ 4300 rpm/ 260 @ 3600 rpm	Max - 5500 lbs	74.0 cu ft/39.9 cu ft	No driver's airbag Avail. 4-wheel ABS	3/36 Bumper-to-Bumper

Data based on information available at time of printing, including some '93 competitive data. See dealer for latest information. *See Dodge's limited warranties, restrictions & details at dealer. Normal maintenance, adjustments and wear items excluded. Warranty provisions vary by manufacturer.

Always wear your seat belt.

POWER BACKPACK.



A Dodge Dakota Club Cab packs an available 5.2L Magnum V-8. It can pull up to 6,400 lbs of trailer capacity. And it has room inside for you, your friends and all of your gear. Which should give you everything you need to put the entire civilized world in your rear view mirror.

DAKOTA CLUB CAB



THE NEW DODGE

A DIVISION OF THE CHRYSLER CORPORATION

ENGINEERING

New engines spearhead Detroit's newest technology.

BY PAUL WEISSLER

● The Big Three carmakers have invested considerable money—and plenty of mental effort—into improvements. New sheetmetal is scarce this model year—at least for this fall—but look for some new vehicles to be introduced before 1994 has run its course.

In the meantime, there are plenty of major and minor improvements to existing platforms—and several outright new engines as well.

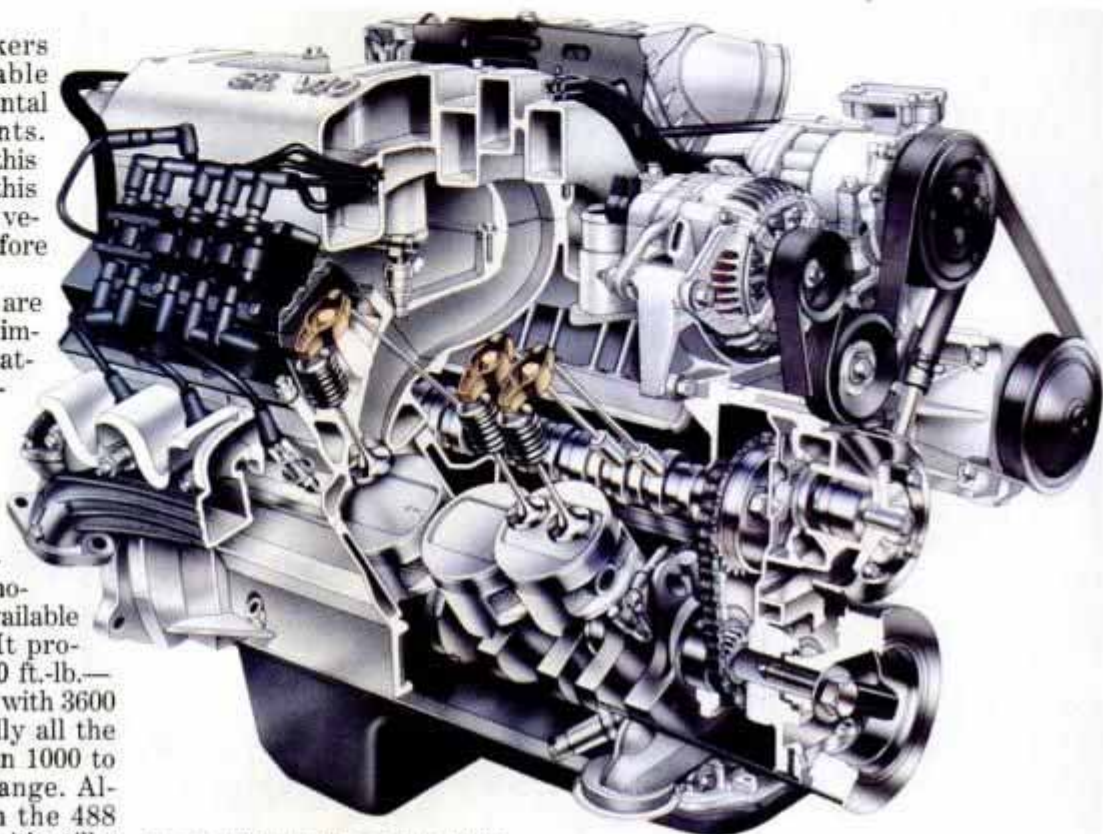
Chrysler Corp.

You don't have to buy a \$60,000 Viper to get a V10 engine anymore. A cast-iron version of the Viper motor is out for '94, and it's available in the new Ram pickup. It produces as much torque—450 ft.-lb.—but at 2400 rpm, compared with 3600 for the Viper. And virtually all the torque is available between 1000 to 4000 rpm—a nice wide range. Although horsepower from the 488 cubes is 100 less than Viper, it's still a very healthy 300 hp.

Yes, the engine is a pushrod design, but it isn't just a lots-of-cubes, yesteryear mill. It has distributorless ignition and a multipoint fuel-injection system that features Chrysler's no-fuel-return-lines design, introduced last year (see "Engineering The '93s," page 46, Oct. '92).

The aluminum front cover holds a water pump with a curved plastic paddlewheel—it looks simple, but it's the result of intensive engineering. The water pump consumes only 3.8 horsepower while pushing 90 gallons per minute at 4500 rpm. The straight-vane paddlewheel draws 8 horses. To improve cooling system leak resistance, the water pump's bypass-hose and heater-hose necks are not pressed in, but are threaded and coated with sealer.

While everyone else is going to inlet thermostat systems to avoid shocking the block with cold water when the stat opens, Chrysler took a different tack. The stat is still at the cylinder-head outlet to the radiator, but it's a king-size cylindrical stat



DODGE RAM 300-HP V10

There's never been a substitute for cubic inches—and Dodge's Ram pickups get 488.

similar to what's used on the really big truck diesels. It has up to four times the opening of a conventional thermostat, so it can precisely control a large flow of water through a coolant-flow circuit that was thermocouple-tested to provide uniform warmup of the cylinders.

The lubrication circuit has rocker-chamber return passages cast into the outside of the head and block and channels in the oil pan so the oil flows away from the crank into the deep part of the pan. This arrangement means that the crank doesn't have to waste power churning through engine oil. The oil on the pressure side of the Ram V10 goes through a new oil filter developed for Jeeps used in the Middle East and other hot, sandy areas. It has a paper-type filtering medium with greater dirt-holding capacity and resistance to higher temperatures.

The crank is cast, compared to the Viper's forging, but the process and excellent quality control result in one

that's the same strength as the Viper. The cylinder firing order is the same as the Viper—it alternates between 90° and 54°, an uneven pattern that was selected after an outside consultant demonstrated that it was the best choice for engine smoothness, short of even firing. However, the uneven firing means the engine doesn't need a split-pin crankshaft, which is not nearly as strong.

Contributing to engine smoothness is a novel, sophisticated engine mount. It has a Y-shaped rubber insert to control shear loads from side-to-side shake. The mount's cylindrical steel housing has other rubber inserts to limit total travel, as well as more rubber mounts for the through-bolt holding the engine to the frame.

Another contributor to smoothness is a very rigid, deep-skirt block (basically a longer stem in the Y-shape). Because it extends well below the crank, the bottom gasket surface for the oil pan is flat for maximum sealing.

The pistons have a moly coating to

THE '94s



FORD'S MODULAR V6
Compact and lightweight, the dohc 24-valve modular is derived from the 4.6 V8.

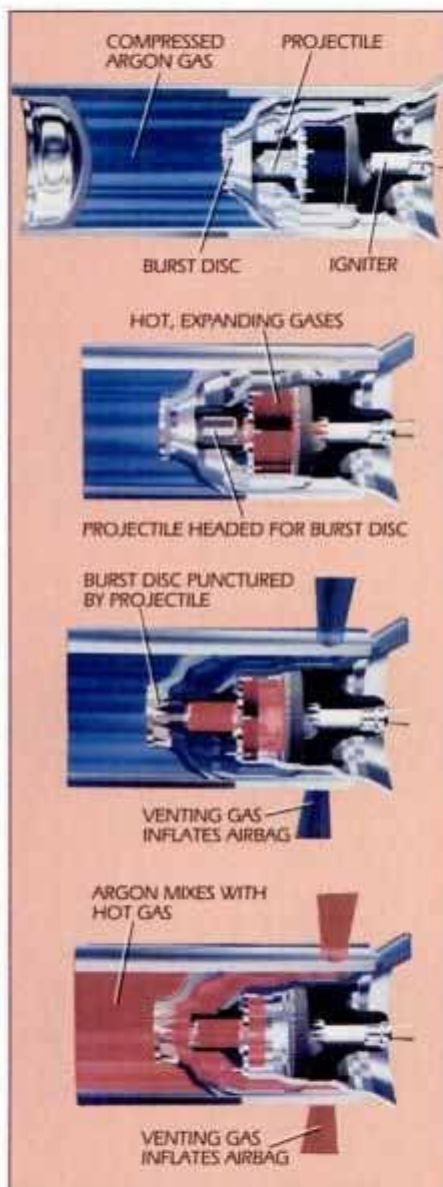
Ford Motor Co.

The other members of the Big Three may have most of their '94 technology dollars in better pushrods, but Ford's banking on overhead cams and multivalve layouts this model year. What is being billed as the world's shortest V6 is going into the transverse-front-drive Ford Contour and Mercury Mystique, Ford's new compacts coming out in the spring.

The 60" 2.5-liter V6 engine block is only about 15 in. long, and although Ford has not disclosed the weight, it



GM'S 3.1-LITER V6
High-output pushrod V6 uses oil pan as a structural element and develops more power per cubic inch than a Corvette V8.



Chrysler minivan passenger-side hybrid airbag uses plastic projectile to puncture disc, allowing cool argon gas to inflate large-volume bag. Conventional airbags use hotter gases from explosive charge, which sometimes cause burns.

reduce friction. And although the moly wears off during engine break-in, it becomes embedded in the cylinder walls so it continues to do the job for the life of the engine.

Safety—fast as a speeding bullet

Firing a gun can save a life—when the bullet hits a target that inflates an

airbag. The '94 Chrysler minivans (Voyager, Caravan and Town & Country) get this design, a so-called "hybrid" airbag used on the passenger side. In the typical airbag, a pyrotechnic material is ignited, and it generates the gas that inflates the airbag. However, this gas is hot—hot enough to cause skin burns—and contains combustion products that escape into the passenger compartment as the bag deflates.

In the hybrid, there's just a small amount of pyrotechnic material and it's molded with plastic into the shape of a small bullet, aimed at a target disc about a half-inch away. When fired, the cartridge goes through the disc, opening up a steel cylinder filled with argon gas at 3000 psi. The argon flows through the punctured target, is heated by the pyrotechnic material and expands through openings into the airbag, inflating it. The gas still is much cooler than a standard airbag system, and the residue of combustion is primarily benign.

R-12 lingers on

With the CFC-based refrigerant R-12 in short supply, and soon to be gone altogether, consumers are beginning to be concerned about the wisdom of buying a vehicle that still uses R-12 and might need an expensive conversion to R-134a at some point in the future.

Although Chrysler was the U.S. industry's pioneer in converting air conditioning from R-12 to R-134a, having started in the mid-'92 model year, it still has some R-12-cooled vehicles in the '94 line, at least at the beginning of the model year. The latest word is that the Jeep Wrangler and plain Cherokee (not Grand Cherokee, which has always had R-134a) will continue with R-12 until the assembly lines can be converted this winter. The Eagle Talon and Plymouth Laser are being phased out (the Laser goes away and a new Talon comes out this winter), so they also continue with R-12. However, any final production of these two carryover models reportedly will still carry a '93 label.

claims it's much lighter than the Mazda 130-hp 1.8-liter V6 and only 5mm (0.2 in.) taller.

It will be rated at about 175 horsepower, 70 per liter—certainly a healthy number. The 2.5-liter V6 is the first of a second group of Ford modular engines (the 4.6-liter V8 is the other), and it can fit into everything Ford makes from an Escort on up.

Although the V6 intake manifold is tuned, it's a flattop design to help keep the height down. Although Ford isn't providing numbers now, it claims the engine is designed for good low-end torque to go with the high-end horsepower.

The balanced performance is achieved at the expense of internal complexity, however. There are four overhead cams (two per bank) to operate the 24 valves, and yes, the camshafts are the latest version of the hollow-tube design Ford introduced on the 4.6-liter V8. Although Ford doesn't need it at this time, the engine is designed for an easy conversion to variable-valve timing.

The two intake valves for each cylinder have separate, side-by-side intake ports, and the secondary ports have throttle-like butterfly plates controlled by the engine computer. Below 3200 rpm, the secondary butterfly is closed. Fuel is sprayed through the primary, and with the help of a fast-burn combustion chamber, the engine operates with the low-end torque characteristics of a 2-valve engine. At 3200 rpm, the throttles open and the air rushing in through the secondary ports provides swirl mixing of the extra fuel being sprayed in.

The V6 has a structural aluminum oil pan and either a direct-mount or a super-stiff bracket for all belt-driven accessories to contribute to engine smoothness.

The tolerances have been tightened up for all moving parts, and although Ford isn't announcing the clearances, it is claiming 10,000-miles-per-quart oil mileage. The pistons have a special Teflon coating to prevent friction-caused starting and running problems after hot soaks and in extreme temperatures.

The 2.5-liter V6 will be the optional engine on the new models. A 16-valve overhead-cam 2.0-liter 4-cylinder will be the standard engine.

Thunderbird/Cougar gets the modular 4.6-liter V8

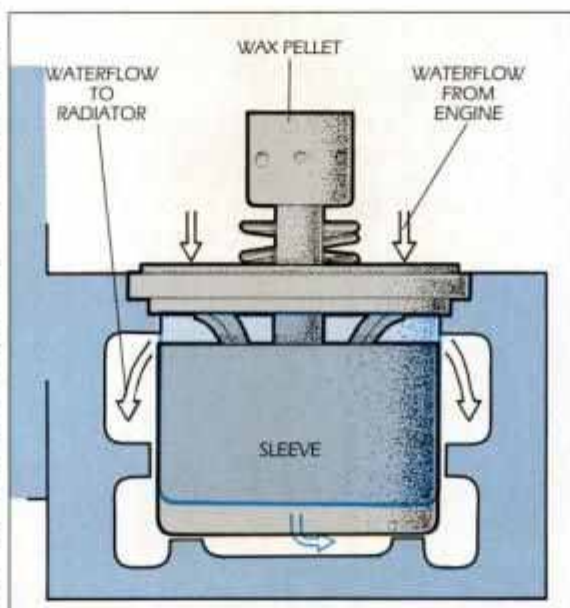
The Thunderbird and Cougar are the only FoMoCo cars that get even a face-

lift at the start of '94 production, and they're also the latest to get Ford's overhead-cam modular V8, a 190-hp 2-valve version. It's one of the two engine options over the base 3.8-liter V6. The other is the 210-hp supercharged intercooled 3.8-liter V6.

The 4.6-liter V8 provides virtually the same performance as the 200-horsepower pushrod 5.0-liter V8 it replaces, with better fuel economy and lower emissions.

The personalized car

Lexus pioneered the basic idea with a his-and-hers memory setup on the driver's seat position, steering wheel tilt/telescope and outside mirrors—all triggered with the remote control. With increased electronic memory capability, Ford takes its first steps to the car that can be functionally



Chrysler's V10 pickup motor uses diesel-style thermostat for even warmup and high flow rates.

personalized for a particular driver with remote control of seat and mirrors on the '94 Mark VIII, but the early-'95 Continental out in the spring goes well beyond. It also will cover his-and-hers wheel tilt/telescope, radio stations and perhaps even the electronic suspension settings.

Transmission shift characteristics and door-locking/unlocking patterns are next on the development agenda. And then the type of instrument panel (digital or analog) and perhaps even color-change panels for a different appearance, too. So far as we've heard, both Ford and Cadillac are writing the lists for the next lines of cars, and there's no end of possibilities in sight.

Lights on

Neon lights are the kind that make an ideal store sign, because they're tubular and can be shaped easily. But

they hardly are the kind you would expect to see as a brake light, because they take so long to go on after you flip the switch.

However, Ford has completed development of a suitable automobile design, thanks to a new electronic ballast that not only provides an instant-on (actually up to 20% faster than conventional bulbs), but is 40% more efficient in its wattage requirements than a pair of conventional bulbs and should last the life of the car.

It also shows how fast technology is moving. Just a couple of years ago, it seemed that light-emitting diodes (LEDs) were the hottest new idea in small exterior lamps. But one long neon bulb can take the place of a string of LEDs and requires only one connection at each end.

Look for neon to be used as the illumination in the center-high-mounted-stop-lamp (CHMSL) on the Mark VIII as a running change sometime this year.

It's all R-134a

It's taking a herculean effort, but Ford hopes to produce only R-134a air-conditioning systems in the '94 model year. There are a few models in which the conversion parts will not be ready at the beginning, so Ford will delay the availability of the cars. For example, the optional 1.8-liter engine in the Escort and Tracer will not be R-134a-ready until early winter, and even the standard 1.9-liter version may be slightly delayed.

Surprisingly, even though the Aerostar is being replaced midway by a new van—the Windstar (although Aerostar production will continue while Windstar production ramps up)—Aerostar will have an R-134a system right from the beginning. Tempo and Topaz are the only other major a/c hangups, and their introduction may be delayed significantly, at least for the 4-cylinder versions.

General Motors

The pushrod 2-valve engine refuses to say die at General Motors. Despite the introduction of the Northstar overhead-cam 4-valve last year, the pushrod is not only alive and well, but drawing a ton of special technical development for '94, pulling ahead of even the Corvette 5.7-liter pushrod V8.

As a result, new versions of the 60° 3.1-liter V6 and 2.2-liter inline 4-cylinder engines actually have higher output per cubic inch than the Corvette 5.7-liter pushrod V8, and come very close to that of the base-performance Northstar.

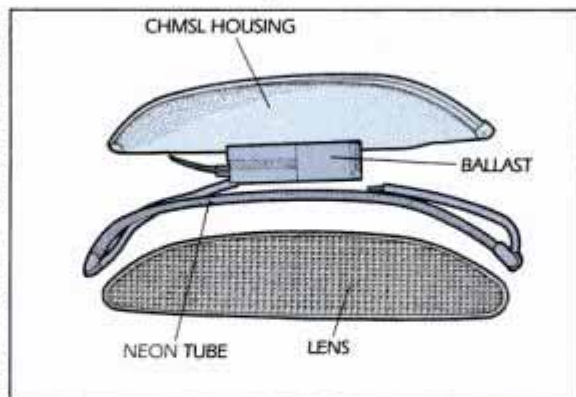
The Corvette produces a total of 300 horsepower, but we're talking about horsepower per liter, of course. And the new GM pushrods have even newer versions of what helped that engine achieve its efficiency, such as ultralow-friction piston rings, roller lifters and lightweight parts (including a steel tube camshaft with swaged bearing journals and steel lobes, similar to Ford's new V8s). The '94 version of the 2.2 produces 10 more horses—120 horsepower, 54.5 per liter. The 3.1 is up 25, to a potential 165 horsepower—53.2 per liter (but because of a quiet exhaust, it's derated to 155 to 160, depending on the model). This compares with 58.7 for the 270-horse Northstar, and 52.6 for the 300-horse Corvette. Two-valve pushrod engines are noted for good low-end torque, but GM has worked to reduce both the weight (literally a gram here, a gram there) and the friction of moving parts. This allows the engine to rev higher, which is what gets the horsepower up. They've also reduced parasitic losses with such detail changes as more precisely made oil pumps.

Although the torque curves are relatively flat, the 2.2-liter Four and 3.1-liter V6 actually torque-peak at 4000 rpm, and maximum horsepower comes in at 5200 rpm, thanks to new tuned-intake manifolding. Those numbers put them very close to most standard-tune 4-valve overhead-camers, which are rpm-limited by their need for low-end torque. The higher output of the new 3.1-liter enabled GM to bury the 90° 3.3-liter V6 that it was using in many compacts.

The new 3.1-liter V6 is pushing the performance envelope enough for the engine's lower end to be a concern, so GM beefed it up by installing an aluminum casting as a structural oil pan, and in racing fashion, cross-bolting the main bearing caps through it. There is somewhere between a .002-in. and .013-in. clearance between the caps and the pan, so it slides into place on the production line, and when the bolts are tightened, the pan bows slightly inward. It doesn't hurt the structure because the pan is a deep skirt and the bolts are close to the top, where the bowing can be tolerated. Other engines that use structural pans have to use shims because the crossbolts are too low and the sides of the pan would crack rather than flex.

One of the tremendous trifles in the design of the new 3.1-liter V6 was repositioning the valves and target-

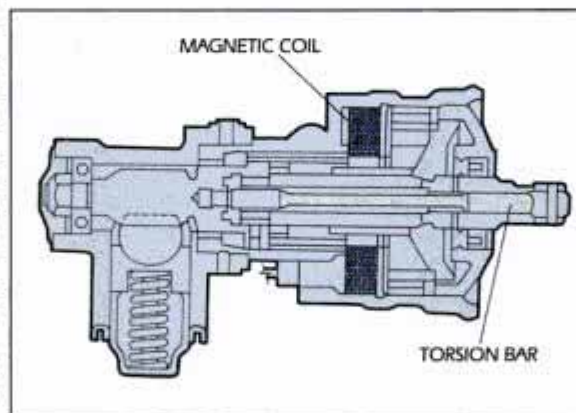
ing the fuel-injector spray, so more fuel gets into the cylinder, rather than just wetting the wall of the port. This helps with exhaust emissions, of course, but also with performance and fuel economy.



Ford will introduce CHMSL with a neon tube and solid-state ballast instead of a light bulb later this year.

The distributorless ignition system gets a 24-notch timing disc, so the engine computer receives 24 pulses per crank revolution, compared with six for the earlier versions of the engine. More pulses permit more accurate spark and fuel-injection timing at cranking rpm, so the engine starts faster and produces lower emissions at idle and fast-idle speeds. The 6-notch setup remains, because it provides a more positive signal at higher rpm.

Another lightweight, low-friction enhancement used in several pushrod GM engines is an injection-molded composite plastic roller-lifter guide. These keep the roller lifters aligned on the camshaft journals and are normally stamped out of sheet steel. Improved engineering-grade plastics can now last the life of the vehicle in the hot and corrosive environment inside the engine.



Oldsmobile Aurora computer controls variable-rate steering with an electromagnet.

These pushrod-based performance improvements have come despite tightening emissions standards and mandates for higher fuel economy. At some future time, the inherent advantages of overhead cams, multi-

valves and variable-valve timing will overcome the pushrod, despite its more compact design. Meanwhile, the pushrod is a competitive design with cost and reliability advantages.

The 2.2-liter and/or 3.1-liter engines are used in just about every sub-compact and compact that General Motors makes.

Goodbye accelerator cable

GM even has its first "drive-by-wire" vehicle in a popular size class—the 6.5-liter diesel in Chevy/GMC C/K trucks under 8500 GVW. This high-tech system, used on BMW and Mercedes gasoline-engine passenger cars among others, means that stepping on the accelerator pedal just moves a variable resistor, rather than a cable to the fuel-injection system. A computer translates the changing resistance signal into appropriate fuel delivery from the injection pump. Electronic control increases the range of injection pump timing to reduce smoke and improve fuel economy.

Return of the crossover

When Cadillac converted its 4.9-liter V6 from throttle-body to multiport fuel injection, it dropped the exhaust crossover passage as unnecessary in redesigning the intake manifold (no fuel mixture to heat for cold drive-away). The passages through the heads were left in, but were blocked off by a redesigned gasket.

However, the new '94 Sedan DeVille exhaust pipes are uneven, and the engineers heard what they considered an un-Cadillac harshness in the exhaust sound. Lots of things were tried, but the one that worked was to redesign the intake manifold to put back the crossover, and change the intake-manifold gasket to reopen and complete the exhaust path through the cylinder heads. This change in exhaust path length retunes the exhaust. "Good thing we hadn't spent the money to retool the cylinder heads to eliminate those passages," commented a Cadillac engineer.

Electromagnetic power steering

GM has a brand-new, super-silky way to provide a proportional assist to its power steering so there's plenty of help for parking but retain road feel at speed. The new system will debut on the early-'95 Olds Aurora coming out in the spring. It uses a computer-controlled electromagnet wrapped around the steering

(Please turn to page 132)



RETURN OF THE WACO

The classic YMF-5 brings back flying as it used to be.

● This past fall I traveled north to Lansing, Michigan, dropped in at Capital City Airport and walked directly into a time I never knew. There on the flight line was a row of mint-condition, jewel-like 1935-vintage Waco YMF-5s.

These were no museum pieces. Each plane was full of 80 octane and ready to fly. And had you the inclination and a fat checking account, you could take one home and fly it for fun forevermore. What's more, the pink slips said these machines were brand new.

What's going on here? As you have probably surmised, the Waco's is an odd little tale.

After the 1978 death of Clayton Bruckner, owner and founder of Weaver Aircraft Co. (for which WACO is the acronym), the executors of his estate decided to divest themselves of all manufacturing rights to Waco airplanes and thereby avoid potential product liability claims. Accordingly, they simply re-

BY WILLIAM GARVEY

turned the Waco type certificates to the FAA.

Meanwhile, Dick Kettles was looking for a way to even out the business cycles at his Lansing FBO. He hit upon the idea of manufacturing a specialty airplane, a classic, a machine for which there was limited but steady demand. He knew from surveying oldtimers that the YMF-5 was that machine.

The Feds couldn't sell the manufacturing rights, but Kettles was willing to bet that no one else would invest the time and money needed to compete with him. He copied the drawings, and then geared up for production, while the rights remained in the public domain—a highly unusual step.

The first reincarnated Waco YMF-5 flew out of Capital City in 1985, and they've been hatched steadily, albeit slowly, ever since. Some 53 airplanes have been delivered to date, with

production now at about 10 aircraft per year, which was Kettles' original target.

For anyone familiar with the sights and sounds of a modern airplane factory, a visit to Kettles' Classic Aircraft Corp. demands a suspension of normal references. There are no huge metal presses, no computer-controlled lathes filleting slabs of aluminum, none of the *brrratta-rattaratta* din produced by platoons of rivet guns. Here, rough hands plane and bend long strips of mahogany and birch into ribs and stringers, and spars are formed from sitka spruce. Hands pull long needles through yards of Ceconite to secure the covering to the frame.

Building a YMF-5 Super is a hands-on project of the highest order. There's nothing automatic about it. For example, the hand sanding between each of the 16 applications of dope and paint to the Ceconite eliminates all traces of weave marks. In the end, some 5000 worker-hours are

required to fashion the YMF-5's 1800 parts into a finished biplane. The price, about \$225,000 for a fully IFR machine, reflects that craftsmanship. But ah, what a thing to behold once completed.

If you ever doubt the ability of American workers to turn out world-class products, study one of these new Wacos up close. Every line is edged sharp, every seam is matched perfectly—and that goes for the visible as well as unseen components. All this, by the way, is the handiwork of Classic's 3-dozen workers, most of whom formerly worked at the local General Motors plant.

I couldn't wait for my turn to fly N5YM, a white and red beauty parked outside. While the new Wacos duplicate their 1930s predecessors almost exactly, there are some welcome differences. First off, the new generation has a full electrical system, including starter, key ignition and lights. Full King IFR packages are the norm, and Cleveland brakes and wheels were specially designed for the born-again machine. Unlike cotton, the Ceconite covering is good for 25 years. The firewall is stainless steel, rather than aluminum. Both cockpits are heated. The 275-hp Jacobs R-755 is rebuilt and upgraded, and its TBO has increased from 300 hours to 1200 hours as a result.

The main gear has been lowered 3 in. to help improve over-the-nose visibility. The fuselage has been lengthened ½ ft. for more pilot legroom and better control feel. And the cockpits have been widened a couple of inches for comfort. The aircraft's 4130 steel tubing is oil-filled to prevent corrosion.

Those improvements noted, all modernity was forgotten as soon as I settled into the leather-seated rear cockpit, secured the chin strap on my flying cap and pulled my goggles into place. The day was crisp and blue and calm—a barnstormer's delight.

Give it 10 pumps of primer, push the starter button and the shaky Jake's seven cylinders blat to life spinning the 92-in. wooden Sensenich into a glistening shellac blur. By definition, taildragger biplanes present terrible visibility problems on the ground, and the Waco holds to that rule. You have to zigzag along the taxiway to see what's ahead and hold your breath until finally reaching the active. Then lock the tail wheel, firewall the throttle, re-



Enlarged, heated cockpit and modern panel contrast with the Waco's timeless form.

lease the brakes, and the clattering beast begins to roll. The tail rises quickly, and at 60 mph you ease back on the stick and glance downward to watch the wheel shadows separate from the concrete.

While climbing to 3000 ft., I scanned the world around and behind me—all flying wires, fresh open skies and farmland stretching to the horizon—and felt something unusual. I realized this is how it was back in the days of Wiley and Lindy, and I could understand its powerful draw. For the first half-hour I couldn't stop smiling like a fool.

But back to work. Level cruise at 3000 ft. worked out to about 110 mph indicated. Slow flight at 60 mph produced a high angle of attack, and when we stalled it at 55 mph, the thing just settled with no wing drop.

Nose down, throttle up, and when the needle hit 140 mph, we pulled

back into a big loop, followed by a second one during which my seat suddenly collapsed—a condition that will bring you to full sensory alert, I discovered. After a series of barrel and aileron rolls and a hammerhead turn, I can report that despite its four ailerons, the Waco will never earn any world aerobatic championships. The aircraft's sheer bulk, combined with its 2950-pound gross weight, makes its controls too heavy, its movements too ponderous for any crisp maneuvering. But then that was never its designers' intent.

"This is a ladies' and gentlemen's cross-country biplane," explains Dick Kettles.

I shot three landings—90 mph and 1300 rpm on downwind, 80 mph on base, keep the runway numbers just above the nose on final, let airspeed bleed off and dance the rudders to touchdown. And I pretty much mastered calm-wind returns to Earth.

And then, sadly, it was over. I had to give it back.

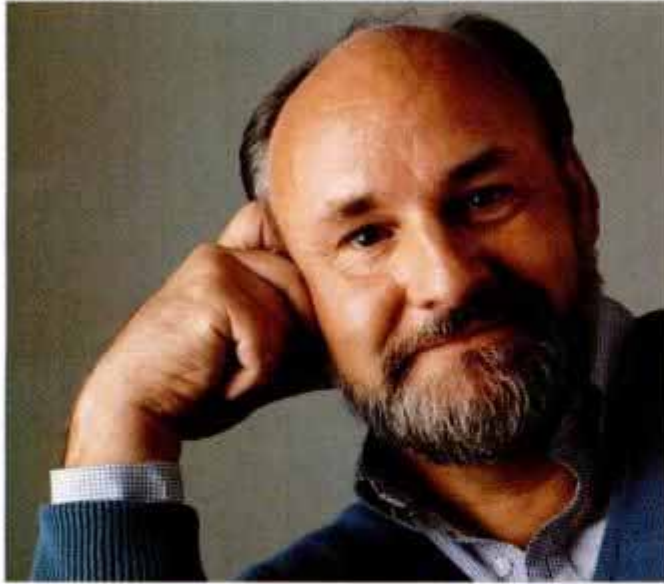
I can't recall when I've enjoyed a flight so much. My encounter with the Waco demonstrated vividly that the word "flying" has taken on two quite different meanings. For there's little shared experience among those who fly pressurized tubes at 40,000 ft. and those who fly a YMF-5. I much prefer the latter.

If you'd like to turn back the clock to, say, 1936, contact Classic Aircraft Corp., Capital City Airport, Lansing, MI 48906. **PM**



Five-thousand hours of hand labor goes into each YMF-5.

BUCKLE UP-TOGETHER WE CAN SAVE LIVES.

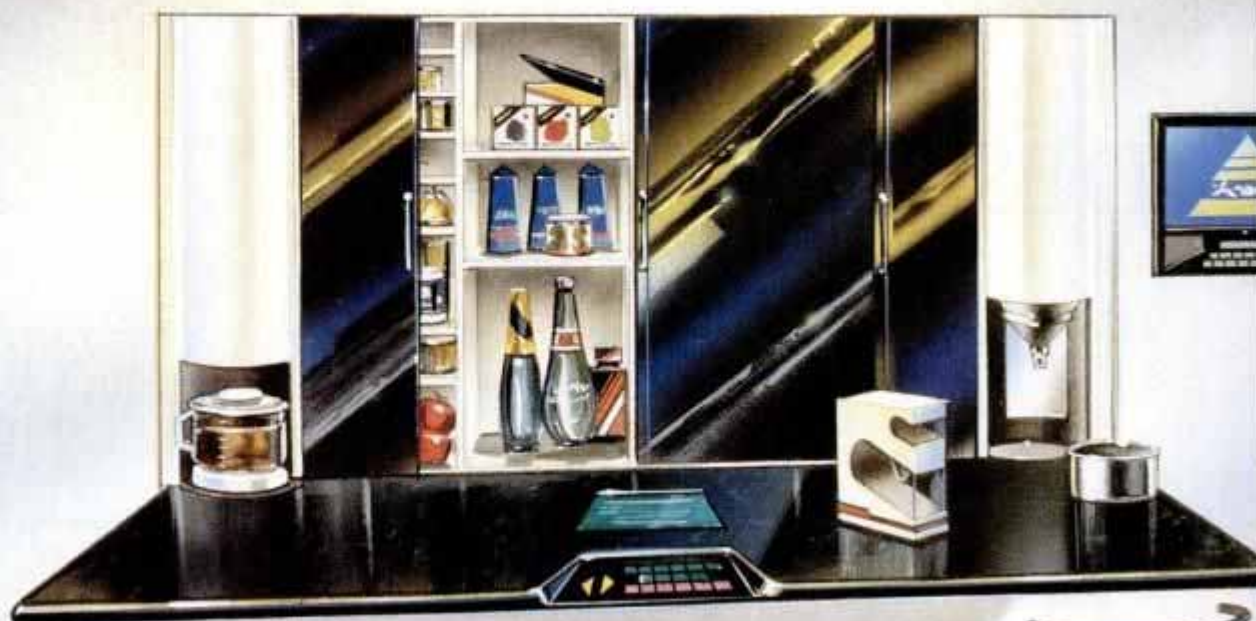


BEFORE OUR DESIGNERS CREATE A CAR THEY TALK TO OUTSIDE *EXPERTS.*

SEVERAL times a year we invite people from all walks of life to come and BRAINSTORM with Ford Motor Company designers and engineers. We talk about cars, sure. But often we talk about non-car things: personal computers, home appliances, music, the environment, quality in very general terms. ∞ This ONGOING DIALOGUE finds its way into the cars and trucks we make, at Ford, Lincoln and Mercury. You can see it reflected in the thoughtful design of an instrument panel. Feel it in the click of a switch. Hear it in the closing of a door. ∞ At Ford we know that to design cars and trucks with relevance and appeal, you have to LISTEN to your customers. It's part of the learning process that leads us to quality.

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Q U A L I T Y I S J O B 1.



COOKING UP THE FUTURE

Designers are preparing a high-tech feast for tomorrow's kitchen. But can they get appliance makers to follow their recipes for change?

BY GREGORY T. POPE; PM Illustrations by Paul Dimare

● Punch your recipe card into a countertop computer and automated cabinet dispensers start metering out the herbs and spices. Other ingredients practically walk off the rotating refrigerator shelves into your hands. In a few minutes, your dinner is broiling away in a see-through glass dome, while side dishes sizzle on induction-heating elements. Soon the robotic serving cart will be ready to wheel the meal into your dining room. Afterward, plates and glasses slip into the ultrasonic dishwasher to be vibrated clean in just 3 minutes.

Frigidaire Co. cooked up this Kitchen Of The Future and served it to the world at a trade show, in the manner that automakers roll out their concept cars. In fact, you might have read about this kitchen in **POPULAR MECHANICS**.

In our April 1955 issue.

Why must we dig into the past to get a taste of the future? Has time stood still for kitchen appliances while the other big consumer items—automobiles and electronics—have raced forward, snapping up new technology at every turn, gunning for a competitive edge?

Appliance makers concede that the three anchors of the kitchen—refrigerator, range and dishwasher—have evolved at a low simmer compared with cars and electronics. Yet they also say there's a good excuse. "You'd see more change in appliances," suggests John Ayotte, Frigidaire's design manager for brand strategies, "if it weren't for the fact that we build them to last for 20 years, so the replacement rate is very slow compared with cars."

But now the industry may be ready to play catch-up



Matthew Goulet's approach starts with a countertop island, of adjustable height, mounted on columns capped respectively by a compact refrigerator and ultrasonic dishwasher. From each column jut pivoting platforms that can swing left or right to accommodate different working habits. One holds the sink, while a range hangs from the other. Meanwhile, a rotating modular pantry system is sunk into a nearby freestanding wall. A conveyor belt brings forward food and spices, summoned by bar code via a touchscreen. The interchangeable storage modules could be kept frozen, refrigerated or left at room temperature, depending on advances in food packaging.

COOKING UP THE FUTURE

with Detroit and Tokyo. Why the change? Well, for one thing, new government regulations are curbing the floods of water, electricity and garbage that flow through the American kitchen. For another, health-conscious consumers have begun to scrutinize the way they prepare and preserve food. And the evolution of the American family—now smaller and shorter on spare time—has simply outrun the evolution of the American kitchen.

These trends stand to move a smorgasbord of technologies off the back burner. They include refrigerators that don't punish the environment, quick cooking methods that don't zap the life out of food and dishwashers that don't waste gallons of hot water on pint-size loads.

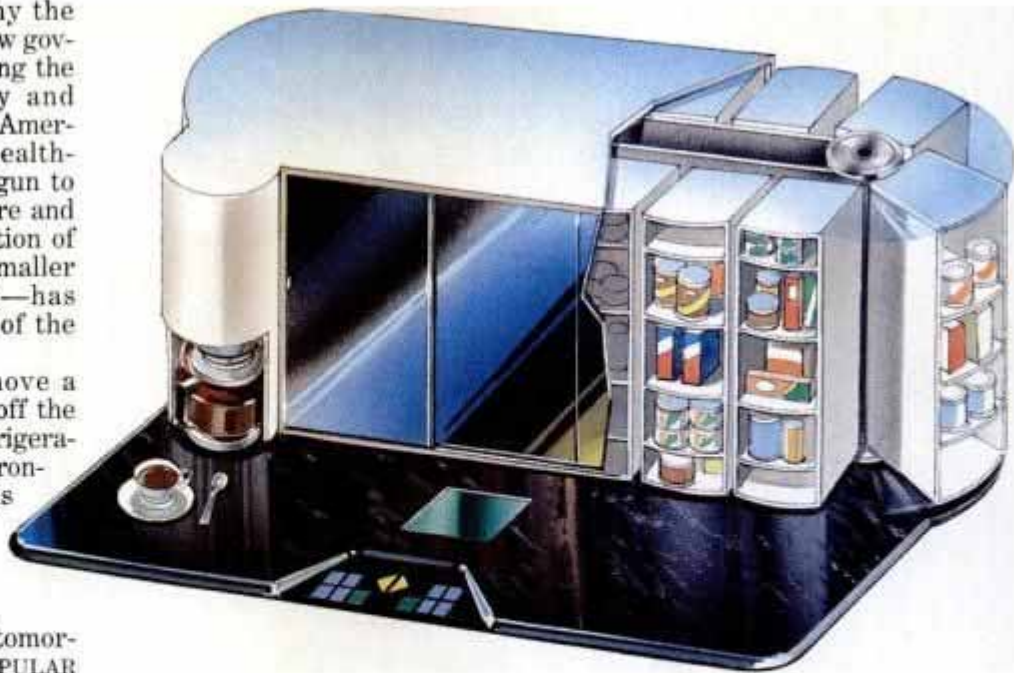
How will all this spice up tomorrow's kitchen? To find out, POPULAR MECHANICS tapped the Rochester Institute of Technology (RIT) graduate program in industrial and interior design. Last winter, under the tutelage of RIT professors Charles Lewis and Nancy Chwiecko, six masters' candidates blueprinted their views of a kitchen of the future. Two of these, by industrial designer Matthew Goulet and interior designer Li-Chin Liu, are featured here.

Both Goulet and Liu opened with two assumptions. One: Dwindling housing space will crimp away at the traditional big kitchen. The other: Technology will free designers from the boxy envelopes that define current appliances. In each design, these premises combined to produce a compact kitchen that could drop into any open space.

Reality check

Do the RIT kitchens measure up to concepts simmering in the minds of appliance manufacturers? They do, it turns out—if you can get the manufacturers to show you their concepts.

Despite their admittedly conservative planning, appliance people are only a shade less secretive than the Pentagon about new products in the pipeline. Frigidaire's Design Center, for example, lies concealed in an unmarked building, several miles from its headquarters outside Columbus, Ohio. Behind the plainclothes front, a team of seven designers mold the mockups and prototypes of future appliances, which stay cordoned off from visitors by firmly drawn blinds. While the group may be tight-lipped on near-term appliance design, they'll readily discuss the concepts



Goulet's conceptual in-wall rotating pantry features storage modules that travel on a conveyor belt. Thermocouples, solid-state devices that heat or cool small areas, permit meticulous temperature control of modules. But new food-packaging methods, perhaps involving irradiation, could minimize the need for refrigeration.

and wish lists that flavor their long-term thinking.

Cool sounds

The machine most in need of a facelift? All fingers point to the refrigerator. "The worst-designed appliance in the kitchen," agrees RIT's Lewis, "the way you have to paw things out of the back. Refrigerators should be purchased in modu-

lar units, one after the other, with nothing more than 12 in. deep."

As a major excuse for the production of chlorofluorocarbon gases—used as refrigerant and for blowing insulation—refrigerators are villainous on the ozone layer. What's more, America's voluminous home refrigerators account for 8% of the nation's total electric bill. But the Department of Energy has mandated that 1993 models operate 30% more efficiently than 1990 models, and even stiffer regulations are on the way.

Conventional refrigeration, with fine-tuned components, can meet the new requirements, say manufacturers. Whirlpool, for example, is tooling up for production of a refrigerator that runs between 25% and 50% more thrifly than 1993 models—without ozone-chewing chlorofluorocarbons, to boot. Behind the efficiency lies nothing fancier than better compressor motors and condenser fans, tighter insulation and a microchip-controlled defroster. Last July, the appliance won a cool \$30-million purse from the Super Efficient Refrigerator Program Inc., a consortium of utilities. The prize money, dubbed the "Golden Carrot," will bankroll a new assembly line and subsidize sales, as the refrigerators must be priced comparably to 1993 models.

Meanwhile, more exotic cooling methods are trickling down from the nation's aerospace and defense laboratories. These technologies promise to shut down the conventional refrig-



Compact refrigerator runs on a sonic compressor, which liquifies a nonchlorofluorocarbon refrigerant and opens and shuts flapper valves to distribute cooling.



erator's power-hungry compressor and freeze out its ozone-devouring chemical refrigerants.

One near-term technology, the sonic compressor, shaves another 10% from a 1993-model fridge's electrical consumption. Instead of a mechanical piston, the sonic compressor uses a standing soundwave—a louder version of an organ pipe's resonance—to hammer the gas into a liquid. Sonic Compressor Systems of Glen Allen, Virginia, is trying to commercialize the device.

A related technology does away with the entire compressor-to-condenser cycle altogether. The thermoacoustic refrigerator, invented a decade ago at Los Alamos National Laboratories, also uses an earsplitting soundwave. But this time, the noise blares at 185 decibels into a small, well-muffled tube filled with pressurized inert gas, such as helium. Buffeted by the roar, the gas undergoes compression and expansion. A heat exchanger whisks the warmth away from the compressed gas, leav-

ing the chamber frosty.

Ex-Los Alamos physicist Steven Garrett—now at the Naval Postgraduate School in Monterey, California—recently re-engineered a compact GE refrigerator with thermoacoustic cooling, to prove that the technology needn't distort the appliance's traditional dimensions. But another cooling technique—solid-state refrigeration—promises to do just that.

This technique relies on the thermocouple, an electronic device in which circuitry joins two chips of dissimilar semiconductor material. Fed a current, the circuitry pulls heat from one chip to the other, leaving one side cold. Says Frigidaire's vice president for industrial design, Robin Edman, "We as designers are looking at this as a way of totally changing the envelope of the refrigerator." In replacing a single compressor sized to cool off a big cavity, thermocouples could nestle among smaller boxes, each with unique temperature requirements. Small, interchangeable refrigeration modules,

Li-Chin Liu's circular kitchen minimizes the structural requirements of the room, but maximizes the utility of the space it encloses. While kitchens are typically tucked away into corners, Liu's design is a freestanding centralized workstation. Both sides of the circle are accessible to multiple kitchen workers, and the open plan extends visual sightlines in all directions. Cylindrical modular appliances, finished in glass or ceramic, echo the design. Cabinets descend from the ceiling on motorized struts for easy access to stored items. Finally, the entire workspace is sealed off by an air curtain—a pressure differential emanating from floor and ceiling slots to prevent cooking odors, airborne particles and high humidity from permeating the rest of the house.

featured in RIT's kitchens, suddenly seem quite plausible.

Advantages? Thermocouples, like all semiconductor devices, run virtually maintenance-free. What's more, they can be reprogrammed to operate as defrosters, or even compact ovens, by reversing the current flow. But they do come with one chilling disadvantage—they soak up even

COOKING UP THE FUTURE

more power than compressor-driven refrigeration systems.

Home on the range

Will the range undergo such a radical transformation? Probably not, suggests Edman. "Certain things won't change, like how you prepare your food," he predicts. "Thirty years from now, you'll still have turkey, not little pills to eat. So you will need some type of cavity to heat food."

In brainstorming sessions, Edman's design team has conjured up its dream oven, which would combine conventional gas or electric elements with microwave, steam and infrared heating. The user could follow a preset sequence of cooking methods or override the automatic mode by punching in a personal recipe. Whether consumers would ever shell out extra money for such a super-range, however, remains a question.

It's more likely that wholesale change will come to the surface elements. One technology that has been stewing quietly for years is known as "gas under glass." A recent twist involves the gas igniting in a mesh of silicon-carbide fibers, instead of a vented combustion chamber, and heating a surface of Ceran high-temperature glass. The ceramic fibers heat up and cool off much faster than electrical elements, without suffering the same heat degradation. San Clemente, California-based Global Environmental Solutions, working with Ceranmaker Schott Glaswerke of Germany, is currently shopping this technology to appliance makers.

One surface-element concept never seems to burn out in consumer's minds, according to Edman. "It's the biggest wish that we hear in research: 'Why can't you make a range that only heats up where we put our utensils?'" An undivided surface, in other words, that stays cool except directly below a frying pan.

Surprisingly, the unitary cooking-surface idea isn't that far-fetched. Fast-food kitchens, for example, have witnessed the introduction of the MetCal self-regulating griddle, in which a large coil underlies the entire surface, heating the griddle by electromagnetic induction. Because the surface material loses its magnetic properties above a certain temperature, it's impossible to overheat. Meanwhile, GE recently added an induction cooktop to its Profile lineup. Under the unit's glasstop lies a magnetic coil that heats up a utensil without warming



MetCal grill heats up through electromagnetic induction, provided via coil. Cooking temperature stays even because the surface's magnetic properties fade if temperature rises too high.

the glass. One drawback: Induction heating only works with ferromagnetic cookware, such as pans made of cast iron or stainless steel.

Cleaning up the dishwasher

"Nothing will supplant the dishwashing system as we know it," says Whirlpool's corporate technology chief Mack Gray confidently, "but design techniques are progressing." Gray and his counterparts at other companies believe that clever design,



Ultrasonic dishwasher fills with water, vibrates food from dishes, then passes water through recycling loop where reverse-osmosis filter provides high-speed cleansing of contents.

rather than clean-sheet technology, will solve this appliance's two faults—its thirst for water, particularly when loads run small, and its back-straining location on the floor.

In a single stroke, Japanese designers have washed away both problems with the compact, countertop-mounted dishwasher.

But will Americans sacrifice a 24 x 24-in. spot on their crowded countertops, or would a better solution feature watertight bulkheads inside the standard floor-mounted box that would swing into place for smaller loads? "That's a solution that's easy to achieve if there's demand for it," says Edman. "But people aren't screaming for it, because they don't know it exists."

And what about the ultrasonic dishwasher? Such a device would fill with water and unleash a barrage of soundwaves, creating an army of microscopic bubbles that rattle food and grease off dishes. Although it could clean dishes quickly, it would run through much more water than a conventional dishwasher. "It's a solution looking for a problem," says Edman.

Yet no Kitchen Of The Future has been without one, from Frigidaire's '50s fantasies to the contemporary GE Plastics' Living Environments concept house in Pittsfield, Massachusetts. One way to bring the idea to fruition would be to run the dishwasher with its own water-purifying system—of the sort that manufacturers are now designing to minimize household water use. Frigidaire's parent company, Electrolux, for example, is testing a system that cleans and recycles water so fast that you could take a shower on 2 gallons of water. Ultrasound, meanwhile, does have the advantage of cutting down on hot-water use. For that reason, the utility Southern California Edison is analyzing the ultrasonic dishwasher as an energy saver.

Sticker shock

Everything you've just read about will cost more than today's equivalent. And that, more than anything else, keeps high-tech appliances pinned to the drawing board.


For this reason, the appliance makers look jealously at their Detroit cousins, who can sell technology-packed cars today for 10 times what they cost in the 1950s. If they can alter public perceptions about dishwashers the way Detroit has changed how people think of brakes, the Kitchen Of The Future will be as mouthwatering as the meals it produces.

FPM

POINTS *of* INTEREST

Collecting beautiful knives is in.
Making your own collectible knife is
even more in.

BY DAN COOPER
PM Photos by David Dewhurst



• Over the years I've done quite a bit of work with wood, metal and jewelry, and while I did enjoy each craft, I began to feel I was spreading myself thin. So about six years ago, I decided to concentrate on one discipline, one that involves the use of all my acquired skills—knifemaking.

Why knifemaking? Well, creating custom knives has been called an art form, and I believe it is. The top craftsmen produce pieces of grace and beauty out of what is essentially a utilitarian tool. Some are valued in the thousands of dollars.

But high-priced showpieces are often fantasy knives that feature extreme shapes and precious stones and metals. My interests are more down to earth. To me, a good knife must be beautiful, comfortable in the hand, affordable and able to perform the function it was designed for. Using these criteria, I designed a knife especially for POPULAR MECHANICS, and I made it in about 5 hours. Although I took a few shortcuts based on experience, I believe most readers can make this knife using the tools in a basic wood shop in one day. Here's how.

The first thing I did in designing the PM knife was draw a template, and then I made a list of materials. The idea behind the design was to create a good-looking custom piece with

POINTS OF INTEREST



a handle made of exotic woods and a sturdy utilitarian blade. To make the knife unique, I added two pieces of solid surfacing material (in this case Corian) and one of brass to the hilt. (See Material's List on page 69.)

To avoid the necessity of using metalworking tools, I recommend buying a commercially available blade blank. This is a solid piece of stainless steel with a rough-ground blade on one end and a tang (shaft) on the other. You can get hardened and finished blanks for about \$20 from such catalog companies as Koval Knives (P.O. Box 26155, Columbus, OH 43226) and Atlanta Cutlery (2143 Gees Mill Rd., Conyers, GA 30207). The blank I used has a drop-point hunting blade with an indentation known as a blood groove. It also has a narrow or internal tang that will be hidden inside the handle.

The first thing to do after assembling the materials (Photo 1) is to prepare the blade by sanding out the grind lines and imperfections with an emory cloth. For finishing and polishing, use a buffing wheel and tripoli compound.

Now move to the drill press and drill two holes in

the tang to accommodate the $\frac{3}{16}$ -in.-dia. brass pins (Photo 2). It's a good idea to wrap a piece of leather around the blade before securing it with a clamp to keep from scratching the surface. The first hole should be about $1\frac{1}{2}$ in. back from the hilt position. The second hole about 3 in. back.

Now move to the main worktable and snug a hand-held belt sander with a 50- or 60-grit belt into a bench vise (Photo 3). Although the blade has been pre-ground, the tang has not and the thicknesses are different. Grind the tang until its thickness matches the blade's. This is also a good time to cut off the threaded end of the tang, which isn't needed for this project. You can use the edge of the belt sander or a hacksaw to cut off the piece.

Next to the knife blank, the most critical piece of this project is the brass hilt. You can get brass bar stock either from a knife catalog company, where you can order most of the materials for this knife, or from a scrapyards. The hilt requires making a slot that will fit over the tang and then snug against the blade as tightly as possible. You can make this slot by marking



Sharp-looking Dan Cooper collectibles, left page from top: 8½-in. full-dress hunter; traditional buffalo skinner with a Soligen steel blade; classic presentation bowie knife with bird's-eye maple handle; and classic full-dress bowie knife with deer antler handle. This page from top: medium clip-point bowie with deer antler and rosewood handle; modified Japanese Tanto with tiger's eyes in the handle; classic presentation bowie with Coco Bolo handle; and 15½-in. full-function, clip-point bowie mountain knife.

the center point of the hilt piece with a pencil and using a drill press. A good tip is to back up the hilt with the brass extension piece, because it, too, requires a slot for the tang.

Choose a bit that's slightly smaller than the thickness of the blade, and then drill part way into the brass. Drill two more partial-depth holes along a horizontal axis on either side of the center hole. Keep drilling partial-depth holes until you punch through. If you go all the way through in one shot, the bit will slide off when attempting to make the side holes (Photo 4).

After finishing the holes for the tang slot, drill countersink slots on either side. These partial-depth holes will form a slot to secure the blade in place. They should be drilled about halfway into the hilt.

Two important tips will help you through the next few steps: 1. Secure the hilt in a jeweler's vise, which is a small portable vise on a swiveling

ball joint, and 2. Use a special flat-ended drill bit for milling work. You can make a flat-ended bit by carefully grinding the end of an old bit. Only the sides have cutting surfaces on this kind of bit, and I use them to grind away the edges in the hilt's tang slot and the two countersink slots. Be careful not to put too much pressure on the bit during this process because it can break easily. Repeat this process to create a tang slot in the brass extension piece. No countersink holes are needed here.

Now it's time to solder the hilt to the blade.

Clean the blade thoroughly, then wrap the tip in a scrap of leather before securing it in a vise (Photo 5). Put a liberal amount of flux in the hilt slot and around the base of the tang, then apply heat from a propane torch. Be sure to apply more heat to the hilt than to the blade. While both must be at the same tempera-

POINTS OF INTEREST



1 Assemble all materials. After cutting to size, there will be 16 pieces. Scrap from local shops works well in knifemaking.



2 Drill two holes in the tang for the brass pins. Protect the blade with a piece of leather before clamping in place.



3 Secure a belt sander in a bench vise, and sand the tang to match the thickness of the blade. Be sure to wear gloves.



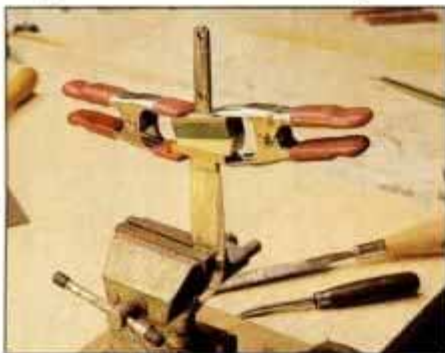
4 Note that a drill press is used as an overhead mill to produce a slot for the tang in the hilt and the extension piece.



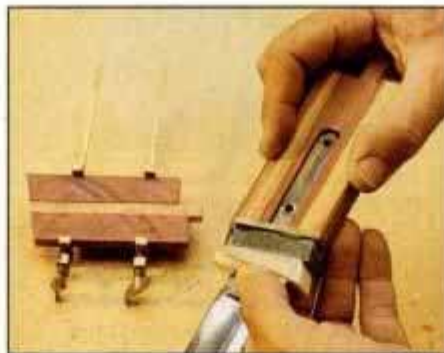
5 To correctly apply the silver solder, make sure the heat from the torch is directed more at the hilt than the blade.



6 Either a knife or a 3-sided file with polished sides can be used to scrape off excess solder. Be careful not to scratch blade.



7 Put epoxy on the extension pieces and clamp them to the hilt. Note the wedge shape of the white Corian piece.



8 Cut a tang slot in a piece of satine, then sandwich it with pieces of tulipwood. Then epoxy the outer scales.



9 After sanding flat all the inside faces of the epoxied pieces, apply epoxy and snug with as many clamps as you own.

ture for the silver solder to adhere properly, avoid overheating the blade (turning it blue) and removing its temper.

When the solder begins to run, make sure you use enough for a good fill with no gaps. The two things to be concerned about here are to avoid overheating and to make sure you have a solid gap-free fill.

After the solder hardens, scrape away the excess with a utility knife or a 3-sided file with the sides sanded flat and polished (Photo 6). This is an easy tool to make, and it comes in handy for scratch-free scraping. For fine work, use a piece of 400-grit sandpaper, which can be wrapped around the 3-sided file. A buffing wheel and compound will give the blade a polished finish.

Now it's time to fit the tang with the hilt extension, which consists of

two pieces of Corian and a brass end-piece. You can buy 1/2-in. Corian in large sheets, but these are expensive. If possible, try to work out a deal with a local cabinetmaker to buy scraps. As a template for the tang slot, use the brass piece that earlier served to back up the hilt on the drill press. Repeat the partial-depth drill procedure used earlier.

As a decorative touch, give the piece of white Corian a wedge shape by sanding it on an angle on the belt sander.

The next step is to epoxy the two pieces of Corian and the brass end-piece to the hilt. For all gluing on the knife, use a 2-part, 2-ton epoxy with a 5-minute set. After mixing and applying the epoxy, clamp the extension pieces snugly against the hilt (Photo 7), but not so tightly that the epoxy will squeeze out from the sides.

Now it's time to work on the 9-piece handle. The satine and tulipwood should be easy to find in 4/4 stock from any exotic hardwood supplier, or you can use wood of your own choosing. The first thing to do is to epoxy the three 3-piece sandwich sections.

Let's start with the center section. Take a piece of satine and cut a slot in one end to fit the internal tang (Photo 8). Use the tang as a template and make a rough cut with either a coping saw or a band saw. Now trim two pieces of 3/8 x 1/4-in. tulipwood and sandwich them between two satine pieces, then epoxy and clamp. Sand both faces to make sure the outer pieces, which are called scales in knifemaking, have smooth, flat surfaces to fit against.

Now trim two pieces of tulipwood to 1/4-in. width and sandwich them be-



10 With all but the brass pins in place, use a belt sander to smooth the sides of the handle. Gloves and a sure grip are required.



11 Draw a profile of the handle using a template based on the photos in this story, or create one by using a French curve.



12 Carefully cut along the pencil line with a coping saw to create the rough shape of the handle. Only fine work remains.



13 Use a belt sander to round out the shape of the handle. Always use gloves. This shot was done just for the camera.



14 Insert the brass pin bar in each hole in the handle. Cut so that the pins extend $\frac{1}{8}$ in. This enables the pins to be flared.

MATERIALS LIST—PM KNIFE

No.	Description and size
1	steel blank with 4" blade and $4\frac{1}{2}$ " tang
2	pieces of brass cut from bar stock, one: $\frac{1}{4} \times \frac{3}{4} \times 1\frac{1}{2}$ " for the hilt one: $\frac{1}{8} \times \frac{3}{4} \times 1\frac{1}{2}$ " for the hilt extension
2	pieces of $\frac{1}{2} \times \frac{3}{4} \times 1\frac{1}{2}$ " Corian, one jade green and one white
5	pieces of finished satine wood $\frac{1}{4} \times \frac{1}{2} \times 5$ "
4	pieces of 1" finished tulipwood $\frac{1}{4} \times \frac{1}{2} \times 5$ "
2	brass pins cut from $\frac{3}{16}$ "-dia. rod

tween two satine pieces. Epoxy and clamp. Note that the glue joints of the center section and the sides, or scales, are not aligned. The staggering of these joints is done to give more strength to the handle.

Now sand the inner faces of the scales on the belt sander to make sure they fit flat against the center section. Cut or sand the forward sections to cleanly match the hilt. The last step before epoxying is to go to

the drill press and drill holes for the $\frac{3}{16}$ -in. brass pins in one scale using the tang as a template. You'll finish the drilling later.

While epoxying the handle, keep in mind these tips: 1. Make sure to carefully position all pieces before clamping, 2. Be sure to clamp every piece and on every axis, and 3. Work fast to get everything done before the 5-minute set time (Photo 9).

After the epoxy sets, use the drill

press to complete the brass pinholes and then a belt sander to smooth out the sides (Photo 10). Then use a pencil to draw a profile on the wood of the PM knife handle. You can either copy it from the photos here or create it by using a French curve (Photo 11). Use a band saw or coping saw to cut along the pencil marks and then a round file or rasp to rough out the 3-dimensional shape (Photo 12). Do the detail work on a belt sander or a drum sander, then finish with fine sandpaper (Photo 13). Buffing and polishing is done on a high-speed buffing wheel with tripoli buffing compound.

Now put the brass pin bar in one of the holes in the handle. Cut the pin $\frac{1}{8}$ in. longer than the width of the handle (Photo 14). Repeat the process in the second hole. Then take out the pins. Now use a drill with tapered countersink bit to slightly countersink the pinholes. Roll the pins in epoxy, insert them into the holes and then gently use a small ball-peen hammer to flare the ends until the pins are tightly seated and don't move. Be careful not to crack the wood. For a fine finish, I use multiple coats of tung oil and then buff with paste wax.

Clean-up work can be done with a file, sandpaper and a buffer. You now have a beautiful knife that can last a lifetime. If you have questions or require more information, I can be contacted by writing to Daniel Cooper, Superior Woodcraft, P.O. Box 890121, Temecula, CA 92589. **PM**

Boating/Outdoors Editor Joe Skorupa assisted in the preparation of this article.

Custom Display Stand



Three-piece satine wood display stand can be assembled in 20 minutes or less.

● After completing the PM knife, you'll probably be more tempted to show it off than put it to hard labor. If that's the case, making a custom display stand is a simple matter.

The base is made of satine wood and measures $2\frac{1}{2} \times 3\frac{1}{2} \times 10$ in. The support pieces are $\frac{3}{4} \times 1\frac{1}{4} \times 2$ in. Use a router to round off the corners and top edges of the base, plus the tops and side edges of the supports.

Then cut a rounded notch $\frac{1}{2}$ in. deep into the top of the back support using a scroll saw to match contour of handle. Cut the back support first, then cut the front support in a narrow V shape to a depth that enables the knife to rest level. Use a band saw for the V cut, and make visual inspections until depth is correct. To secure the supports, drill and countersink the bottoms and insert screws through the bottom of the base. —D.C.



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THING A TRUCK CARRIES
ISN'T IN BACK.**

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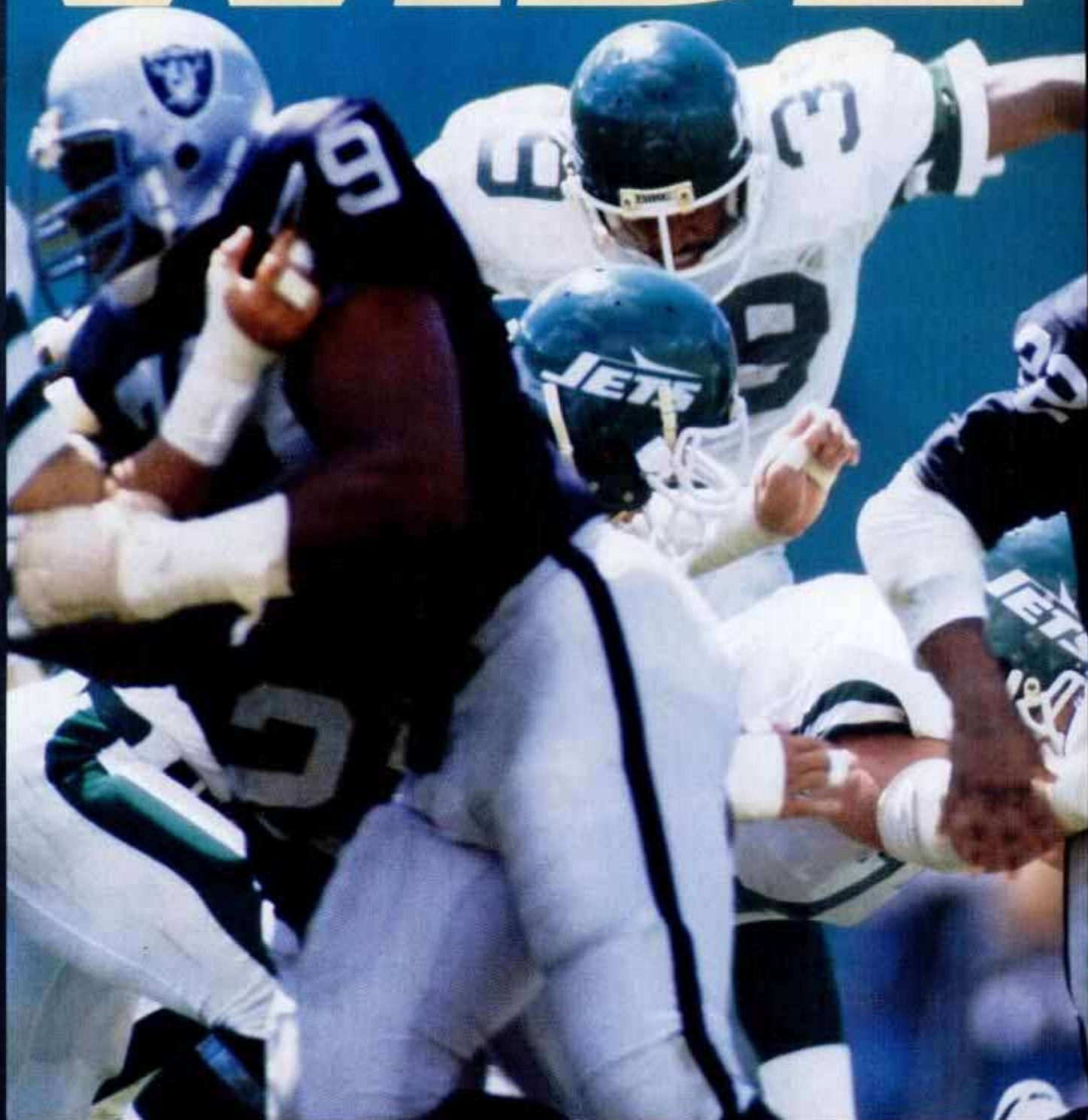
1994 F-SERIES



BUILT FORD TOUGH

ELECTRONICS

WIDE



● Look. Blink. Look again. Your eyes aren't playing tricks on you. Those new TVs on the showroom floor really are wider than the screens you're accustomed to—about one-third wider. This greater rectangular sweep gives them more in common with the movie house than the typical household TV. For all the talk about home theater in recent years, these wide receivers finally bring the theater home.

This new generation of television makes its debut in different screen sizes and display styles, from 34-in. tubes to 58-in. rear-projection sets. They come from JVC, Panasonic, Pioneer, Quasar and Thomson's ProScan and RCA brands. Prices vary too, from \$2500 to \$6500. What most have in common is a buzzword you'll be hearing a lot on the sales floor: "16-by-9."

The 16:9 (16-to-9) buzzword refers to the propor-

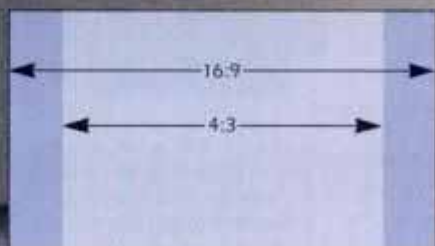
TV

The television of the future finally comes home, bringing with it a movie-size picture.

BY STEPHEN A. BOOTH, Contributing Editor



tions of the screen, specifically the width-to-height ratio. Although it wasn't an issue until now, the TVs in use since before "The Honeymooners" wed have had 12:9 proportions, usually called 4:3. When expressed in their least-common denominators, the new sets spec out at 1.78:1 versus 1.33:1 for the old. Say that three times, fast, and you'll see why TV makers settled on the 16-to-9 designation.



New 16:9 TVs are one-third wider than existing 4:3 models. The 16:9 aspect ratio is akin to movie theater screens.

Technical reasons aside, TV's original 4:3 ratio was meant to match the 1.33:1 movie proportions popular at the time—called Academy Ratio. But back when the theater industry saw the boob tube as a threat to its livelihood, moviemakers sought a hook to bring people back to the box office.

CinemaScope, with its 2.35:1 ratio, was Hollywood's first attempt to make an end run around video by going wide. The year was 1953 and the movie was "The Robe"—the type of sex-and-sandals epic that could really exploit the widescreen treatment. Over the years, different widescreen systems and ratios went to the movies—and left. Things got as wide as 2.76:1 with Ultra Panavision 70, and today's Panavision remains 2.35:1, but standard widescreen in the United States settled in at 1.85:1.

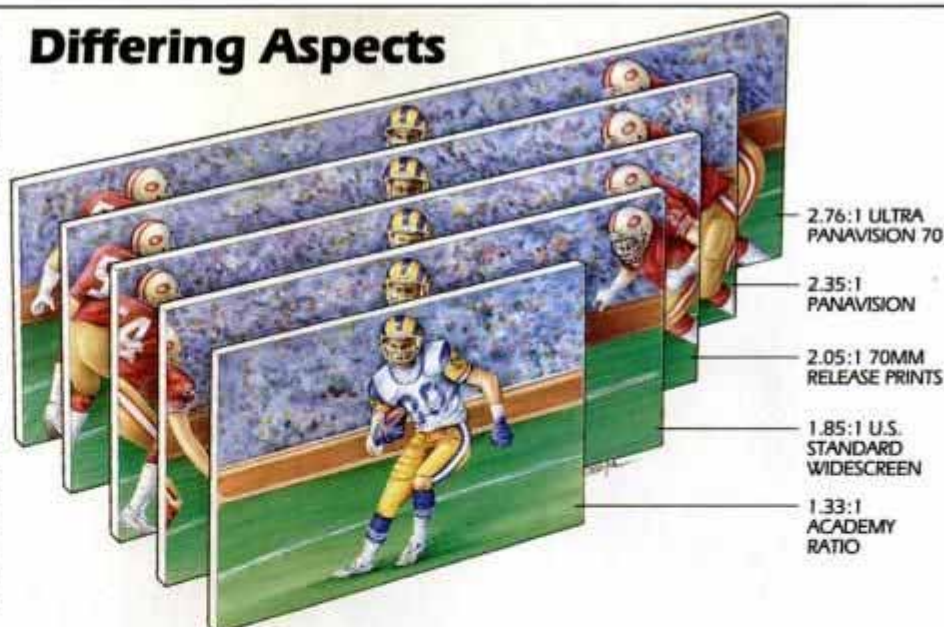
That's still too wide to display on a 1.33:1 television screen. Consequently, widescreen movies are shoe-horned to fit TV by a process called pan-and-scan. Instead of just lopping off the sides of the image—simple cropping—technicians rescan the film, panning horizontally to keep the central action on-screen. It's similar to televising a hockey game: The camera's supposed to follow the puck. But as every hockey fan knows, the action isn't always where the puck is—sometimes the fight is elsewhere.

Even with the most skillful pan-and-scan, about 30% of the movie's horizontal image is missing. In extreme cases, dialogue comes from off-screen or the pan-and-scan ping-pongs between two characters too far apart to converse in the same frame at the same time. Usually, it's just a matter of details trimmed from the periphery of the scene—details that the director probably intended you to see.

Home viewers got a chance to see the big picture with the arrival of prerecorded video. Movies are sometimes available in "letterbox" widescreen proportion on videocassettes and video-discs. In fact, more than 600 widescreen movies can be found on disc.

Letterbox videos reproduce the entire breadth of the original film. But to accommodate the full width, the height of the image shrinks proportionately. The black bands that appear above and below the picture give it a slot-like appearance on your TV, which is why

Differing Aspects



PH ILLUSTRATION BY DON MANNES

the term letterbox came to be. On foreign-language films, the lower band is often used for subtitles.

Letterbox video is a mixed blessing. On a modestly sized TV, the characters can appear quite small. Secondly, the quality of vertical resolution suffers. Letterbox movies don't use all of the 484 scanning lines available for the picture on a TV, usually only about 363. The rest are squandered on the black bands. Depending on the picture content, images might appear coarse on a large TV.

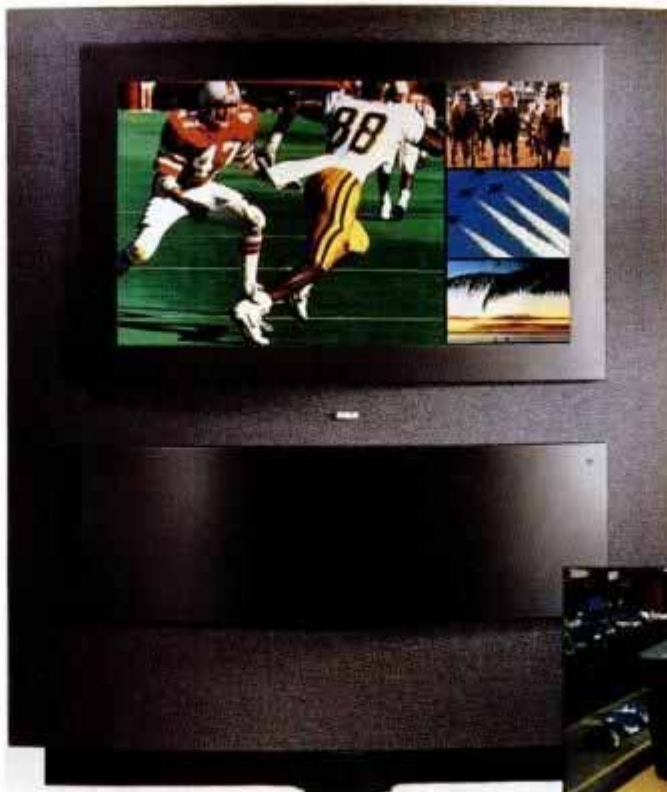
The new breed of widescreen TVs

eliminates much of what is objectionable about letterbox. For one thing, the 1.78:1 aspect ratio of the new sets is just about perfect for 1.85:1 widescreen movies. Regardless of brand, all the widescreen sets have a zoom feature that expands a 1.85:1 letterbox image to fill the whole screen. That nullifies the complaint about tiny characters.

Meanwhile, wider movie ratios such as Panavision and Ultra Panavision can be zoomed to fill the screen widthwise while displaying thinner top and bottom bands. They can be zoomed to fill the height of the screen too, although horizontal information will be cropped.

With displays as wide as 34 to 58 in.—large-screen by any standard—most movie buffs won't feel the need to sacrifice width information for height. Actually, first-on-the-block widescreen owners probably will use the zoom feature to teach new tricks to 4:3 TV broadcasts.

When displayed normally on a wide receiver, conventional 4:3 telecasts or videos will appear centered on the screen with black bars on either side. All the new mod-



RCA's 16:9 TVs, shown at right on the assembly line in Bloomington, Indiana, can capture a normal TV image while also displaying what's on three other channels. The 4:3 image can be blown up to fill the screen.

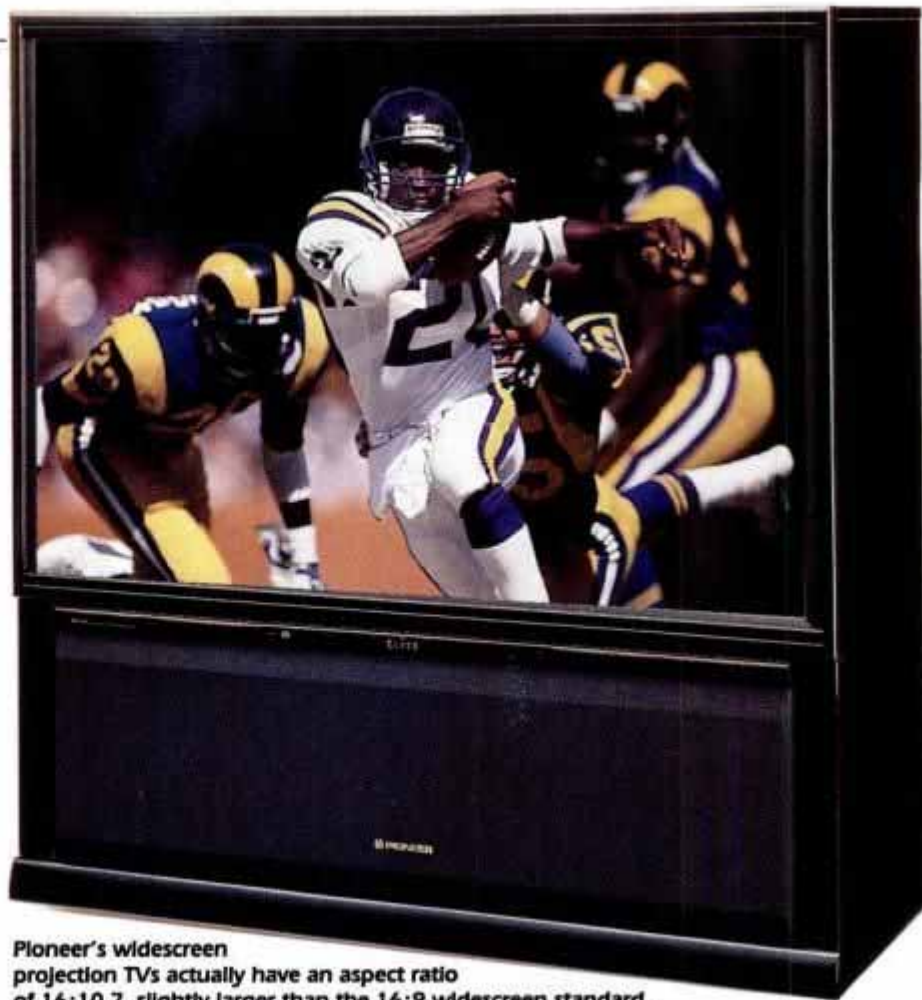


els let you shift the image to one side and use the remaining 25% black (read "blank") portion to display picture-outside-picture (POP)—other TV channels or another video source.

Another option is to take that central 4:3 image and blow it up to fill the display's width. Of course, when you expand the 4:3 image widthwise, the top and bottom of the picture disappear off-screen.

Naturally, the new 16:9 TVs have to compensate for this problem and the wide receivers from RCA and ProScan, JVC and Pioneer do. Perhaps no TV does it better, though, than the RCA G34169ET and ProScan PS34190 (both 34-in. tubes, \$4999). You are in control.

Both have a unique scrolling feature that lets you move the zoomed image up or down. Let's say you're watching a movie with lots of facial closeups, whereby the zoomed image results in facial closeups that lobotomize characters at the eyebrows. Simply use the remote control to scroll the image downward and give your subjects a hairline. Or, you might be watching a ballgame where long, wide-angle shots predominate but box scores, stats or other textual information appear at the bottom of the screen. Again, simply apply the zapper to scroll the image up, edit out the grandstand crowd but keep the game action and stats on-screen.



Pioneer's widescreen projection TVs actually have an aspect ratio of 16:10.7, slightly larger than the 16:9 widescreen standard.

JVC and Pioneer handle the image manipulation differently but also uniquely. Instead of giving you the

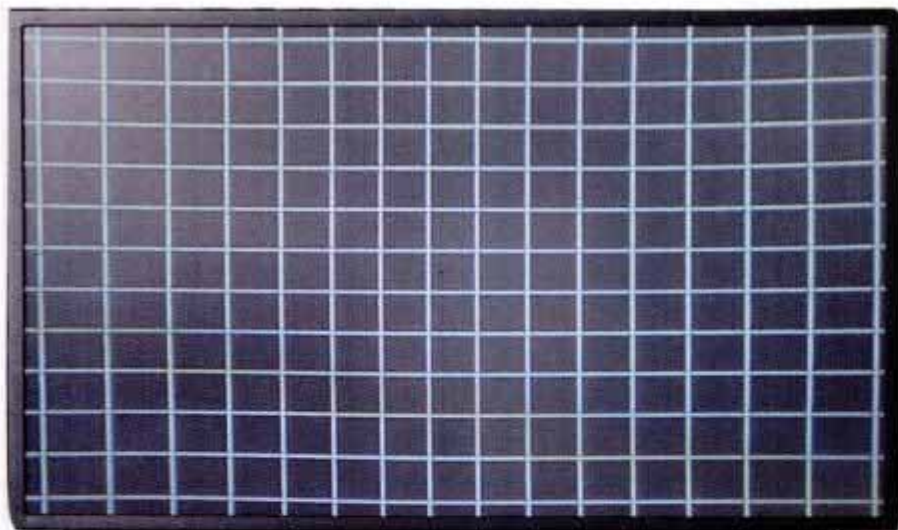
joystick, they seem to be saying, "Leave the flying to us."

In JVC's case, the 55-in. NV-55BX4 rear projector (\$4495) fills the width of a 16:9 display with a 4:3 image without losing any vertical information. It does so by stretching the image where it matters least—at the extremes. The company's Panorama Mode leaves the central 60% of the picture intact, then pulls the 20% at the left and right progressively. Though this might sound strange, our eyes-on evaluation discerned nothing objectionable. It's cheating, for sure, but with images originally meant to be displayed in 4:3 ratio, there usually isn't much on the sidelines worth crying over.

If JVC gives its pitchers a home-field advantage by expanding the foul territory, Pioneer favors its hitters by bringing in the fences. The 10 rear-projection TVs (PTVs) in Pioneer's line (45 in. to 55 in., \$2500 to \$4000) are the exceptions to the 16:9 rule: Their aspect ratio actually is 16:10.7.

Though the number seems bigger, and sales hype will try to make it out to be, it ain't. A ratio of 16:10.7 factors out to about 1.5:1, wider than yesterday's TV but not so horizontal as tomorrow's. Consequently, widescreen movies shot in 1.78:1 and 1.85:1 will display minimal letterbox bars. Meanwhile, the Pioneer PTVs

(Please turn to page 127)



JVC expands a 4:3 image to fill the 16:9 screen by stretching the picture at the periphery. The on-screen grid shows squares at the center of the picture. At the edges, the squares are stretched into rectangles. The effect is hardly noticeable when viewing an actual program.

JVC

PHOTO BY BOY AT INQUIRY

INSET PHOTO BY FOCUS ON SPORTS



ICEHUNTERS

One of the worst iceberg seasons on record tests the system of aircraft, satellites and computers that guards against a repeat of the *Titanic* disaster.

BY MICHAEL DANE; PM Photos by Skip Gandy

• A thick Newfoundland fog settles around the Coast Guard C-130 as the flight crew brings the rugged beast to life. "No. 3 engine cleared...rpm...fuel flow...ignition." Back in the Hercules' cavernous cargo bay, three members of the International Ice Patrol study the day's flight plan. Assisted by two of the world's most effective surface search and mapping radars, they will comb thousands of square miles of frigid North Atlantic water for the deadly reefs of ice that drift down from the Greenland glaciers each year.

The hazards of the North Atlantic are legendary. Within the International Ice Patrol's 45,000-sq.-mile area of operations, a complex system of arctic and temperate currents collide, creating dense fog banks. Riding south on the chill waters of the Labrador Current, fleets of icebergs ranging in size from million-ton dreadnoughts to hundred-ton "growlers" present a silent, ever-changing obstacle course.

Yet these waters are vital to commerce. The great circle routes linking Europe and North America pass

through here, and fishing boats are lured by the bounty of the Grand Banks. This morning's flight will demonstrate one link in a complex system devoted to preserving lives and livelihoods in an unforgiving environment.

Titanic legacy

The International Ice Patrol (IIP) can trace its origins to a clear night in April 1912. Just south of the Grand Banks, at about the latitude of Providence, Rhode Island, the *RMS Titanic* encountered a small iceberg that sent more than 1500 to their deaths.

The disaster shocked governments on both sides of the Atlantic into unprecedented cooperation. On February 17, 1914, the Revenue Cutter Service, forerunner of today's U.S. Coast Guard, was charged with the mission of ice patrol during the season of iceberg danger. The cost of the patrol was to be borne by the nations that created it. After 80 years, the U.S. State Department still sends each of 18 participating countries a bill based on the gross registered tonnage that traverses the danger zone under its flag each season.

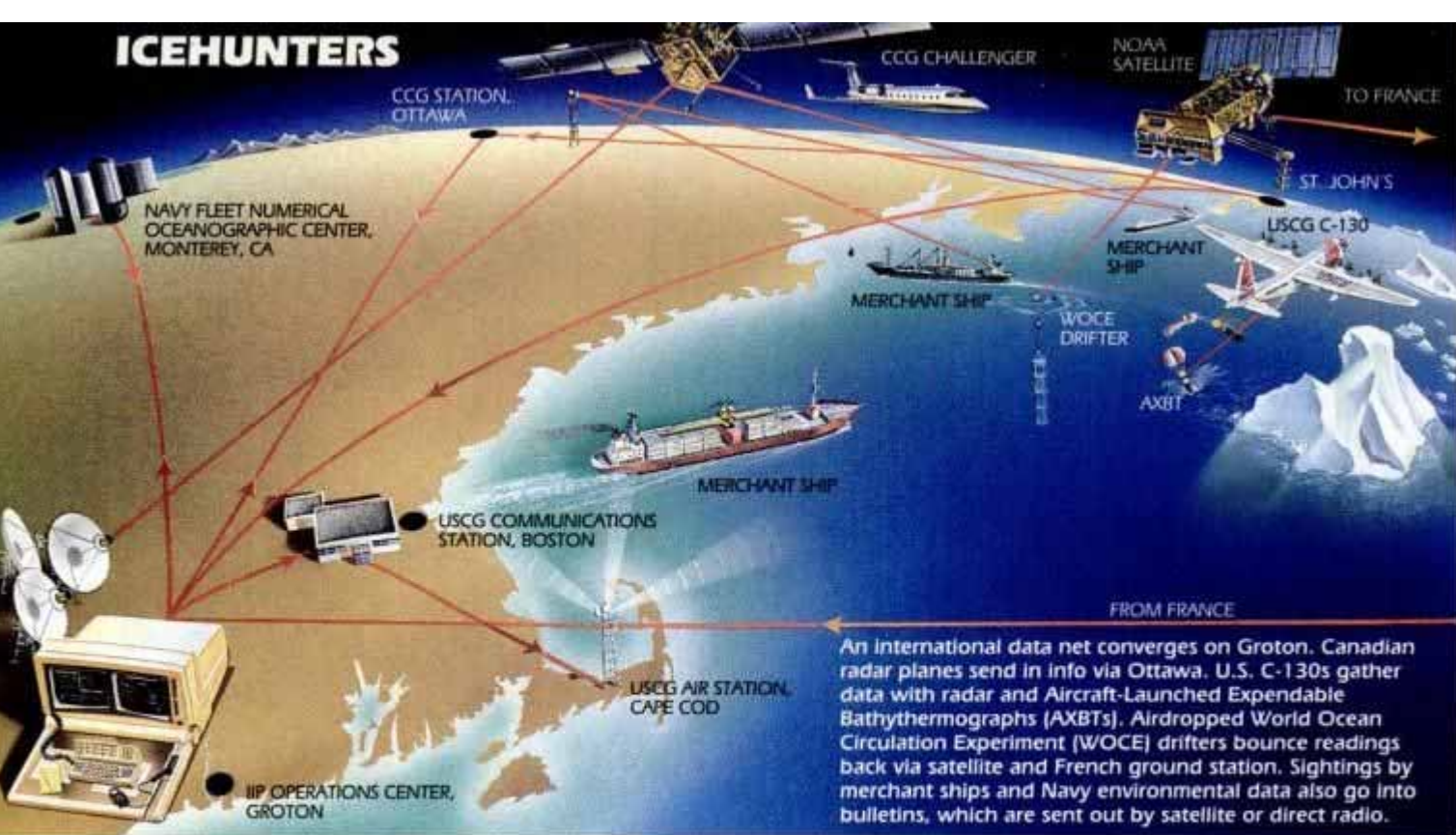
"Surprisingly enough," says International Ice Patrol chief scientist Don Murphy, "they've always paid." It may be that they know a bargain when they see one. For about \$3 million a year, the IIP deploys radar-equipped aircraft, satellite-tracked buoys and air-dropped ocean temperature sensors, employs a sophisticated computer model to predict the drift paths of





Coast Guard 1504 banks to get a good look at a growler off St. John's, Newfoundland.

ICEHUNTERS



An international data net converges on Groton. Canadian radar planes send in info via Ottawa. U.S. C-130s gather data with radar and Aircraft-Launched Expendable Bathythermographs (AXBTs). Airdropped World Ocean Circulation Experiment (WOCE) drifters bounce readings back via satellite and French ground station. Sightings by merchant ships and Navy environmental data also go into bulletins, which are sent out by satellite or direct radio.

hundreds of icebergs and transmits continually updated ice bulletins in voice, text and graphic formats to ships at sea. Since its inception, not one ship has been lost to ice in the IIP's patrol area.

Iceberg central

Heart of the IIP network is an operations room housed in the U.S. Coast Guard R&D Center in Groton, Connecticut. The campus-like center is home to the Ice Patrol's 12 Coast Guard personnel. Specialized knowledge is contributed by two civilians: Murphy, an oceanographer by training, and Greg Wright, a computer expert.

When we visited, Wright sat before the twin screens of an Intergraph workstation and explained the Ice Patrol's Berg Data Management and Prediction System (DMPS).

On the right screen is a high-resolution color image reminiscent of a Strategic Air Command target diagram. A topographic map is overlaid with dozens of circles of varying sizes, meandering lines trailing from their epicenters.

What appears to be topography is actually bathymetry—the shape of the ocean floor. Off the Newfoundland coast, a glowing blue line shows where the section of the continental shelf known as the Grand Banks drops off into the depths of the North Atlantic.

Wright moves a mouse to select the center of a circle, bringing up a text file on the left screen. "What you have here," he says, "is the attribute

report for that berg. It tells you who sighted it when, radar or visual, size—everything we know about the berg."

Returning to the graphics screen, Wright explains the symbology used to track the bergs. Surrounding each target is an "error circle" reflecting the degree of uncertainty in each berg's position. The DMPS uses drift algorithms to crunch ocean current and wind data, generating a drift track. But predicting the motion of errant mountains of ice is an uncertain business. "There are just too many variables in the ocean environment," says Murphy. "We've tested

ocean currents, overlaying a swarm of tiny blue arrows on the display. "Current vectors," says Murphy. "Here's an area where bergs become extremely difficult to predict," he says, pointing near a submerged mountain called the Flemish Cap. Below it, the glowing blue arrows look like a tangled diagram of some ancient skirmish.

Accurate predictions are particularly vital this season because an unusual number of icebergs have drifted outside the patrol's area of operations and into waters where they could catch mariners offguard. Why? Cmdr. Alan Summy, operational leader of the International Ice Patrol, has ideas but no answers. "It could be a change in the Gulf Stream-North Atlantic current system," he says, "or perhaps a new jet off the Labrador Current."



This Nov. 1933 PM article testifies to the IIP's long history.

our model by marking bergs with airdropped tracking buoys and found that its predictions are good out to about five or six days."

Each day a berg drifts unsighted, accuracy drains away and its error circle grows—from a 10-mile radius on day one to 30 miles on day five.

Going to a menu, Wright selects

Predicting the unpredictable

The basic algorithms at the heart of the Ice Patrol's predictive model were written in the 1970s, but until a year ago, all berg locations had to be plotted by hand. The new DMPS, with its powerful graphics capabilities, is the result of years of close cooperation with the Canadian Atmospheric and Environmental Service.

Starting with the Coast Guard's numerical model, the Canadians developed a graphical interface that multiplies the user's power to analyze berg location and environmental data.

"It used to be that every berg we



Aboard the C-130, icepicks make visual sightings (left), and radar operators man console with FLAR on left and SLAR on right.

spotted was a new berg," says Murphy. "Now, we have the predictive ability and the accuracy to say 'okay, that's the same berg we saw before,' and re-site it." The operational benefits are tremendous. Instead of flying ice reconnaissance from Newfoundland every day of the iceberg season, the Ice Patrol can now send out a reconnaissance detachment, or "rec-det," every two weeks.

In 80 years of performing its primary mission—alerting ships at sea to the boundaries of the area of ice danger—the Ice Patrol has amassed a considerable body of intelligence on its adversary.

Silent destroyers

The ice that now threatens ships in North Atlantic sea lanes once fell as snow on Greenland. Accumulating over centuries, the snow was compressed by the weight of successive layers to form an icecap that is in some places as much as 2 miles thick.

Where Greenland's icecap meets the sea, huge chunks are broken off by tidal action and the incessant pounding of waves.

The newly calved icebergs effervesce in the arctic water as they begin to melt, releasing tiny pockets of compressed air trapped during their formation. With a density ranging from 0.82 to 0.87 times that of water, the bergs ride low with only one-eighth of their mass visible above the surface.

Icebergs come in all sizes, but the true giants are found only in arctic waters. Some tower 300 ft. above the water, measuring more than a third of a mile in length and breadth. Such

a berg might displace 1½ million tons.

In the early years of the IIP, many attempts were made to destroy icebergs by means ranging from naval gunnery to torpedoes and aerial bombardment. The bergs shrugged off the worst the Coast Guard could dish out, and the experiments were abandoned.

"In fact," says Summy, "breaking up a big berg into smaller pieces can increase the danger by making detection more difficult." In 4-ft. seas, small bergs known as "growlers" can virtually disappear in the swell. Yet, a typical growler still packs a 100-ton punch.



In full daylight, with clear visibility, larger bergs pose little danger to a ship with alert lookouts. But off the Grand Banks, fog, haze and foul weather are the rule. In this environment, icebergs seem almost designed for stealth, their milky-white color blending with the mist.

Ice flight

Not even the best shipborne radar sets can be completely relied upon to provide a warning. Glacial ice is 60 times less reflective to radar than

metal is. In heavy seas, a growler can be almost impossible to detect, even with the expert use of anti-clutter devices. Worse, atmospheric conditions off the Grand Banks at the height of the ice season tend to reduce radar propagation, cutting detection range.

The key to ice detection is altitude, or "height of eye." Radar-equipped Coast Guard C-130s, flying carefully choreographed search patterns at 6000 to 8000 ft., can see down into wave troughs and pick even small bergs out of the clutter.

Coast Guard 1504 is one of two HC-130H Hercules aircraft that are the mainstay of the IIP's ice-recon capability. From its base in Elizabeth City, North Carolina, the aircraft and its 10-man flight crew make the hop to Providence, where I get on with Senior Ice Observer Lt. Al Ezman and two other "ice-picks." From there, we fly on to St. John's, Newfoundland.

The next morning, as we taxi out for the first flight of the rec-det, a Canadian Dept. of Oceans and Fisheries King Air is shutting down its engines. "Looks like the fish police aren't flying today," says one of the flight crew.

As soon as we're airborne, the runway lights are swallowed by the mist. "Could we land here in these conditions?" I ask the pilot, Lt. Cmdr. Dan Osborne. "No," comes the easy reply. "If it's like this on the way back, we'll be spending the night in Gander or wherever we can get in."

Just behind the flight deck, two Ice Observers provide visual verification

(Please turn to page 131)

HOME&SHOP JOURNAL



HOME IMPROVEMENT

PAVING THE WAY

A step-by-step guide to installing brick driveway pavers.

BY CLIFF GROMER

● If your driveway looks like a jigsaw puzzle marred by cracks and make-do patch jobs, consider redoing this drab and boring surface with handset driveway pavers. They are

available in a wide range of materials including concrete, asphalt and brick and in an even wider range of colors, textures and patterns. When you combine their beauty with their well-

known durability, you end up with a surface that will be an eye-catching focal point of your landscaping for years to come.

Perhaps its greatest asset, however, is the paver's flexibility. While rigid concrete and asphalt surfaces can crack due to relentless freeze-thaw cycles, a mortarless, semi-rigid interlocking grid of pavers—set on a bed of sand—is designed to float with the ground movement and give with any stress. The pavers themselves can be laid relatively quickly once the base is properly prepared. And, once installed, pavers can be easily replaced if damaged or removed for



the pavers in place and installing edge restraints to keep the pavers from moving.

Depending on your experience, you can do all or part of this job yourself. For most of us, however, the best path would be to have the surface and subbase prepared by professionals, leaving the less complicated installation of the sand bed, brick pavers and edge restraints to fill up our weekends.

Site preparation

Begin by laying out the areas to be paved. Drive stakes into the ground at the corners, and run mason's string to establish reference points for the finished surface. For proper drainage, allow a minimum slope of 1 in. in 10 ft. We opted for a uniform slope from the garage slab to the sidewalk.

Take up your existing driveway material and determine the condition of the subgrade. A professional usually can tell if extensive subgrade preparation will be necessary by the age and condition of the existing surface. A relatively new surface with severe cracking usually indicates a problem. You can rent an air compressor and a jackhammer to break up concrete (Photo 1), or use the old reliable pickax and prybar method. Once the surface is broken, remove all the debris. You can use the tried-and-true wheelbarrow-to-pickup-to-dump method, if this is allowed in your area, or simply arrange to have

access to underground utilities.

For our job, we chose some repressed chamfered brick pavers from Glen-Gery Brick. One color, Spring Hue, was used for the overall pattern, while another, Chambersburg, was used for occasional darker-colored accents. (Glen-Gery has many different styles and colors of pavers, as well as other types of glazed and unglazed bricks, to satisfy the requirements of nearly any landscape or paving job.) We also chose a herringbone installation pattern, but there are other options to suit different tastes. These should all be on view at your local brick dealer.



This badly cracked and broken asphalt driveway was a perfect candidate for replacement. Brick pavers are a very durable and attractive alternative to asphalt and concrete.

Before you begin

Generally speaking, there are five key steps to installing a paver drive: preparing the site, laying down a subbase, installing a sand bed, laying

Pavers: Spring Hue and Chambersburg Repressed Chamfered Pavers by Glen-Gery Brick, Wyomissing, PA 19610

Retaining wall blocks: Keystone Blocks, Anchor Concrete Products, Brick, NJ 08724

Installation: Lombardi Paving, Matawan, NJ 07747



1 Begin by breaking up old asphalt or concrete. Use an air hammer and a compressor or work with a pick and prybar.



2 Remove all the concrete or asphalt debris. Then excavate to the proper depth to accommodate the subbase and the pavers.



3 Once the surface is prepared, lay down a 6-in.-thick layer of reprocessed concrete to establish the primary subbase.



4 Then install the secondary subbase by spreading a blended layer of crushed concrete and $\frac{3}{4}$ -in. crushed stone.



5 If you need a retaining wall, like we did, lay out the position of the wall using level mason's string, as shown.



6 Spread a base of fine sand where the retaining wall will be, and then start installing the block. Level each in place.



7 Stagger the courses of block as you go up. It's better to align the full blocks first, and then cut the half blocks to fit.



8 Measure, mark and cut the blocks to size with a masonry saw or with a masonry blade installed in a circular saw.



9 As you stack the blocks, make sure to fully engage the retaining lip on the back of each with the course below.

a dumpster on site and hire a professional with a backhoe or Bobcat to remove everything (Photo 2).

If the existing subgrade and stone base are in good condition, you can finish grade and compact the base, lay down your sand bed and install the pavers. Problems such as a shifting or settling subbase, poor drainage and so forth, however, require taking

up the subbase and excavating the soil—normally about 8 in.—until you hit firm, unmolested ground.

Since stabilizing the subbase is critical for the finished job, unstable ground should be looked at by a professional for specific recommendations. Very wet ground resulting from a high water table or an underground spring in the area usually re-

quires additional drainage measures, such as running a drainpipe from the subbase to the street—if zoning regulations permit—or into a small dry well. We were able to stabilize the soft clay soil by cutting down the grade a total of 12 to 15 in. to accommodate a deeper stone subbase for support and drainage.

In stable soil conditions, lay a sub-



10 Spread out the sand for the setting bed, and then compact it with a rented vibrator to a depth of about 1½ in.



11 Embed flat steel screeding bars in the sand bed. Adjust the height of the bars to match the bottom surface of the pavers.



12 Using a 2 × 6 board that spans the width of the bars, screed the sand base to a uniform height. Fill any gaps as you go.



13 Set the bricks for the shoulder course on one side of the drive, and then start with the overall pattern in one corner.



14 When the pattern reaches the other side of the drive, stretch a string for the shoulder course and mark the bricks.



15 Pick up each brick from the pattern that needs cutting and number it in sequence so it can be replaced easily later.

base of ¾-in. crushed stone in 4-in. layers, raking it flat and compacting it with a gas-powered vibrating machine. Use care around utilities to ensure uniform compacting. Under normal conditions, a crushed-stone subbase 4 to 6 in. deep is sufficient for a walk. Vehicle loads require 8 to 12 in. of crushed-stone subbase.

In soft-soil conditions, as we encountered, first lay down a 3-to-6-in. subbase of 3-in.-size stone in 3-in. layers. Recycled concrete, also called reprocessed concrete, is a less expensive alternative that works just as well (Photo 3). Flatten and compact the subbase after each layer with the vibrator. Then spread two 3-in. layers of ¾-in. crushed stone or reprocessed concrete (Photo 4). Vibrate to compact the surface after each layer. The final compacted surface will determine—in large part—the contour of the finished paved surface, so take extra care with this step.

Edge restraints are used around the drive to contain the pavers and to keep them from shifting. Various materials, including rot-resistant wood,

metal or bricks set in concrete, can be used for restraints. On our job, we used a small retaining wall on one side and a simple concrete-filled trench on the other. No matter what edge-restraint system you use, establish the location of one side. Then lay out a sample of your paver pattern against this fixed edge for a trial fit. Keep in mind that adjusting the location of the opposite edge restraint a few inches can significantly reduce the number of cuts in the pavers that will be required to make the pattern fit in a balanced way. Once the location of both edge restraints was established, we built our retaining wall.

Retaining wall

To build the wall, lay out the position of the base course of blocks using stakes and string (Photo 5). Lay down 1½ in. of sand for the setting bed. Smooth the sand and place the blocks down squarely on it. We started at the corner of the house and laid the blocks down the walk and around the corner to the drive.

Tap the blocks into position with a

rubber mallet to set them to the correct height as determined by the mason's string. Butt the blocks along the string and, in the flat sections, check for level with a 4-ft. level (Photo 6). Lay down the second course of blocks, staggering the joints over the base course. Measure for a half block (Photo 7), then mark a whole block with a square and cut it with a masonry saw (Photo 8).

A beveled lip at the rear of the block prevents it from shifting forward on the base course, so make sure this lip is pushed tight against the blocks below (Photo 9). The weight of this upper course also prevents the base course from shifting.

Pavers

To lay the pavers, prepare the base by spreading the sand setting bed and compacting to a 1½-in. depth with the vibrator (Photo 10). Then, screed the sand to a depth that will bring the pavers up to the desired finished height. Work from the top of the drive toward the street. First, lay down a pair of flat steel bars about



16 Cut the bricks with a rented, water-cooled masonry saw. Cut each paver $\frac{1}{4}$ in. shorter than the mark.



17 Fit all cut pieces back into the pattern following the numbers. If a piece is a little too long, recut it.



18 Once all the cut pieces are in place, install the shoulder course, making sure each brick is flush.



19 With all the pavers in place, spread a thin layer of sand over the surface and force it into the cracks with the vibrator.



20 Once all the cracks are filled with sand, sweep up any extra sand and rinse the entire surface with water.



21 Dig a 4-in.-wide \times 6-in.-deep trench where the bricks meet the soil. Fill with concrete to keep the bricks from moving.

3 to 5 ft. apart. Then, adjust the height of the bars by placing a paver on each bar and running a mason's string between your reference strings on both sides of the driveway (Photo 11). This string should just brush the top of the test pavers. Screed the sand by sliding a straightedged 2×4 or 2×6 down the length of the bars (Photo 12).

Start laying the pavers by placing them squarely in the sand, one flush against the other. Don't slide them into position to avoid creating a ridge of sand against the paver. Start your pattern at one point—preferably a lower corner—and work outward from there. If you start your paving from different points, it's almost impossible to match up the areas where they meet. Select a starting point on the project that allows for continuous access, and set the pavers in the desired direction (Photo 13).

On our project, we opted for a shoulder course of full straight pavers before starting our 45° herringbone pattern. We used a fixed edge reference on the left side of the drive—our retaining wall—but we let

the right edge float until the pattern covered the full drive area.

Fitting pavers around corners and other obstructions and against the shoulder course requires cuts. Several types of cutting devices are available, including masonry saws and mechanical and hydraulic guillotines. The saw is the most accurate tool and the best choice when you have a lot of cuts to make.

Lay as many full pavers as possible in the pattern. To position the shoulder course on the right side of our drive, we laid full pavers on top of the pattern and traced a line along the edge of the shoulder course to indicate the cuts needed in the pavers below. To set the left edge of the drive, we ran a string from the shoulder course at the retaining wall down to the sidewalk. We then scribed a line on the pavers for the required cuts (Photo 14).

Remove the pavers to be cut. You can cut them one at a time, which can be time consuming, or use a numbering system to identify the position of each paver (Photo 15) and cut them

en masse. Mark the unit to be cut exactly at the edge line. Then cut $\frac{1}{4}$ in. behind the line (Photo 16). Never force a cut that doesn't fit. Fit the cut pieces back into the pattern (Photo 17), and lay down the shoulder course—in our case, between the pattern and the retaining wall (Photo 18).

Once all the pavers are laid into position, spread fine sand over the bricks and run a vibrator over the entire surface (Photo 19). This further firms up the bedding sand and also forces some of the sand into the joints between the blocks, which improves the interlock. Do not vibrate within 1 yard of an unrestrained edge of the paving. This will cause joints to open and force the surface to dip or bulge. Sweep loose sand into the joints to completely fill any voids, and continue sweeping to remove any surplus sand (Photo 20). Finish the job by setting the right-side concrete edge restraint. Dig a trench 4 in. wide \times 6 in. deep and trowel in some concrete (Photo 21). Once the concrete has set (at least 24 hours), the drive is ready for service. **PM**

COMPARISON TEST

RECIPROCATING SAWS

When it comes to just plain cutting, there are few saws as versatile as these.

BY THOMAS KLENCK,
Associate Home
Improvement Editor



● Let's say you're converting that little-used spare room into a second bath. You need to take down a wall, add a new window and reroute some plumbing, wiring and the hot-water heat. There's a lot of stuff to be cut—metal and plastic pipe, wallboard, flooring and that bane of all typical saw blades, nail-embedded wood. The job isn't going to be pretty—at least not in the early stages. You could take out your circular saw and sabre saw to get the work done. Or, you can take a tip from the folks that do this kind of work every day, pros that wouldn't be without the one saw that does it all—the reciprocating saw.

Reciprocating saws are not your run-of-the-mill homeowner tools. Unlike other power tools, most manufacturers only offer heavy-duty models designed for professional use. However, this tool has a place in the serious do-it-yourselfer's arsenal, as well. If you are involved in extensive remodeling, are building your own home or cottage or simply want the capacity to take on



MILWAUKEE 6527



RYOBI RJ-100VK



AEG SSPE 800



PORTER-CABLE 9637



SEARS 17102

big jobs with the resources that a pro would expect, a reciprocating saw may be a worthwhile investment.

What's so special about this tool? First of all, it's designed to cut through most of the materials found in a house. Equipped with the right blade, you can handle metals ranging from cast iron to copper, wood, nails, plaster—in fact, anything except masonry. Secondly, you can make straight, curved, angled and plunge cuts—all in areas that most other saws can't even reach. And finally, this saw's massive construction means that it will be around doing the job for a long time.

There is a down side. Reciprocating saws are typically large and heavy (most are more than 16 in. long without the blade, and average nearly 8 pounds), and they come without fences or guides for making precise cuts. These are strictly freehand tools that you control with a good eye and a strong arm.

Reciprocating saws are basically mechanical keyhole saws. They utilize a tapered blade that ranges from a standard 5-in. length up to about 12 in. for special applications. Special blades are available to suit the mate-

rial, and some are designed for composite materials, such as wood with embedded nails. Bimetal blades are more expensive and feature hardened-steel teeth fused to a tougher, but less hard, steel body. Unlike sabre saws, where several blade designs exist and some models require a specific blade shank, reciprocating saw blades are standard.

The blade is held to the reciprocating shaft with a small blade clamp and Allen screw. The shaft itself is either rectangular or circular in cross section and rides back and forth in a pair of linear bearings (see drawing on opposite page). Square-shaft tools have a wraparound blade clamp that encircles the shaft end. Most round-shaft tools, on the other hand, have a simple split-shaft clamp. To facilitate plunge cutting and work in confined spaces, the blades can be reversed in the blade clamp.

To transform the rotary motion of the motor into linear, reciprocating motion, these saws use one of two transmission designs. The most common features a helical pinion gear that powers a flat drive gear at right angles. The drive gear has an offset roller bearing that acts as a crank. In

conjunction with a channel mounted to the reciprocating shaft, or slider, the circular motion is converted to reciprocating motion.

An alternative mechanism is employed in the Milwaukee and Porter-Cable saws. Here, the rotary motion is transmitted to a driveshaft that has an angled, offset end. Mounted in a ball bearing on the offset driveshaft end is a crank, or arm. The top end of the crank is held captive in the reciprocating shaft through a ball-and-socket arrangement. As the driveshaft rotates, the crank moves through an arc that corresponds to the changing angle of the offset shaft end, and the top of the crank pushes the reciprocating shaft forward and backward.

Although reciprocating saws are powerful tools, they aren't known for their blazing speed and therefore don't require the high-amp motors usually found on circular saws. The saws we tested range from about 6 to 8.4 amps. Our selection is comprised of variable-speed models. Variable speed allows you to handle different materials effectively and provides greater control. The speed is regulated at the trigger, with some models



HITACHI CR10V



DEWALT DW 306



BOSCH 1632



MAKITA JR3000V

having a separate speed dial to set the maximum speed. Most manufacturers also offer their design in a nonvariable-speed version with two fixed speeds.

The only adjustable component on a reciprocating saw is its foot, or shoe. This part is analogous to the base on a sabre saw or circular saw and resists the cutting thrust of the

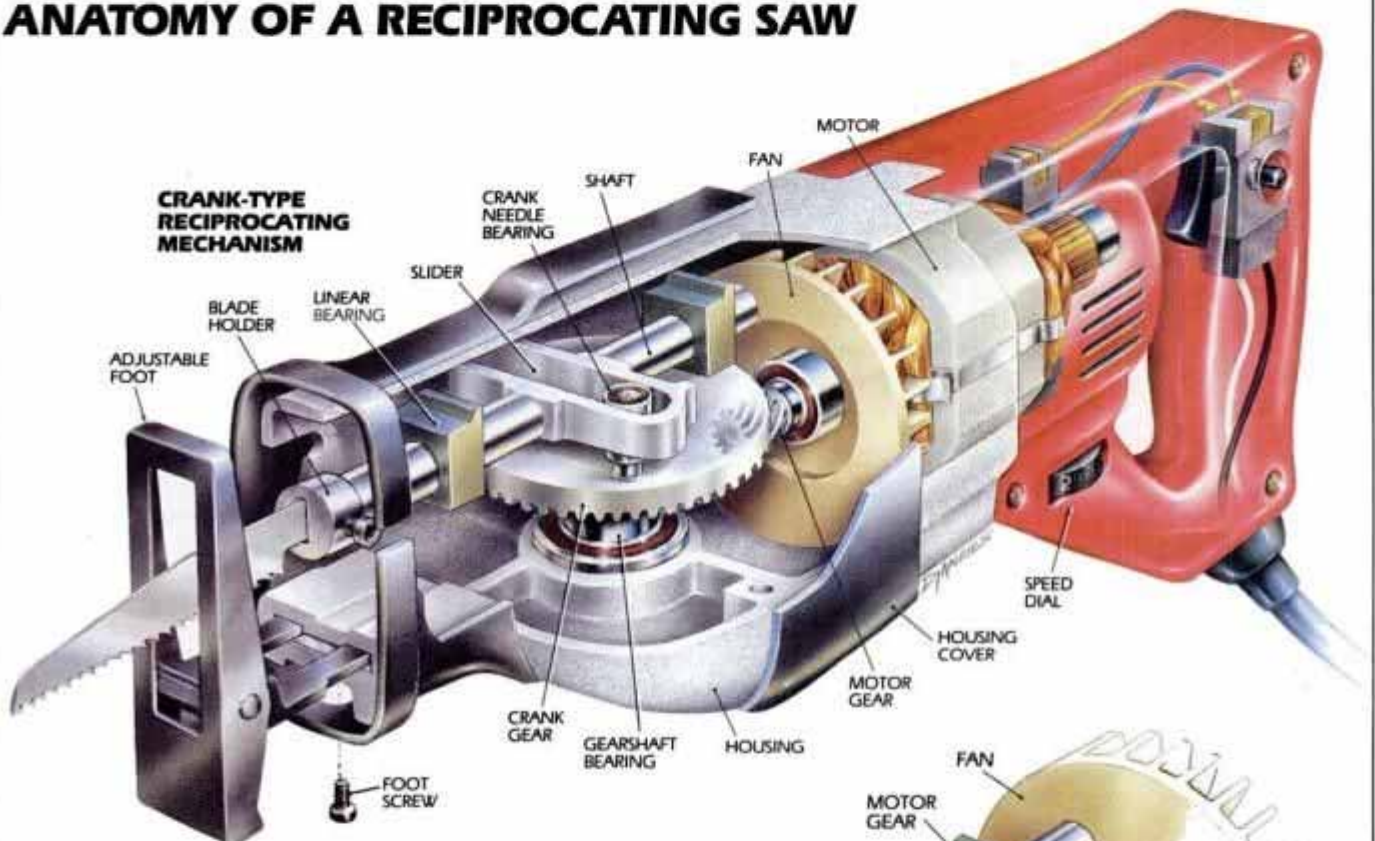
blade. On a reciprocating saw, the foot usually pivots and can be adjusted in or out to allow more or less blade protrusion. This is handy when you need to shorten the depth of cut, and enables you to use the complete blade more effectively. On all saws, the blade is angled down slightly in relation to the shaft to create a more aggressive return cutting stroke and

to help clear the waste on the forward stroke. Some saws also have orbital action similar to the high-end sabre saws. Orbital action increases cutting speed on softer materials.

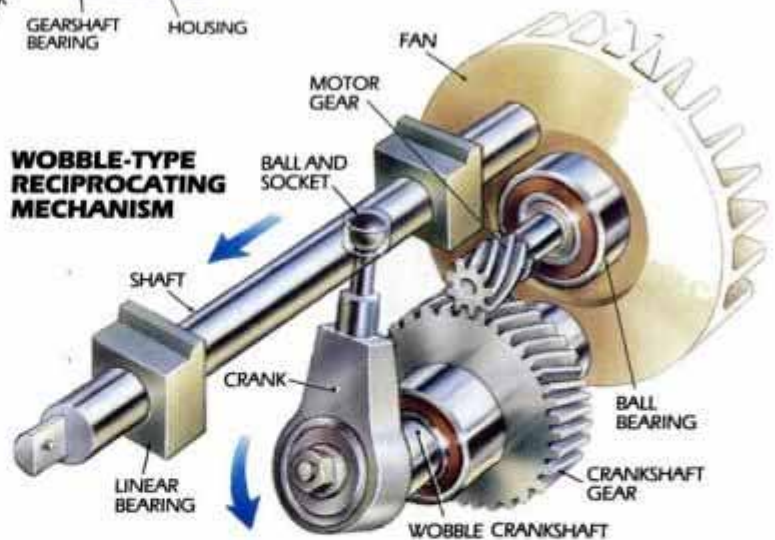
AEG SSPE 800

AEG's entry is a full-featured variable-speed tool with a powerful 8-amp motor. It features a speed dial to

ANATOMY OF A RECIPROCATING SAW



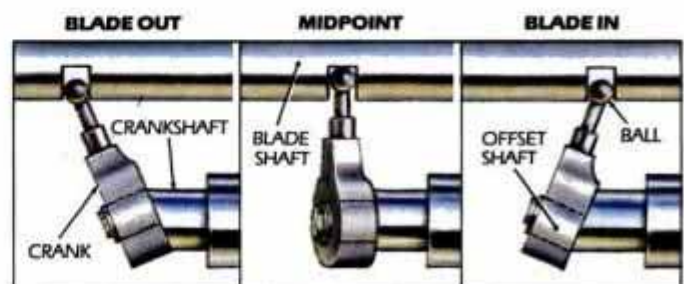
WOBBLE-TYPE RECIPROCATING MECHANISM



The long housing of a reciprocating saw encases the motor and drive mechanism. The blade is secured to the end of the reciprocating shaft, and the shaft slides in linear bearings. Rotational power from the motor is converted to the reciprocating motion of the blade shaft through one of two mechanisms.

In the crank-type mechanism (above), the helical motor gear engages a flat drive gear to change the axis of rotation. A needle bearing positioned near the perimeter of the drive gear travels from side to side in the slider as the drive gear rotates, pushing the slider and blade shaft in and out.

In the wobble-type drive mechanism (right), the motor gear powers a driveshaft with an angled, offset shaft end. A wobble crank mounted in a bearing on the offset shaft leans forward and backward, following the changing angle of the offset shaft as the driveshaft turns. The top arm of the wobble crank powers the reciprocating shaft in and out.



set maximum speed, and the trigger has a lock-on button for long cuts. It also has a 2-position orbital switch for maximum effectiveness in wood or metal. The reciprocating shaft is rectangular in cross section and, although lighter than the shafts of most other models, forms a solid, one-piece component with the slider. Our DeWalt unit also has a rectangular shaft, and both the DeWalt and AEG share a similar blade clamp design. Although the blade clamp works well, blade changing is hampered by poor access to the setscrew.

The design of the foot provides very poor cut visibility when it's set for maximum blade protrusion. In order to see a cutline, you have to extend the foot and sacrifice cutting depth—a job that requires loosening three Allen screws. Instead of pivoting, like most others, the foot is fixed but circular in shape to provide contact with the cutting surface at different angles. The Allen wrench for changing the blade or adjusting the foot fits in a storage compartment in the housing.

This saw felt lighter than many, and its narrower housing made it easy to handle. It doesn't have the typical rubber front-housing cover that most versions do, but it does come with an auxiliary handle similar to the kind found on heavy-duty drills.

In our speed trials, we found the AEG to fall in the upper middle of the pack—a finding confirmed by its long 1³/₁₆-in. stroke and orbital action. Nonorbital cutting in wood is slightly slower, although the difference is more noticeable when cutting with the grain. The saw is relatively easy to plunge when making internal cuts.

Bosch 1632

This Bosch saw comes with three orbit ranges along with straight cutting to suit just about any material you're

likely to encounter. And at 8.4 amps, it should be able to get the job done quickly. We found the tool compared with the upper half of the group in terms of cutting speed.

Blade installation is straightforward, and there's adequate visibility and Allen screw access for this job. The Allen wrench is stored in a holder on the cord near the handle. Like most other models, adjusting the foot also requires the Allen wrench. However, the job is far from easy as the rubber shroud over the housing must be pulled back to reach the screws. Once you get them loosened, you'll find about 3/4-in. foot travel. The shoe is the standard pivoting type, and cutline visibility could be better.

The 1632 is a typical example of Bosch quality, and the tool feels powerful and well built. The cord length, however, is a skimpy 6 ft. 8 in.—not enough to reach the ceiling with the tool plugged into an outlet near the floor. And, we wonder about all those orbital options. They may be of use, but our impression is that you'll either use full orbit or straight cutting. The speed differences, at least when cutting wood, between full and no orbit are simply not that great.

DeWalt DW 306

Like the AEG unit, the DeWalt has a fixed, nonpivoting shoe. In contrast, however, visibility for blade changing and following a cutline is excellent. This was the only saw in our group with a shoe that was not adjustable for controlling blade depth.

Although the DeWalt boasts 8-amp power and its drive mechanism supplies an average 1¹/₈-in. stroke, the saw falls in the lower half of the group in terms of cutting speed. Of course, this tool doesn't have orbital action. But even so, it didn't fare that well against orbital tools that were set for nonorbital cutting. When

ranked with the other nonorbital saws, we place it ahead of the Sears and Ryobi, but behind the Milwaukee and Makita. Variable speed goes up to 2400 spm (strokes per minute), and maximum speed is set on a 6-position speed dial. Variable speed is controlled at the trigger, which can be locked at maximum position.

In terms of feel and appearance, this tool is solid and stable. The rubber housing cover is easy to grip and hold on to, and the DW 306 handles plunge cutting well. The Allen wrench is held in a strap at the end of an 8-ft. rubber power cord. As with all DeWalt tools, this saw comes with impressive manufacturer support including a free one-year service contract, a 30-day no-questions-asked refund period and a free loaner if the saw breaks down and you get it serviced at an authorized center.

Hitachi CR10V

At a modest 6.5 amps and 1-in. stroke, the Hitachi might seem outclassed by all the other tools except the Sears, Ryobi and Makita. In practice, we found this 3-position orbital saw falling in the same ballpark as the 8-amp, nonorbital DeWalt. When stacked against the big orbital saws—the P-C, Bosch and AEG, the CR10V just isn't that impressive. For example, one plywood cutting test showed the Hitachi at full orbit about on par with the heavier tools when they were set for straight cutting.

As with the Bosch, we question the need for anything more than two orbit positions—full orbit and straight cutting—since the difference in performance is marginal.

The pivoting foot is adjustable for blade protrusion over a 1/2-in. range and is loosened by pulling up a portion of the rubber housing cover to access two screws. Unfortunately, the screws pass through open-ended

RECIPROCATING SAW SPECIFICATIONS*

MANUFACTURER	MODEL	PRICE ¹	AMPS	STROKE	SPEED RANGE (spm) ²	ORBITS ³	WEIGHT (lb.)	LENGTH	CORD LENGTH	NOISE LEVEL ⁴
AEG	SSPE 800	\$274	8	1 ³ / ₁₆ "	500 to 2500	1	7.25	18"	10'	93
Bosch	1632	\$255	8.4	1 ³ / ₁₆ "	0 to 2400	3	7.9	18 ¹ / ₂ "	6' 8"	95
DeWalt	DW 306	\$254	8	1 ¹ / ₈ "	0 to 2400	none	7.3	17 ¹ / ₂ "	8'	93
Hitachi	CR10V	\$259	6.5	1"	700 to 2200	2	7.9	16 ³ / ₁₆ "	8' 5"	89
Makita	JR3000V	\$252	6	1 ³ / ₁₆ "	0 to 2300	none	6.4	15 ³ / ₄ "	8' 10"	88
Milwaukee	6527	\$309	8	1 ¹ / ₄ "	0 to 2800	none	8.75	17 ¹ / ₂ "	7' 9"	90
Porter-Cable	9637	\$265	8	1 ¹ / ₈ "	0 to 2600	1	9	18 ³ / ₄ "	10'	96
Ryobi	RJ-100VK	\$243	6	1"	0 to 2300	none	6.6	14 ³ / ₈ "	6'	95
Sears	17102	\$125	6	1"	0 to 2500	none	6.5	18"	10'	94

* All saws shown come with a carrying case. 1. Suggested retail price, tools frequently sell for less. 2. Speed range given in strokes per minute (spm). 3. Numbers indicate orbital options in addition to straight cutting. None indicates only straight cutting. 4. Noise level of free-running tools at maximum speed as measured on dbA scale.

slots in the foot that allow the foot to fall out easily during adjustment. When you combine the small range of adjustment with the difficulty of getting the job done, it might be more practical to consider the foot non-adjustable. Blade changing is also less than simple due to poor Allen screw access. You have to find the screw through a small hole in the rubber housing cover and then poke the Allen wrench through.

The variable-speed trigger can be locked on, and maximum speed is set on a speed dial. While normal cutting performance is acceptable, we found plunge cutting to be difficult. Regardless of how we tried, we were unable to make the operation go as smoothly as with most other makes. Finally, the foot provides relatively poor cutline visibility.

Makita JR3000V

Makita's offering is a nonorbital saw with a below-average amperage rating, but a healthy 1³/₁₆-in. stroke. While it doesn't come near the big orbital tools in cutting speed, it does rank well with nonorbital tools, falling just behind the Milwaukee.

Although access to the foot adjusting screws is similar to the Hitachi, Makita's foot can be adjusted over a 1-in. range and won't slip out in the process. Blade installation is easy due to good visibility and a wrap-around blade clamp similar to the AEG and DeWalt.

This saw falls on the lighter side of the spectrum in terms of weight and size, so it's generally easy to handle. And, it's the quietest tool in our test group. It doesn't have a speed dial, but it does have a trigger-lock button that locks the tool on at maximum speed.

Milwaukee 6527

Up until a few years ago, if you opted for a Milwaukee Sawzall, you got a durable, hard-working, industry-standard tool that, quite frankly, didn't stand up to the competition in terms of power. Fortunately, Milwaukee has changed all that with the introduction of their Super Sawzall. Equipped with an 8-amp powerplant, this improved tool stands up fairly well to any other make—even without orbital action. We found that this saw consistently led the other non-orbital tools in cutting power, and came pretty close to threatening the top place holders—Porter-Cable, AEG and Bosch.

However, the Super Sawzall has

more to offer than good cutting power. All reciprocating saws vibrate. You simply can't get a heavy shaft moving back and forth at more than 2000 spm and not know it. Milwaukee's innovation is to equip the reciprocating mechanism with a counterbalance that reciprocates in a direction opposite to the main shaft and blade. The result is a significant reduction in vibration.

Unlike most other manufacturers, Milwaukee has quite sensibly reasoned that if the saw's foot is adjustable, it might as well be easy to adjust. Their design is operated by a simple locking lever and the foot has three preset positions. Similarly, Milwaukee has provided excellent blade access for quick and easy changing and superior cutline visibility.

The model 6527 comes with Milwaukee's Quik-Loc replaceable power cord. It's also available with a standard cord as the model 6528. Neither version is double insulated, and they come with 3-prong plugs.

Porter-Cable 9637

If you're power hungry, and are prepared to accept nothing less than the best in this regard, you ought to look seriously at the Porter-Cable 9637. No matter what we put our test group through, when it came to cut-

ting speed, the P-C was at the top. It's also the biggest, heaviest and noisiest tool in our group.

Blade changing is simple due to an easily accessed screw and a wrap-around blade clamp. However, adjusting the foot depth is less of a pleasure, and the foot only moves through a range of about 5/8 in. Blade speed is controlled entirely at the trigger, and there's no lock button. We also found cutline visibility to be lacking.

In terms of orbital action, though, this P-C, like AEG's entry, has the most sensible arrangement for a saw of this type. The tool only has two positions—straight cutting for metal and orbital for wood. The design isn't fancy, but provides the basic options for anything you come across.

Ryobi RJ-100VK

Ryobi's reciprocating saw is just about the most compact and lightweight tool in our selection. And, for many applications, those two characteristics would be considered a plus. On the other hand, heavier tools are more likely to soak up vibration and provide stability—qualities important in a reciprocating saw and that the RJ-100VK is a little short on.

In terms of power, we rank this tool right behind the DeWalt and

Compact Cutter

• While most reciprocating saws feature the same basic design—a D-handle and a long heavy body that demands two hands for proper control—one manufacturer offers an innovative alternative.

Porter-Cable's model 9647 Tiger Cub (about \$205) is designed to handle all typical reciprocating saw jobs without the bulk and weight of a typical model.

The tool is designed around a compact barrel-grip housing and weighs in at 5 pounds—about two-thirds the weight of an average reciprocating saw. These features combine to allow one-hand cutting in tight, hard-to-reach places. In addition, the saw measures only 13¹/₂ in. long so it fits between studs, floor joists and rafters spaced on standard 16-in. centers.

The Tiger Cub is powered by a 4.8-amp motor and has a variable-speed dial for setting blade speed between 400 and 2600 spm. The

switch is a simple on/off sliding unit versus the variable-speed trigger switches found on the larger tools. The foot is not ad-



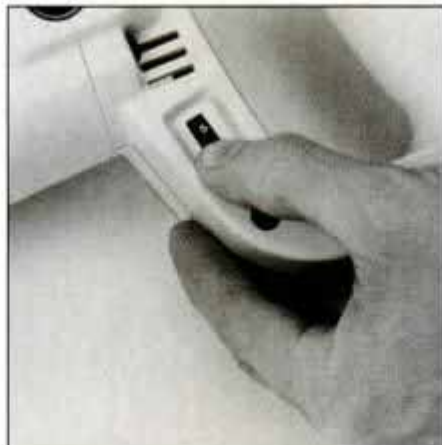
justable for blade depth, but provides good cutline visibility, and the tool comes with an auxiliary handle that can be removed. The Tiger Cub uses all standard reciprocating saw blades.

Although not as aggressive as some of the bigger tools, we found this 1-in.-stroke saw holds its own, and the compact size gives it an edge in terms of versatility—especially when working in confined spaces such as crawlspaces and attics.

—T.K.



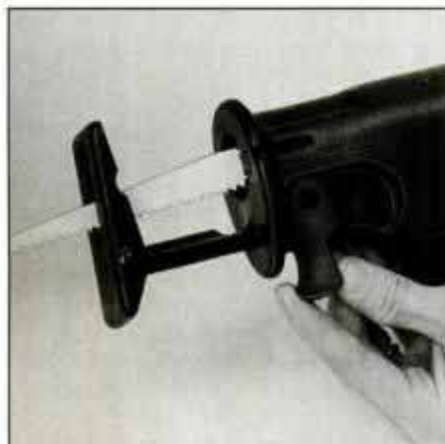
All variable-speed saws feature trigger-controlled speed. Speed dial on the trigger of Bosch unit sets the maximum speed.



Some saws have a separate speed dial for setting maximum motor speed. DeWalt saw (shown) features six speed settings.



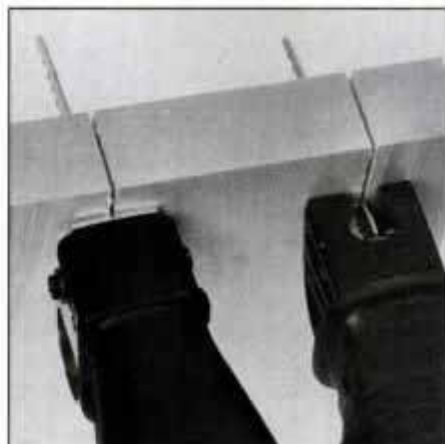
Bosch, AEG, P-C and Hitachi tools tested have orbital action plus straight cutting. Orbital action speeds cutting in wood.



All saws except DeWalt have an adjustable foot to control cutting depth. Milwaukee (shown) uses a simple lever to lock foot.



Saws require an Allen wrench to install blade. Milwaukee and AEG store wrench in housing. Others store wrench on cord.



Cutline visibility varies greatly. AEG (left) obscures cutline, while DeWalt (right) provides excellent visibility.

ahead of the Sears. With a 6-amp motor and minimal 1-in. stroke, this saw does have power limitations. Cutline visibility is barely adequate, but blade installation is straightforward due to an easily accessed screw. Foot-depth adjustment is also simple, and the foot moves through a 1-in. range. Like the P-C, the Ryobi saw doesn't have a speed dial, but it does have a trigger-lock button.

The RJ-100VK does a good job at plunge cutting and handles other typical cuts moderately well. If your demands aren't that excessive, the tool will do the job.

Sears 17102

Although reciprocating saws are generally offered in a professional grade only, this Sears version is clearly designed for those on a budget, or those whose needs are modest. Like the Ryobi, this saw has a 6-amp motor and a 1-in. blade stroke. And, while it's rated with a higher top blade speed than the Ryobi, we found its cutting power to be minimal. Unlike the professional tools, the Sears of-

fering refused to be pushed—it seemed to cut slower when pressure was applied than when left alone to cut under the force of its own weight.

The saw's foot is adjustable for depth through a relatively wide, 1¼-in. range, but nonpivoting. When the foot is set back for maximum blade extension, it doesn't bear against the stock during some bevel cuts—the front housing protrudes too far. Blade installation is simple, with good screw access.

Taking the plunge

If you decide to buy a reciprocating saw, here are a few points to think about. Variable speed means versatility and, considering that tools with this feature only cost a little more than their fixed-speed counterparts, it should be a priority. Orbital action is a more debatable issue. If you demand the fastest cuts in a range of materials, orbital action is for you. However, nonorbital saws perform quite adequately and, if you're looking for durability, it's always wise to opt for the simpler design.

Based on our test group, the saw to own is the Milwaukee Super Sawzall. While it isn't the fastest, its smooth operation made cuts seem effortless, and reduced user fatigue should translate into more work done over a given period of time. However, if vibration isn't a concern and you're simply looking for brute force, you won't go wrong with the Porter-Cable. This heavily built tool always ranked at the top for aggressive cutting. Right there with the P-C are the Bosch and AEG entries.

The Makita, DeWalt, Ryobi and Hitachi are our midrange selections, with the Makita leading the pack in terms of power, size and sensible design. The DeWalt is the leader for cutline visibility, and Hitachi wins in terms of features, fit and finish. The Sears reciprocating saw looks good for occasional use and has the price to back it up. However, keep in mind that the other tools are often heavily discounted—especially through mail-order tool distributors, and the price advantage of the Sears may not be so great.

PM

HOME
IMPROVEMENTSINK/VANITY
RETROFIT

BY MERLE HENKENIUS

PM Illustrations by
George Retseck

● One sure sign of an outdated bath is a wall-hung sink. Not only do these fixtures look low budget, they deny you the valuable storage space offered by a vanity cabinet. If your bathroom is cramped, as most are, then a vanity will add storage space. By concealing the sink's plumbing, it will also make the bathroom look a little less mechanical, and it does so without costing a fortune. Making the change is easier than it looks.

If adding storage space is not your top priority but fixing up an old bathroom is, then now also is the time to replace the sink, especially if its faucet set is worn out and dripping. It also makes sense to replace the sink if you are thinking of painting and freshening up the grout lines in the tilework.

Choosing a vanity

We chose a 24-in.-deep oak-front vanity with two drawers and a door to fit a limited space. Our vanity top is a plastic composition material with a basin molded in. And, finally, we chose a Moen single-control faucet. The combined cost of these items was just over \$200. If you have the patience to wait for specials and close-outs, you might well trim \$50 from that figure. On the other hand, if you're so inclined, you could spend \$1500 for a long vanity and an expensive top, basin and faucet.

As for the style of vanity, consider the position of the water and drain fittings in your bathroom's wall or floor. Don't buy a vanity with drawers that will obstruct these piping connections. As for the length, you'll find standard sizes to fit almost any space, from 18 in. to 6 ft. If your vanity will abut the toilet, most codes require that the countertop ends at least 15 in. from the center of the toilet.

And finally, if you don't care for molded tops, you can build a custom top of high-density particleboard and plastic laminate or tile. You would then cut a hole in the top for a porcelain, plastic or china basin.



You can shoot for an entirely custom installation by building the vanity cabinet as well. The cabinet is simply a box with a space for a toe-kick beneath it. The cabinet can be built out of high-density particleboard and covered with the same plastic laminate used on the top, or you can build it out of lumber. You can make the doors yourself or buy doors from Porta-Door Co. Inc., 65 Cogwheel Ln., Seymour, CT 06483. This company's wide product line includes cabinet drawers and hardware and other products you would find useful if you decide to go the custom vanity route.

Also, see "Kitchen Remodeling," page 87, Apr. '90. The process used to build and retrofit kitchen cabinets applies to bathroom vanities also.

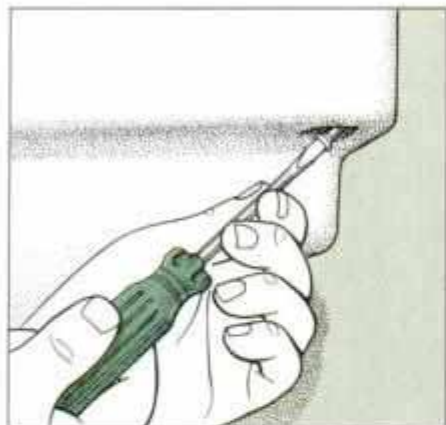
Removing the old sink

To remove the old wall-hung sink, start by shutting off the water at the meter or beneath the sink. Then, cut through the caulk seam between the sink and the wall.

Change the blade in your utility knife if it isn't sharp. Often the bead of caulk at this joint has hardened, and it is difficult to remove. Cut through the caulk as completely as possible to reduce wall damage when you lift the sink off its support bracket. Next, check the lower sides of the unit for fastening screws. Not all sinks will have these screws, but if yours does, remove them (Fig. 1).

Also, loosen the compression nuts where the supply riser joins the compression adapters (Fig. 2). In this installation, the supply valves to the sink are located in the basement—a common arrangement in older homes. Your sink may have supply valves located on the risers below the sink, however. The process to remove these is basically the same. Loosen the compression nut at the top of the supply valve. If you want the extra convenience of having the supply valves located directly under the sink, now's the time to add them.

Remove the trap, and lift the sink up and out until it breaks free

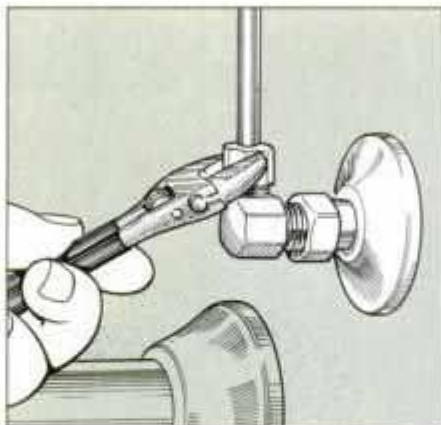


1 After the caulk at the top of the sink has been cut through, remove the screws that hold the sink to the wall.

(Figs. 3 and 4). Next, remove the metal support bracket (Fig. 5).

Wall repair

Some of the older wall-hung sinks, especially those with front-mounted faucets, have extra-high decks. These will leave some wall damage exposed above the new vanity top. It's usually easier to make these repairs before installing the countertop. In most cases,



2 Shut off the water below the sink, or in the basement, and loosen the compression nuts on the supply risers.

it's simply a matter of patching the rough areas with drywall compound.

You might find it easier to paint the wall before installing the vanity. This way, you won't have to cover the vanity with a dropcloth or neatly cut in around it when painting.

Installing the vanity cabinet

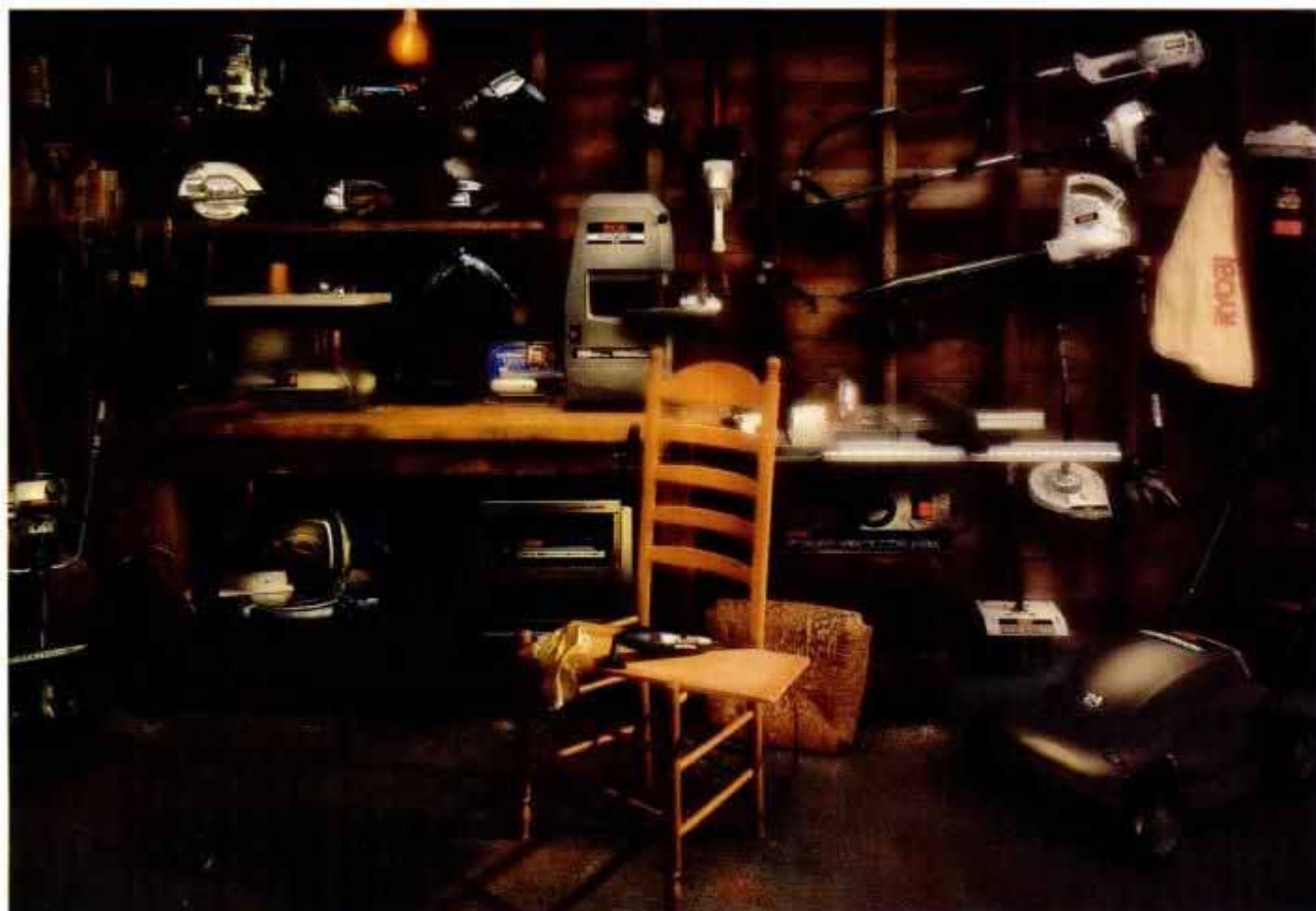
To install the vanity, pry the baseboard and shoe molding from the



3 Undo the trap by loosening the nut at the wall and on the drain's tailpiece. Tongue-and-groove pliers work well here.

vanity wall using a flat bar. Use a block of wood behind the flat bar to prevent it from breaking through the drywall. If the nails holding the trim in place are visible, then it may be easier to punch them through the trim using a nailset, rather than trying to pry away the trim and nails at one time.

Slide the vanity against the wall in a position that allows for easy access

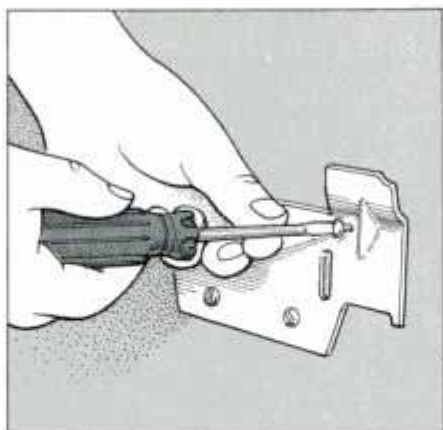


Call 1-800-525-2579 for more information.

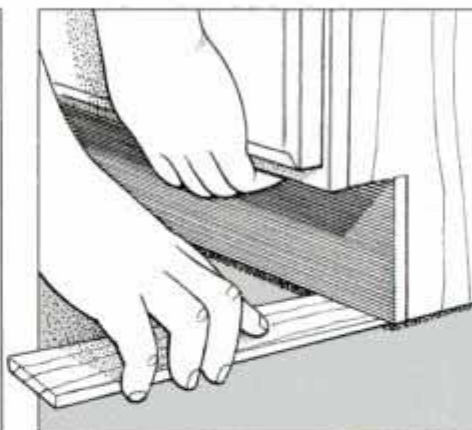
Ryobi America Corp., 5201 Pearman Dairy Road, Suite 1, Anderson S.C. 29625-8950 ©1993 Ryobi America Corp.



4 With all the plumbing connections undone, lift the sink from its sides and pull it clear of its wall bracket.



5 The wall-sink support bracket will interfere with installing the vanity, so it's best to remove this as well.



6 If the vanity cabinet tips away from the wall, shim the base with some pieces of scrap or cedar shingles.

to the permanent plumbing. If your plumbing pipes enter through the floor, you need to bore holes in the cabinet floor. Measure carefully and use a holesaw to make these holes. If the permanent drain ends at floor level, install a 6-in.-long plastic tailpiece extension with a compression fitting to raise the drain opening. Then, lift the vanity onto the pipes. If the pipes enter from the wall, as most do, the

open back of the cabinet will accommodate the plumbing connections.

A common problem associated with any cabinet installation is a sloping floor or out-of-plumb wall. As such, a cabinet may fit against the wall at the floor, but, at the same time, may gap away from the wall near the top. To correct this problem, shim the base until the cabinet fits flush with the wall (Fig. 6). With minor shimming,

silicone or latex tub-and-tile caulk will hide the shim. Extreme gaps can be concealed with lengths of cove molding, which are stained or painted to match the bathroom's woodwork.

In any case, position the vanity against the wall and locate the wall studs behind it. Bore pilot holes through the vanity's back support and into the studs. Screw the cabinet to the studs (Fig. 7).

They say the clues to a man's obsession can only be found in his soul. We, however, think you should also check the garage.

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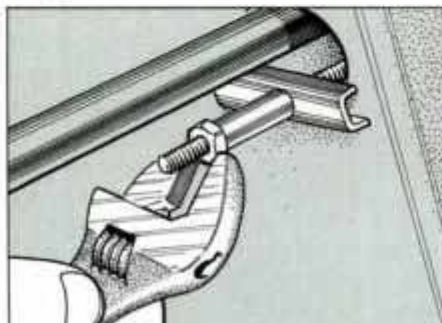
7 Locate the wall studs, bore the pilot holes and drive two screws through the vanity's back brace into the studs.



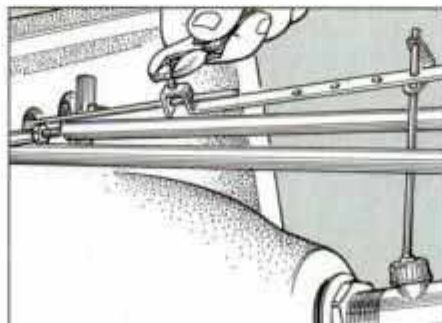
8 Press plumber's putty around the drain flange. Thread the drain into the flange from the underside of the basin.



9 Secure the drain by tightening the jamb nut until it feels snug and most of the putty is squeezed from the flange.



10 Insert the faucet bolts through the holes in the basin deck (the top of the vanity). Tighten the nuts.



11 Install the pop-up assembly and lift rod in the faucet and basin. Tighten the setscrew against the lift rod.

Plumbing the vanity basin

Before installing the vanity top, mount the faucet and drain assembly in the basin. Begin by pressing a 1/4-in.-dia. roll of plumber's putty onto the underside of the drain flange (Fig. 8). Insert the drain through the bottom of the basin and turn it into the flange threads. Then, tighten the jamb nut on the drain until its rubber washer seats against the drain spud and most of the putty is squeezed from the flange (Fig. 9). Don't overtighten this nut. Stop when it feels snug.

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Sales Associate
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Next, slide the base gasket over the faucet bolts, and insert the bolts through the sink's deck holes. Thread the jamb nuts onto the bolts and tighten one side of the faucet. Pivot the other side of the faucet until it's aligned properly on the deck, and tighten the second nut (Fig. 10).

With the faucet and drain mounted in the basin, install the pop-up assembly. Start by inserting the pop-up drain plug into the drain. Skewer the pop up with the lift lever. Then, tighten the ring surrounding the lift lever until it feels snug.

Next, feed the lift rod through its hole in the top of the faucet and slide the adjustable clevis onto the rod. Push the lift lever down as far as it will go (thus raising the pop-up plug in the basin), and connect the clevis clip and clevis to the lever. The lift lever should pass through the second hole from the bottom on the clevis. Tighten the clevis setscrew against the lift rod (Fig. 11).

We chose a faucet that came with supply risers permanently attached. If yours has threaded shanks, attach 18-in. ball-head risers to the shanks before mounting the basin or top. A vanity offers little working room, and making these connections in advance will save you the bodily contortions required to connect them later, after the vanity is installed, using a basin wrench.

Setting the countertop

If your countertop is made of wood, you could screw it to the vanity from below, through the cabinet's corner brackets. But with a molded top, it's best to cement it to the cabinet and the wall. Construction adhesive works well and so does silicone caulk. Just squirt a small amount of caulk on the top of the cabinet in a half-dozen places. Then, lift the counter onto the vanity, so that the backsplash rests flush against the wall (Figs. 12 and 13). Before caulking the backsplash, however, make the plumbing connections.

To connect the supply risers, bend them to meet the compression adapters head on. This is usually a compound bend, requiring a little care to avoid kinking the risers. Don't bend the riser near the adapter or the compression nut and ring won't fit. With the risers aligned, mark them with a pencil and cut them to length with a tubing cutter. Finally, slide a compression nut and ring onto each riser and tighten it into the adapter (Fig. 14). Avoid

overtightening. Finger-tight, plus two full-rounds, will be sufficient.

You may be able to reuse the old chrome trap from the wall-hung sink. If so, it's a good idea to replace the friction washers. If the old trap has seen better days, the best replacement is a plastic-tube trap, which has beveled compression washers. These traps are inexpensive, rust-free and the nuts don't require wrenching. Hand tighten the nuts on the new trap (Fig. 15).

Finishing touches

With the vanity and top installed, caulk the backsplash and replace the baseboard and shoe molding. The best caulk to seal the vanity backsplash is a latex tub-and-tile variety (Fig. 16). Just wet the seam between the backsplash and wall, and lay a bead of caulk in the joint. Work the caulk into the joint with your finger, and wipe away all excess caulk with a damp rag. As the caulk cures, it will shrink slightly, yielding a watertight

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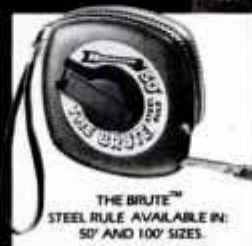
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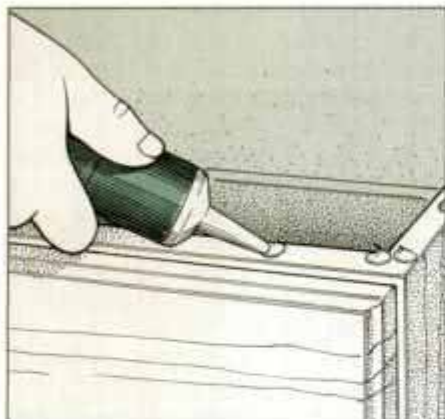


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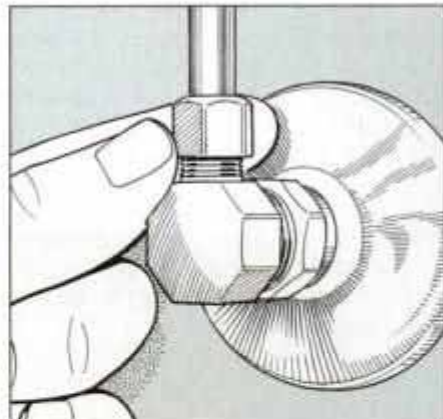
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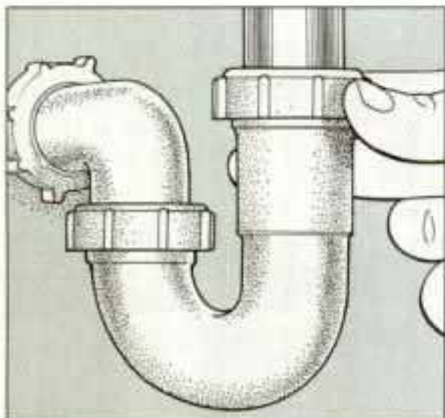
12 Apply adhesive caulk to the top of the vanity cabinet. Put a dot at each corner and at several places in between.



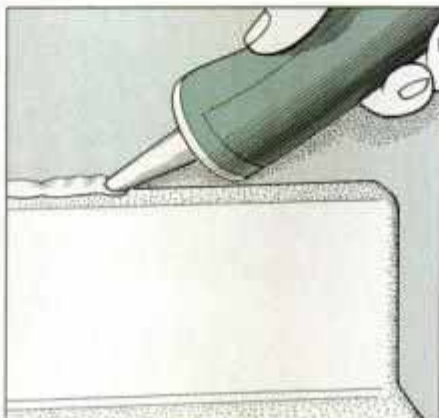
13 Place the vanity top on the base, and push it against the wall. Wipe off any adhesive that oozes from under the top.



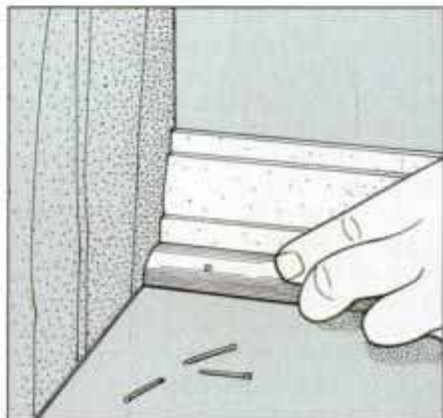
14 Trim the supply risers to length with a tubing cutter. Fasten each riser with a compression fitting.



15 Use a plastic trap for the new drain connection. Hand tighten the nuts on the trap—do not use a wrench.



16 Seal the vanity top where it meets the wall with latex tub-and-tile caulk. Smooth the bead with your finger.



17 Cut the baseboard and shoe molding so they fit tightly against the vanity. Then, nail the moldings in place.

seam that is nearly invisible.

As for replacing the woodwork, if you can, reuse the base and shoe molding. Crosscut them to length, and fasten them with finish nails (Fig. 17). Countersink the nailheads,

and cover the nail holes with color-matched putty.

Don't forget to check for leaks. Turn on the water to the faucet, either in the basement or vanity cabinet. Run both hot and cold water through

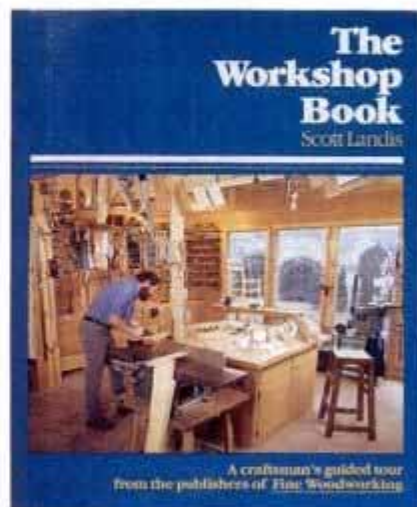
the faucet to check for leaks at the compression adapter or at the supply valve. Let the water drain to check for a leak at the trap. With any luck, your installation will be good and dry, and offer years of trouble-free service. **FM**

BOOK REVIEW

THE WORKSHOP BOOK

● To many of us, a workshop is just a dusty place in the basement or a corner of the garage. But, as *The Workshop Book* makes clear, it doesn't have to be that way. A workshop can be a place that greatly increases your efficiency and enjoyment, whether your woodworking is for pleasure or profit. This book gives an engaging account of workshops large (4000 sq. ft.) and small (the size of a closet). There are general woodworking shops here, hobbyist shops, a boat shop, some where chairs are made and even one shop that makes everything from apple cider to wood-stave tanks for watering cattle.

Scott Landis, its author, roamed all over North America to gather his information. The book starts by examining the history of workshops, starting with 17th- and 18th-century examples. From there, the book takes in not only all manner of shops but how their owners cope with dust extraction, safety, lumber storage and electrical power. I was impressed at the ingenuity of the woodworking devices employed by the craftspeople interviewed. For example, one uses knockdown plywood sawhorses (the three pieces are slotted together). There's lots of usable information here.



The book costs about \$35, plus \$4 postage. Write The Taunton Press, P.O. Box 5506, Newtown, CT 06470; (800) 888-8286. —Roy Berendsohn

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HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Installing A Basement Toilet

I would like to install a toilet and other fixtures in my basement, but the waste pipe is 3 ft. from the floor. The house is a basic ranch, and there is no place I can put another bath but downstairs. Are the flush-up toilets any good?
 JOSEPH ASCHER
 MERRICK, NY

Flush-up toilets use water pressure rather than a pump to lift the waste water up to the level of the sewer pipe. These devices clog easily, use a 3/4-in.-dia. discharge line and are not approved by many municipal codes.

An alternative to a flush-up toilet is the Zoeller Qwik Jon, a sewage removal system that consists of a flush tank, a sewage pump and a backflow device (the toilet is not included).

The toilet mounts on top of the flush tank. In the case of a wood floor with full-size joists, the tank can be hidden. The toilet flushes into the tank, and the tank contents are pumped to the sewer line or septic tank. A do-it-yourself model and a professional model are available.

For information, contact Zoeller Co., P.O. Box 16347, Louisville, KY 40256, or call (800) 928-7867.

Terrazzo Care

What are the correct procedures to care for terrazzo tile? Should it be waxed, buffed, stripped yearly and rewashed again? Some say never wax or strip terrazzo tiles, others say the opposite.

E. WEIGEL
 STRATFORD, WI

For readers unfamiliar with terrazzo, it is a concrete floor with marble chips embedded in it. The chips must cover 70% of the floor area. The floor can be either cast in place or precast and ground smooth. The other 30% of the floor consists of a portland cement or epoxy binder.

Once a year, the floor should be stripped of old sealers and resealed with a product designed for terrazzo. A terrazzo floor should never be waxed with a general-purpose floor wax, as this results in a discolored and slippery floor.

The National Terrazzo & Mosaic Association (NTMA) recommends using pH-neutral detergents that have been formulated for terrazzo use. The association says that the cumulative effect of using soaps, rather than detergents, will cause the floor to become dull and lifeless.

The NTMA recommends sweeping the floor daily using a yarn-wick brush treated with non-oily

sweeping compound (available from janitorial supply houses). Scuff marks and stains should be removed by hand with a neutral cleaner diluted in warm water.

Lightly soiled floors should be damp mopped weekly, using a neutral cleaner. Heavily soiled floors should be scrubbed with a mechanical buffer and neutral cleaner.

For more information, contact the NTMA at (800) 323-9736.

Downspout Dry Wells

I am a reader from Qatar in the Arabian Gulf. I took great interest in the article on downspout dry wells that was published in your September 1992 column. I'd like more information. For instance: What is the daily rate, in liters, that can be passed through it? Is it possible to use more than one drum at a time?

ESSA BIN ESSA AL-KOWARY
 DOHA, QATAR

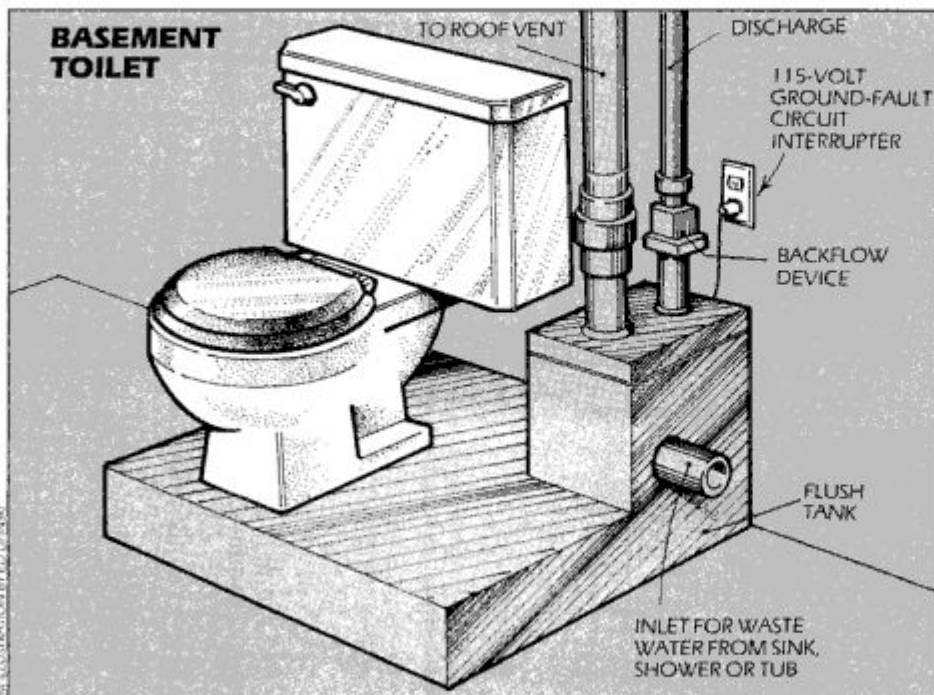
The amount of water any dry well can accept depends on the size of the well and the percolation rate of the soil. A hydrologist can determine the amount of water entering the dry well by taking into account the rate of the rainfall, the roof area, the size of the gutter channel and the cross-sectional area of the downspout. However, most homeowners are realists and not theoreticians. If one dry well is not effective, they put in a second and a third.

Dry wells can be installed in series or in parallel. When installed in series, each well has an outlet near its top. If the dry well fills up before the water can leach into the ground, the water flows through the outlet to the next well. When dry wells are installed in parallel, a distribution box similar to that used in a septic system is installed. The box, which is plastic or masonry, has an inlet from the downspout and two or three outlets, each going to a dry well. The dry wells should be spaced so that they have enough soil around them to absorb all the water they will receive.

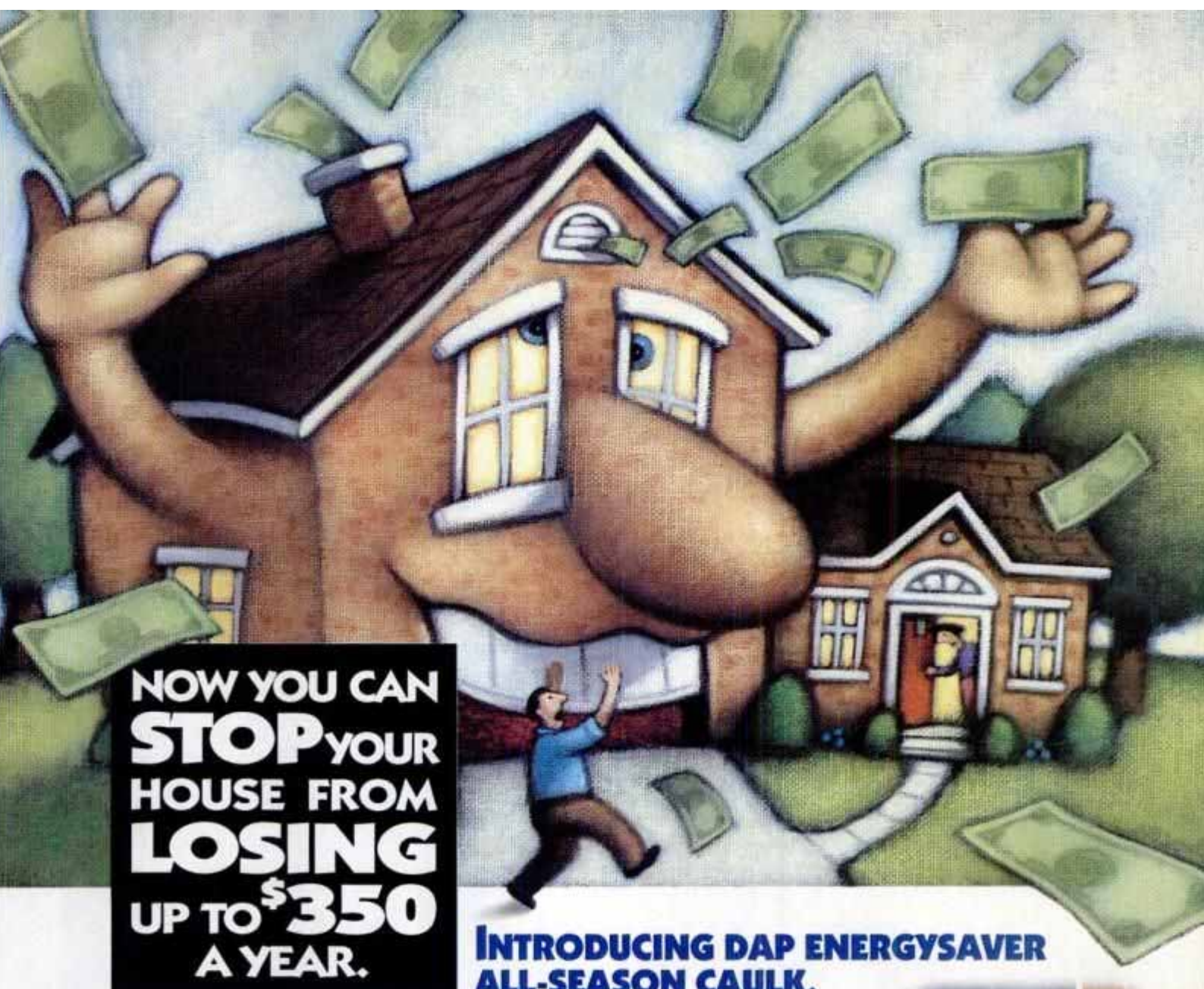
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DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.



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TOOL TEST

SKIL BENCH GRINDER

TEXT AND PHOTOS BY
 ROSARIO CAPOTOSTO,
 Contributing Editor

● Skil's recently introduced 6-in. bench grinder is well equipped for work in the home shop. It has a relatively powerful and quiet ¼-hp induction motor and a sturdy cast-iron base. It also has a convenient quench tray, fully balanced medium- and coarse-grit ¾-in.-wide wheels, toolrests and spark deflectors.

We used the grinder to remove stock, sharpen twist drills, put an edge on a hatchet and produce a hollow ground bevel on a wood chisel. In all four tests, the machine produced good results because it was free of vibration and its wheels ran true.

However, its toolrests adjust only toward or away from the wheel face. They do not pivot. Thus, we had to gauge the tool angle by eye while



The Skil Model 3396 bench grinder performed well in a series of tests that included removing metal and grinding a cutting edge on hand tools.

grinding the chisel and the hatchet. To do this, we used the toolrest as a fulcrum and found that it took some practice to produce a good edge.

The Skil Model 3396 bench grinder

costs from \$70 to \$80 at hardware stores and home centers. For more information, write to S-B Power Tools Co., 4300 W. Peterson Ave., Chicago, IL 60646. **PM**



1 The grinder comes with coarse- and medium-grit grinding wheels—a perfect combination for large sharpening jobs.



2 The machine's toolrests do not pivot. You have to learn to use a rest as a fulcrum while grinding edge tools.



3 Use the grooved toolrest for grinding drill bits. Lift the bit and twist it to correctly shape the point.

PAMPHLET REVIEW

SAFETY TIPS

● It's incredible that nearly 12,000 people in the United States were injured in grinder/buffer accidents at home during 1991, but that is the grim fact provided by the Consumer Product Safety Commission.

At least 380 people were injured with stationary machines, while a minimum of 1400 people were hurt using portable grinder/buffers. As for the other 10,100 people injured, we don't know what kind of grinder/buffer they were using.

Norton Co., a manufacturer of grinding



wheels and abrasives, has a basic pamphlet on grinder and abrasive safety. For instance, the company advises you to stand aside when you start your grinder and let the machine come up to speed. Unlikely as it may be, if the wheel breaks apart, you won't be caught unaware and be injured by pieces of flying grinding wheel. Norton also reminds you not to grind on the side of the wheel, unless the wheel is designed for it, and to dress a glazed wheel to restore its cutting ability.

For all the good advice in the pamphlet, all it costs you is a self-addressed stamped envelope. Write to Norton Co., MS30143, One New Bond St., P.O. Box 15008, Worcester, MA 01615.

—Roy Berendsohn

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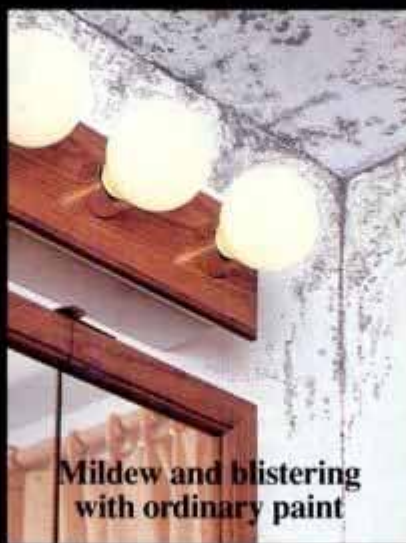
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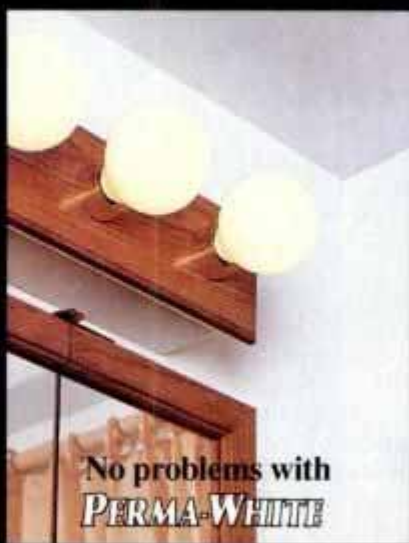
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APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Light's Out

I have a 25-year-old 16-cu.-ft. Sears Coldspot refrigerator model No. 106.667221, serial No. 7B16044. It has a bad light switch. Can you tell me how I can replace this switch?

RALPH R. DAVIS
TURTLE CREEK, PA

A replacement light switch is still available under Sears part No. 548219. Fortunately, this repair is an easy one. The switch costs about \$10. You can buy it from any Sears repair parts center or a local appliance parts store.

To remove the old switch, first unplug the refrigerator. Open the door and insert a screwdriver with a thin blade or a putty knife (with masking tape wrapped over its blade) between the top of the switch and the plastic breaker trim. Gently pry on one side of the switch, then the other until the locking tabs on the switch release.

Carefully pull the switch with wires out of the hole in the breaker trim. Disconnect the two wires from the old switch, and push them on the terminals of the new switch. Push the new switch back into the breaker trim until it snaps into position. Plug in the refrigerator and test the switch.

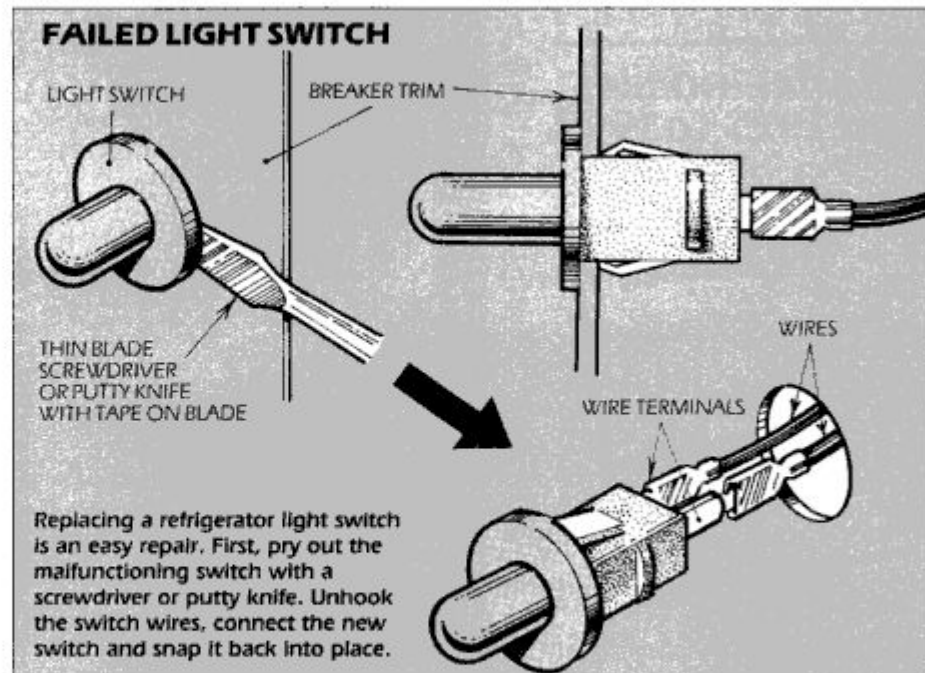
Dishwasher Runs And Runs

My Maytag dishwasher cycles properly except that it will not shut off. It cycles past OFF and starts washing again. The only numbers I can find are on the timer. It is model No. 275BE, 9-01421. Any suggestions on how to repair this?

J. FERREE
ATLANTA, GA

Your dishwasher is either a model WV 100 or a WV 101 and is about 10 to 12 years old. To confirm this, look for a data plate attached to the upper left corner of the tub opening. This data plate should supply you with the model number, series number and serial number of the machine.

As far as the appliance's problem is concerned, it appears that the



timer is at fault. Most likely a set of contacts within the timer, which controls voltage to the small timer motor, is stuck closed. As the timer advances to the end of the dry cycle, and to the OFF position, the contacts are supposed to open, preventing voltage from going to the timer motor. Because these contacts are stuck closed, the timer starts the cycle over again.

Test the timer by connecting a voltmeter to the two black timer motor leads. If the meter reads that voltage is present at the end of the dry cycle—when the timer knob clicks and advances to the OFF position—then the contacts are sticking. There should be no voltage at this point.

A replacement timer assembly is still available for your machine. It's part No. 9-01421, and it costs about \$60 at any Maytag repair parts center.

Inaccurate Caloric

I have a Caloric range model No. RSD369-UL, serial No. 5762674. I recently had to replace the oven temperature control. The new control does not accurately set the oven temperature to the temperature on the dial, and the appliance store where I bought the part will not let me return it. What can I do?

BRIAN RAHILL
TOMS RIVER, NJ

Buy a mercury oven thermometer (\$8 to \$16), and place the thermometer in the center of the middle oven rack. Close the door, and then

turn the oven to 350° F. After the oven has heated up, and cycled on and off for about a half-hour, look at the thermometer's temperature. Note the temperature at which the oven cycled on and at which it cycled off. If the average of these two temperatures is not within 25° F (plus or minus) of the dial setting, recalibrate the control.

The thermostat on your range has a calibration adjusting screw located down in the dial stem of the control.

To gain access to this screw, first pull the control knob off the dial stem, being careful not to turn the thermostat stem. Then, insert a very thin-blade screwdriver down the center of the dial shaft onto the adjustment screw.

Using pliers, hold the dial stem at the 350° F setting, while turning the adjustment screw clockwise to decrease the temperature or counterclockwise to increase temperature. A turn of the calibration screw as little as one-eighth or one-fourth of a full revolution varies the temperature by 30° to 40° F.

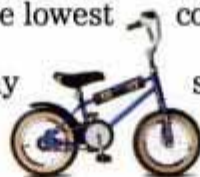
With the dial set at the temperature of 350° F, the oven should cycle off at about 355° F, and it should cycle on at about 345° F.

If, after these adjustments, you are unable to get the oven temperature within the desired temperature range, take the control back to the store where you bought it, along with a copy of your sales receipt. A Caloric replacement thermostat comes with a 1-year replacement part warranty.

Your home could use an oil change.



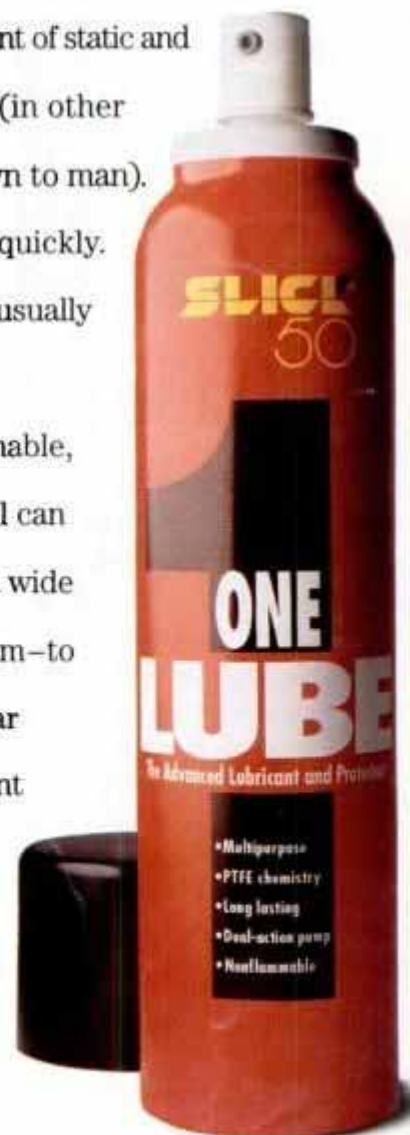
What could possibly make a household lubricant better? PTFE. It's in One Lube.[™] It's also in the *Guinness Book of Records*. As having "the lowest coefficient of static and dynamic friction of any solid" (in other words, the most slippery solid substance known to man).



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Also consider One Lube is non-flammable, and comes in a non-aerosol can that will pump either a wide spray or a precise stream—to get at everything from a door lock to an oar lock. And what you have is a home lubricant that's, well, worth changing to.





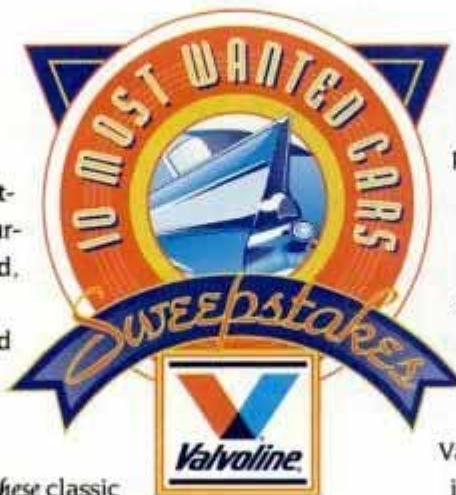
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PARTS & ACCESSORIES FOR YOUR CAR

● Consider this as a winter survival guide for your car. Caught in a battle between mother nature and man (buried in snow on one hand, and pelted with road salt on the other), your car or truck needs all the help it can get.

Winter places particular stress on your cooling system. Antifreeze/coolant failure could be catastrophic here. While road salt does a good job on ice, it also has an appetite for metal, and any chink in your car's ar-

mor is an invitation to rust and corrosion. So we've included products on these pages to keep your vehicle's guard up—inside and out.

It's all here—and more, too. So when winter is through, your car won't be, also.

Editor's Note—All claims in the descriptions that follow are made by the manufacturers and/or distributors and have not been verified by the editors of POPULAR MECHANICS.



Floating Garage

The Floating Garage suspends from most overhead structures and can be installed in minutes. Unlike a car cover, the product does not contact the vehicle's surface. You just drive in and out. The garage is made of rain-repellent, breathable polycotton material, and costs \$129. An optional anchoring system costs \$5. Contact: The Floating Garage, 881 Dover Dr., Suite 3, Newport Beach, CA 92663; (714) 646-1106.

Clear-Coat Spray

Mopar Corrosion Inhibitor, available in 13-ounce spray cans, helps prevent the formation of rust and corrosion on wheels and other painted or unpainted surfaces. The product is nonconductive for spray protection of electrical connectors, terminals and grounds. The clear-coat finish will not crack or discolor even in extreme hot or cold conditions. Contact: All Chrysler Corp. dealer parts departments.



Long-Life Antifreeze

Zerex Extreme 4/50 uses new corrosion-inhibitor technology and offers a 4-year/50,000-mile guarantee against damage to the cooling system caused by freeze-ups, boil-overs or corrosion. Available at all auto parts and accessories outlets.

Contact: BASF Auto Products, 100 Cherry Hill Rd., Parsippany, NJ 07054; (800) 445-4134.



FALL CAR CARE



Plating System

Electroplate small metal parts, trim and fasteners made of brass, copper or steel for a corrosion-resistant, silvery finish. The system includes plating container, electrolyte, 1.5-volt battery and instructions. Contact: *The Eastwood Co., 580 Lancaster Ave., P.O. Box 296, Malvern, PA 19355; (800) 345-1178.*

Auto Alarm

Hijacker Auto Alarm is designed to foil auto hijackers and car thieves. In addition to standard alarm features, the anti-hijack feature allows the culprit to get a safe distance away before it is activated with passive, manual or remote triggering. Accessories such as pain generator, dual-zone radar or shock sensor, door module and programmable voice can be plugged in. Contact: *Levitron International, 4055 Oceanside Blvd., Suite L, Oceanside, CA 92056; (619) 630-7910.*

Lead Additive

If your car or truck was designed to run on leaded fuel, Lead Supreme 130 is the only additive that blends toluene with tetraethyl lead for octane boost and valve protection. One ounce of the product added to 1 gallon of 92- to 93-octane unleaded gas increases octane by two points and provides .171 grams of lead per gallon. Contact: *Stone Oil Co., P.O. Box 345, Statesboro, GA 30459-0345; (912) 489-2896.*



Lots of plugs can
This one started a



Auto Transmission

GM Performance Parts HydraMatic 4L60 high-performance 4-speed auto transmission replaces the 700R4 in many GM cars and trucks. The heavy-duty transmission features a lock-up converter, high-strength steel torque converter housing and upgraded internals. The unit comes with wiring harness, calibration kit and instructions for installing in computer- and non-computer-controlled vehicles. *Contact: All franchised General Motors dealerships.*

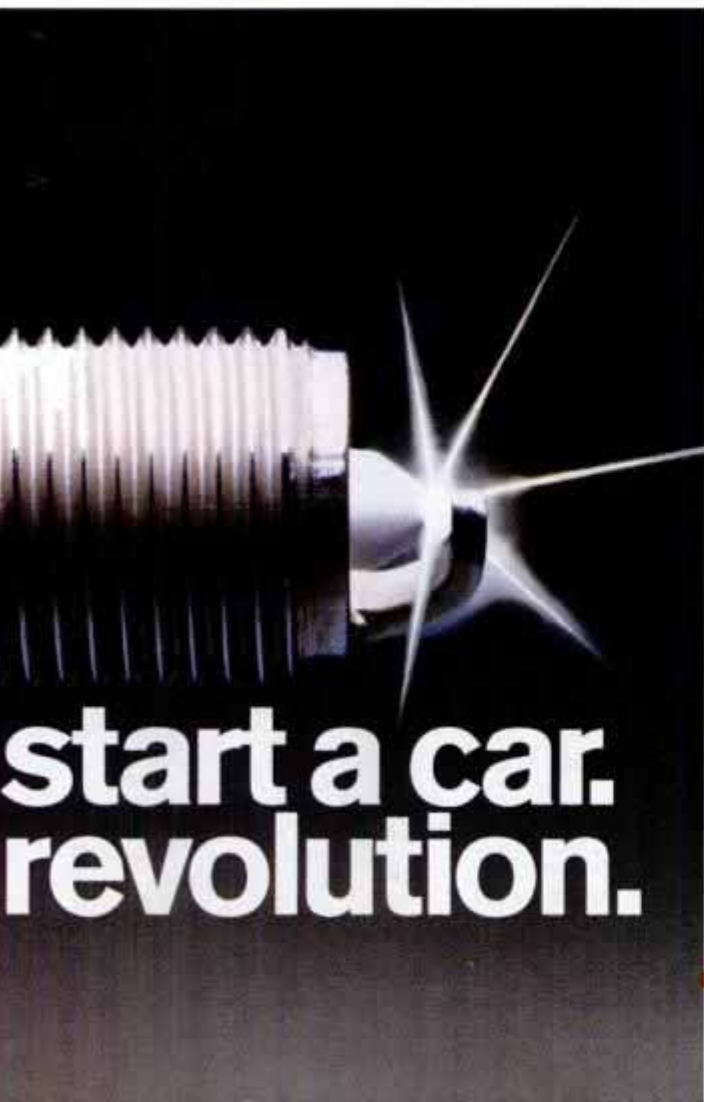
Panel Flares

Bushwacker's Panel Flares for CJ-7 Jeeps install onto front fenders and rear body panels with no sheetmetal alteration. They add about 6 in. of tire coverage, allowing street-legal use of up to 10-in.-wide wheels, and provide protection from rocks, sand and mud. *Contact: Bushwacker, 9200 N. Decatur St., Portland, OR 97203; (503) 283-4335.*



Electronic Tester

Sunpro Sensor Tester Plus handheld tester checks sensors on domestic and import vehicles, and tests ignition modules on Ford, GM and Chrysler products. The unit also checks the DC idle speed motor, continuity, battery voltage, wiring and diodes. *Contact: Actron Mfg. Co., 9999 Walford Ave., Cleveland, OH 44102; (216) 651-9200.*



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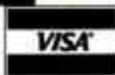
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Step N Seat provides convenient access to the bed of a pickup or flatbed. The unit, made of a strong aluminum alloy, mounts on the pickup tailgate and folds away when not in use. Two models fit standard- and compact-size pickups, and are compatible with bed liners, tailgate protectors and truck caps. *Contact: SNS Inc., 2201 W. 29th St., Topeka, KS 66611; (913) 267-9175.*

Engine Heat Protection

E.H.P. Wet Blanket is a 1/4-in.-thick ceramic-based material used for insulating underhood components from heat. Usable in temperatures up to 3200° F, the blanket is wrapped around a heat source, such as an exhaust pipe, and reduces its radiating temperature by half. It contains no asbestos. *Contact: Concours West, 5915 Seaside Walk, Long Beach, CA 90803; (310) 433-2121.*



Splash Guards

Street Spatz Splash Guards offer an attractive alternative to the traditional splash guard. The guards feature a custom-molded look, with universal application for all cars and light trucks. They're available in seven colors. *Contact: Highland Group Industries, 31200 Solon Rd., Suite No. 1, Solon, OH 44139; (216) 498-0001.*



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Water Remover

Prestone Water Remover emulsifies water in the fuel system and removes it through the exhaust system. This is unlike methanol-



based gas dryers, which lower water's freezing point, but do not necessarily remove the water itself. Methanol also can be corrosive to the fuel system. Water Remover contains corrosion inhibitors and fuel-system cleaners. Available at all auto products outlets. Contact: First Brands Corp., P.O. Box 1999, Danbury, CT 06813; (800) 326-2835.



Trunk Extender

If your cargo is too large to allow your trunklid to close, Trunk Extender adjusts automatically to the correct length to hold down the trunklid. The unit features two security hooks and no-tangle operation. It costs \$9.95. Contact: More Than Gifts, P.O. Box 217, East Meadow, NY 11554-0217.

Trim Restorer

Bumper Black is designed to restore, beautify and protect all types of exterior trim—regardless of color. It restores trim that has discolored and looks white or gray.

The product deep cleans both smooth and textured surfaces, such as bumpers, mirrors and door handles, and protects against weathering.

Contact: The Wax Shop, P.O. Box 10226, Bakersfield, CA 93389-0226; (800) 323-9192.



Fuel Injection

Holley Pro-Jection retrofit fuel-injection system for carbureted V8 vehicles is designed for installation on pre-computerized cars and trucks. The system comes with a throttle-body unit, adjustable electronic control module and

inline electric fuel pump. Available for 2- and 4-barrel configurations, and with a kit for emissions compatibility. Contact: Holley Replacement Parts Div., P.O. Box 2003, Warren, MI 48090-2003; (313) 497-4000.

Two-Step Polish

The new 2-step Show Car Polish system super-bonds to your vehicle's finish for a deep, wet-looking shine with double the protection of just the polish itself. No single-step polish or wax can match it, according to the distributor. It's easy to apply, and available only by mail order for \$24.90. Specify for regular or clear-coat paint. Contact: ZBCO, 5700 Arlington Ave., Suite 9V, Bronx, NY 10471; (718) 796-5402.



Truck Performance Chip

Performance Resource now has replacement high-performance computer E-proms (chips) for 1993 GM trucks, vans and sport/utilities. The chips, also available for 1987 and newer GM vehicles, increase torque up to 25% for

noticeably quicker acceleration and provide crisper all-around throttle response. Fuel economy—especially when towing—is increased up to 15%. Contact: Performance Resource, 12 Barbara Dr., Fairfield, NJ 07004; (201) 343-0680. **PM**

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OUTDOORS

GEAR YOU CAN USE

BY JOE SKORUPA, Boating/Outdoors Editor



● Longtime readers of PM know that this column was called All Outdoors years ago. No doubt, one of the former editors felt a bit daunted by the column's inclusiveness, or all-inclusiveness as he might have put it. Perhaps he even considered using, "Everything Under The Sun." It would have been equally apt.

Although the column has certain limitations, such as those topics covered by other PM departments, the subject matter covered here can range from sports gear to 4x4s, kayaks to mountain bikes, exercise equipment to hot-air balloons. But why stop there? Subjects can also include fishing, rollerblading, target shooting, camping, ATV riding, sled-dog racing, snowmobiling, the environment, endangered species and virtually anything else that pertains to serious recreational fun.

But back to the main point: There's really no need to expand the column's title. Without a modifier, Outdoors says it all. So, in the spirit of inclusiveness, this month's column covers new products that range from, well, everything under the sun.

The first of these is Yamaha's new

Timberwolf 4x4 ATV. What makes this model unique is the application of a 4x4 drive system in a midsize sporty ATV. Keep in mind that most 4x4-equipped ATVs are large utility machines.

Yamaha unveiled the go-anywhere Timberwolf recently in the rustic hill country of Washougal, Washington. Given the ATV's relatively trim profile and slim weight (397 pounds), the Timberwolf 4x4 features a versatile combination of agile sportiness and powerful utility.

Using the same powerplant as the standard Timberwolf—an air-cooled 4-stroke sohc 229cc engine—the new 4x4 is basically in a class by itself. Since most 4x4 ATVs are found in larger classes, such as Yamaha's Big Bear (348cc) and Kodiak (387cc), the addition of sure-footedness in the sporty Timberwolf

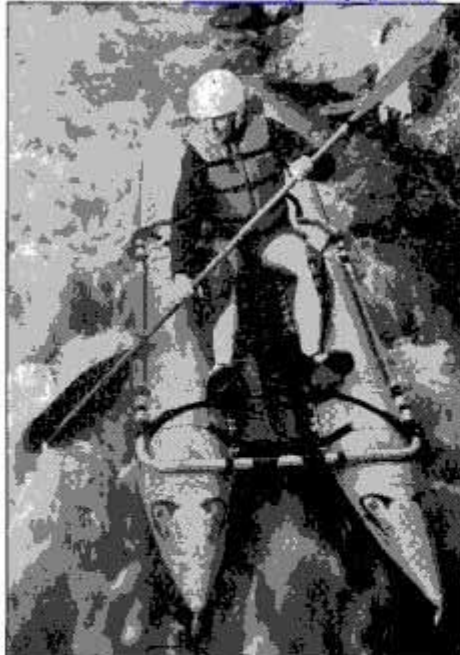
gives this perennial best-selling model something to howl about.

In addition to all-wheel traction, the 4x4 Timberwolf also has an improved suspension. The front end comes with MacPherson struts, while the rear has a race-inspired swing arm. Travel in both the front and rear is an impressive 4.92 in. Other features include a reverse gear, shaft drive, an electric starter that works in any gear, a sealed rear

(Please turn to page 117)



For the ultimate tailgate party, the Coleman Kitchen is a complete outdoor food preparation center.



High and dry in the inflatable WaterWolf.

brake that's recessed into the rear wheel and a trailer hitch. Suggested base price is \$4299. For more information, write to Yamaha Motor Corp., 6555 Katella Ave., Cypress, CA 90630, or call (714) 761-7800.

Tailgate parties for sporting events and picnics in the park or on the beach have expanded lately into big-time food preparation. It's not uncommon today to be miles from civilization and still enjoy dishes such as eggs benedict, steak, lobster, blackened fish, ribs, chili, blender drinks and much more. And while the name has stuck, the tailgate itself has proven to be inadequate as the ideal centerpiece of the well-equipped outdoor food fest.

The solution? The **Coleman Kitchen**, which not only includes a kitchen cabinet, counter space, a spice rack, a paper-towel holder and a sink, but it weighs just 35 pounds and fits into a handy nylon storage case that's about the size of a suitcase. With the addition of a stove, cooler and utensils, the Coleman Kitchen becomes a complete outdoor food preparation center.

The main benefit of the Coleman Kitchen, in addition to its portability, is its organizational convenience. Once you put the legs down, flip up the top and open the side extensions, you suddenly have wonderful things to work with—shelves, racks, counter space and hanging hooks—and all are within easy reach and at an ideal height.

Built with a rugged anodized aluminum frame and polished aluminum surfaces, the unit comes with a 2-year limited warranty. Suggested retail price is \$249. For more information, write to the Coleman Co., 250 N.

St. Francis, Wichita, KS 67202, or call (316) 261-3211.

While there are many benefits to sitting on a small boat, such as a catamaran or pontoon boat, as opposed to sitting in one, such as a canoe or kayak, the potential is truly maximized for aficionados of river running. Quite simply, you can't swamp a boat that has no space to hold water. The **WaterWolf Kayak** and **WolfCat** take full advantage of this concept by supporting riders on a platform suspended between twin inflatable tubes.

Professional raft outfitters have proven that inflatable-tube construction is equal to the challenge of handling the world's toughest rivers. To make the two WaterWolf models durable, the tubes are made of a nylon fabric that's coated with UV-inhibiting polyurethane. With the addition of an internal aluminum frame, welded seams and a Kevlar weave, these rip-stop tubes can be inflated to 8 psi (twice the industry standard) for unparalleled responsiveness.

Both the WaterWolf Kayak and the WolfCat are composed of two 10-ft. tubes, a frame and an adjustable seat. The difference is that the WolfCat's frame can expand and separate the tubes for increased stability. Prices for the lightweight craft start at \$980. For more information, write to WaterWolf, P.O. Box 3341, Telluride, CO 81435, or call (800) 358-3169.

Not every **POPULAR MECHANICS Design & Engineering Award** winner boldly breaks new ground such as inventing radar-invisible aircraft or developing computer chips the size of an atom. In 1992, for example, one award was given to a company that built a fishfinder that not only inspected the water below the boat, but also inspected the water alongside of it. The technology was hardly groundbreaking, yet no one had done it before, and the benefit to fishermen was considerable.

Well, award-winning Bottom Line has contributed to the betterment of fishing once again with the introduction of the **Fishin' Buddy**. Like the award-winning Sidefinder, this unit has the ability to look both below the boat and to the side. What's new is that it's portable and can be used on virtually anything that floats.

Bottom Line's unique new side-and-bottom-viewing sonar unit is a one-piece design that uses a C-clamp to mount on boats, docks, canoes and inflatables. Installation is a snap because the 5-pound unit is self-contained—the display screen and transducer are linked together by

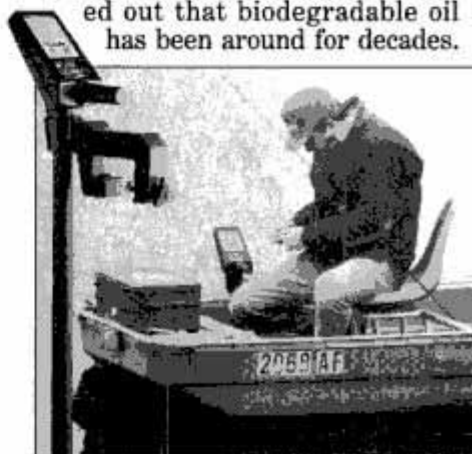
an adjustable telescopic shaft.

Despite its small size and light weight, the Fishin' Buddy is a powerful set of underwater eyes. It can peer up to 120 ft. horizontally and 240 ft. straight down. Like most fishfinders, it has the expected features: bottom and fish alarms, super-twist LCD screen, backlit display, temperature readout, multiple modes and many others.

The 6500-pixel screen is on the small side, measuring only 2.5 in. x 3.3 in., but that's the tradeoff for extreme portability. The transducer cone angle is a versatile 8°.

The Fishin' Buddy comes in two models and begins at about \$129. For more information, write to Bottom Line/Computrol, 499 E. Corporate Dr., Meridian, ID 83642, or call (208) 887-1000.

A note to careful readers of my Aug. '93 Boating column, "Yamaha's Second Decade:" I didn't mean to imply that Yamaha invented biodegradable oil. Several of you pointed out that biodegradable oil has been around for decades.



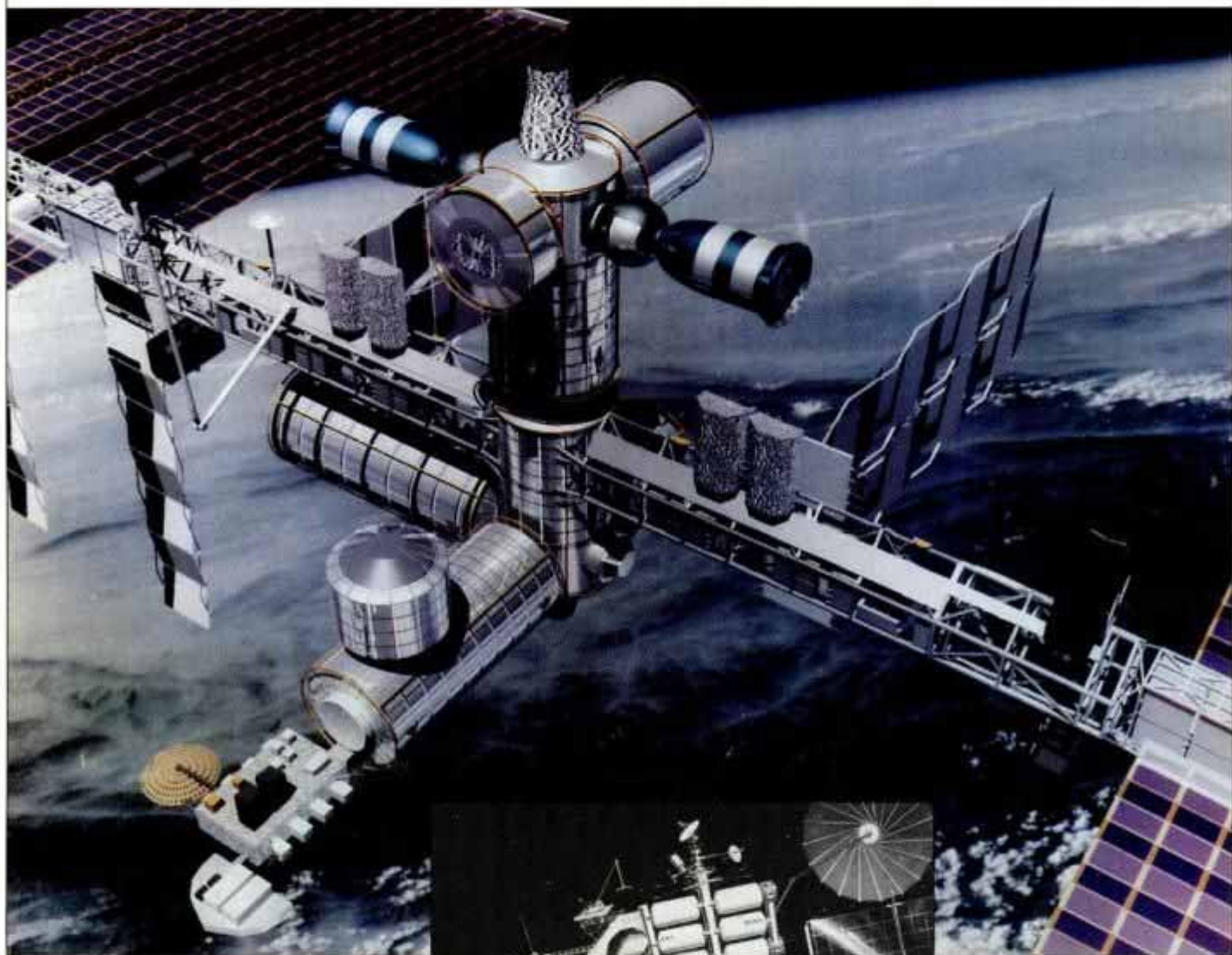
The Fishin' Buddy is a portable bottom-and-side viewing finder.

However, I was implying that Yamaha was breaking ground in developing a biodegradable 2-cycle oil for marine engines. Well, it turns out I was wrong. The company Amsoil has been making a 77% biodegradable 2-cycle oil for about two years. The cost of a quart is about \$7. For more information, you can write to Amsoil, Amsoil Bldg., Superior, WI 54880, or call (800) 777-7094.

Although I stand corrected, Yamaha Promar biodegradable oil is still in a class by itself. Yamaha began making the oil in an attempt to comply with increasingly stringent European pollution standards that require marine 2-cycle oil to be more than 80% biodegradable. As far as I know, Promar is the only oil that can meet this threshold. However, I'd be interested in hearing from any reader who knows more about the subject. **PM**

CHANGING STATIONS

BY ABE DANE, Science/Technology Editor



NASA ILLUSTRATION (TOP); PM ILLUSTRATION BY ED VALIGURSKY (INSET)

● If you're interested in America's space program, you probably know the numbers. Roughly \$8 billion has now been spent on space station *Freedom*, and it's been 9 years since Ronald Reagan originally set forth the grand vision of an international team of astronauts working side by side in orbit. This was to be our toehold in space, the springboard for human journeys throughout the solar system.

You're probably also aware that from early on this dream has been in flux. In fact, as this is written, the final details are being hammered out on the most recent of about a dozen new designs proposed over the years.

What you may not know, however, is that amid the great and tangled mess of congressional debates, management reorganizations and config-



Color illustration shows approximate station configuration chosen by President Clinton. As this is written, a transition team is working out the details. Black-and-white illustration ran in PM in the mid-1980s, when NASA's ambitions were far grander.

uration changes, people have actually been forging metal, writing software code, assembling components and steadily going about the task of making an actual space station.

When the new administration ordered the most recent redesign this summer, the previous configuration had just passed its critical design review. That meant plans had at last advanced to the point where the contractors were free to commence building

—which they did, and continue to do.

So how does all the political to-ing and fro-ing affect what would be a tremendously difficult effort under the best of circumstances?

"It's been a challenge to everyone," says Doug Stone, Boeing's chief engineer on the project. "We have to make sure that our people stay focused on doing a quality job and aren't distracted by the fact that somebody is publishing a new config-

uration every day in the newspaper."

So far, Boeing has fabricated large, aluminum ring forgings that will brace the skins of the cylindrical laboratory module and of the node that connects it to other parts of the station. Some skins have been made as well, machined from pieces of flat aluminum stock into a weight-saving waffle-grid pattern, then placed over forming tools in an annealing oven so that they gradually bend to the right curvature.

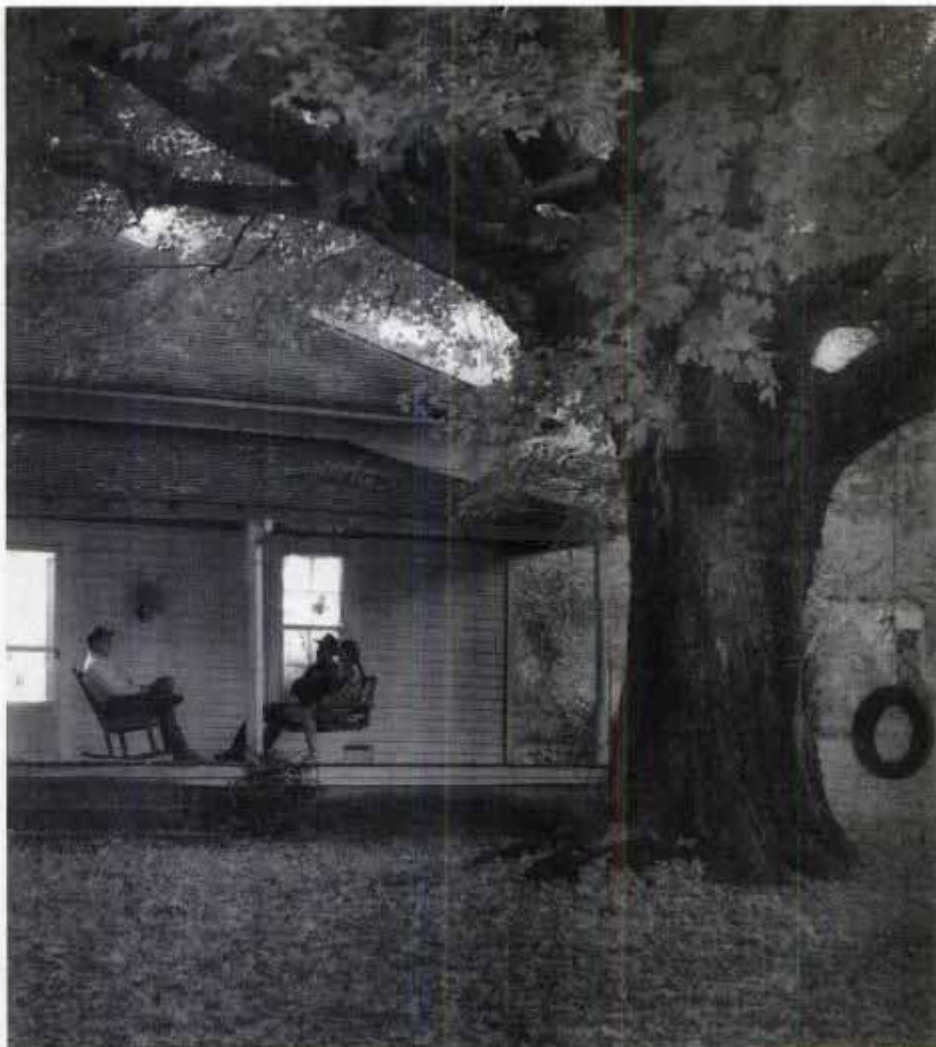
Boeing has been fortunate in that much of its work is on the station's pressurized areas, which are among the parts least changed in the redesign. "There's almost no time or effort lost there," says Axel Roth, deputy manager of the space station projects office at NASA's Marshall Space Flight Center.

McDonnell Douglas, which is responsible for the trusses that serve as the station's backbone and for its propulsion systems, may be more seriously affected. Like Boeing, it is building what's known as "qual" hardware, equipment identical to the final product except that it will go through rigorous qualification testing on the ground instead of going to space.

The truss structure goes together something like a balsa model plane, built up from bulkheads and stringers. The bulkheads are machined down from 7000-pound billets of aluminum into 14-ft. hexagons weighing 400 to 700 pounds. According to Gus Ludwig, director of production operations and logistics for McDonnell Douglas's space station effort, parts for the first 30-ft.-long truss segment are just about ready for bolting together in their assembly jig. The first propulsion module, which holds rockets and propellant to keep the station in position, is already being assembled.

Originally, eight propulsion modules were planned, with four hooked up to the station at any given time and four more back on Earth being refueled. Although the possibility is now receding, the latest redesign at one point considered replacing the modules with part of a classified military satellite. The truss segments will almost certainly be scaled back.

To Ludwig, the changes in design, and particularly the slips in schedule, are frustrating. He had hoped that seeing the station into orbit would be the crowning event of his 35 years in the business. "This was going to be my swan song," he says. He also worries about the young and enthusiastic workforce that moved to town, bought houses and began families during more optimistic times. Still, he maintains, "This is the most exciting program I've ever worked on." **PM**



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MOTORSPORTS

RAUL ON A ROLL

BY JEREMY SHAW



PM PHOTO BY STEVE SWOPE

PM PHOTO (INSET) BY CHEER, DAY ANDERSON

● Midsummer was an exceptionally busy time for the PPG IndyCar World Series. After a month with the relative stability of working at a single track—Indy—every day, the IndyCar circus found itself crisscrossing the country to run six races in about eight weeks—a harrowing pace for men and machines both.

For Team PM and Dick Simon Racing, the hectic midseason swing produced what could be regarded as a more or less normal ratio of success and disappointment. Raul Boesel continues to be the standard-bearer. With 10 races in the books, he stands a solid third in the season standings, trailing only points leader Nigel Mansell and Indy-winner Emerson Fittipaldi.

After his excellent showing at Indy, Boesel followed up with his first IndyCar pole on the demanding Milwaukee Mile. Proving that his Indy run was no fluke, Boesel etched his name into the Milwaukee record books with a sensational new qualifying record run of 165.752 mph in the Duracell/Mobil 1/Sadia Lola T93/06 Ford-Cosworth XB. The old mark—162.924 mph—was set by defending series-champion Bobby Rahal.

"I honestly didn't expect to go that quick because the track seemed to be a bit slower toward the end of the last session," said Boesel.

Boesel's Milwaukee effort was proof positive of the progress made by the team this season. In addition to the aerodynamic tweaks the team added for Indy, Boesel's Lola sprouted small deflectors in front of the sidepods, similar to those used by several Formula One teams this season. The custom touches to the Dick Simon Racing Lolas were developed in private wind-tunnel test sessions, and it's a further credit to the team that almost identical appendages adorned Mansell's car on race day at Milwaukee.

The PM/Dick Simon team had high hopes of finally scoring its first victory, but had to be content with second place, even though Boesel led the most laps. Ironically, it was Mansell, the 1992 Formula One World Champion, who scorched through to

Raul Boesel, currently in third, is pacing the team.

earn his very first win on an oval.

Scott Brayton also had an excellent day at Milwaukee, coming home sixth in the Amway/Northwest Airlines Lola/Ford-Cosworth.

Boesel added yet another second at Detroit, followed by a trio of disappointing seventh-place finishes at Portland, Cleveland and Toronto. But when the IndyCar tour got to the high banks of the Michigan International Speedway for the second 500-miler of the season, Boesel was back in form. He jockeyed his Lola to fourth place on the MIS starting grid—comfortably ahead of both Fittipaldi and fellow Penske Racing phenom Paul Tracy—then fought his way through a tough afternoon of



Jimmy Vasser has switched from Chevy to Ford power for the balance of the season.

PM PHOTO BY STEVE SWOPE



Raul Boesel's excellent driving and exceptional consistency have put him in championship contention midway through the '93 season.

caution flags and flat-out racing to hold on to his starting position.

In fact, Boesel looked set for a third-place finish until being caught out by the final caution period. Boesel had just made his final fuel stop under green flag conditions. With the leaders running laps at around 32 seconds, he lost a lap in the process. Arie Luyendyk, though, was set to make his own pit stop just a couple of laps later, and was able to take full advantage when the yellow lights blinked on. He took on service without losing a lap. Ultimately that was to be the difference between them.

Boesel, nevertheless, gained dramatically on Fittipaldi in the season standings, since his fellow Brazilian could manage no better than a 13th-place finish.

The '93 season so far hasn't been quite as kind to Boesel's teammate Scott Brayton, who usually qualifies well but falls prey to various mechanical woes. And even when his qualifying position hasn't been in the top 10, his times have been competitive—an

indication of the overall strength of IndyCar racing today.

Brayton's experience at Toronto provides a good indication of the depth of the 1993 IndyCar competition. When the grid was set for the



Small problems have slowed Brayton's Lola.

demanding Toronto street circuit, Brayton found himself in the 10th row, with the 19th fastest time. However, if his time had been just 1 second plus a blink quicker, he would have been third on the Toronto grid. That's close racing!

Jimmy Vasser continues to show great promise in the third PM car. He added to his points tally at both Milwaukee (eighth) and Portland (11th) with his year-old Lola and

Chevy/A engine, and then switched to the same Ford-powered Lola he ran at Indy, finishing 11th again.

At first, car owner Jim Hayhoe reckoned the switch might have been a mistake, since they had more setup information for the Chevy-powered car. But it seems now that Vasser may be able to run the more powerful Ford car for the balance of the season. As a result, the information gained at Toronto will be important.

Watch for Vasser to become a regular point scorer in races still to come.

All eyes, though, are on Boesel. To date, he leads all comers in terms of miles completed this season (2475.096 of a possible 2493.930) and laps completed (1377 of 1387). He has also led a total of 104 laps in 10 races.

That's exceptional consistency, and consistency—plus speed—is what wins championships. In racing, nothing pays off like being around at the finish. It's hard to win when you're not. And winning is what Dick Simon and company have in mind. **PM**

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Don Johnson, V.P. Product Engineering
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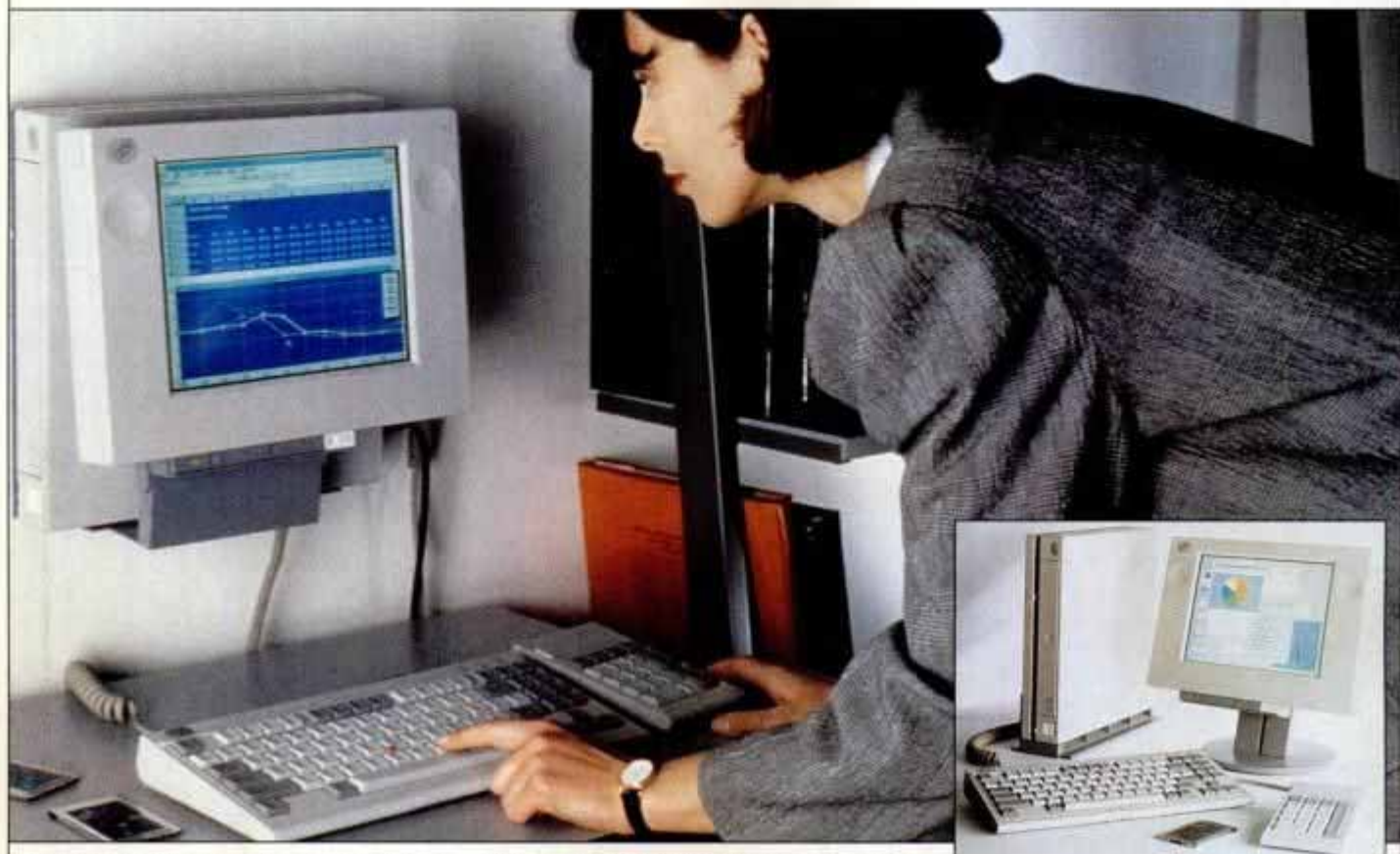
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COMPUTERS

SMALL WONDERS

BY STEPHEN A. BOOTH, Contributing Editor



● Small isn't news in personal computers. Lots of portables pack the wallop of a desktop PC, while size and weight keep diminishing: Laptops, notebooks, subnotebooks and even palmtop computers are plentiful in this fall's lineup. What continues to amaze is the amount of processing power and the variety of functions that PC makers can now shoehorn into a

battery-operated portable computer.

It's not just a matter of shrinking components. It's making all those downsized genies run more efficiently on available power. Ironically, the kind of intelligent power-management developed for portables is working its way back to the desktop world—in the interest of energy conservation.

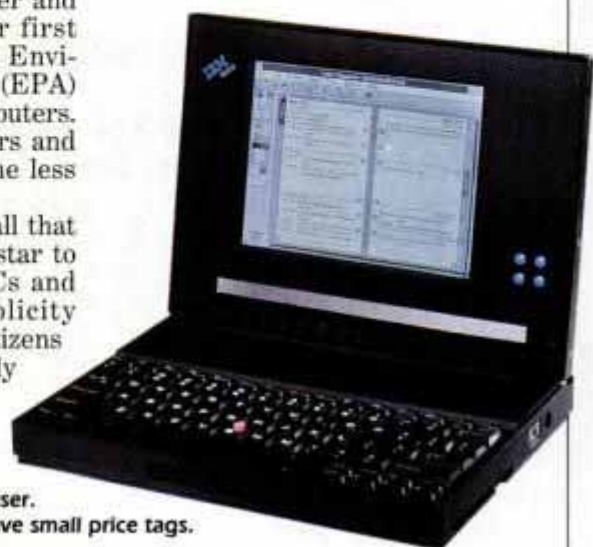
Call them green PCs. IBM, Acer, AST Research, DTK Computer and others are introducing their first models that comply with the Environmental Protection Agency's (EPA) Energy Star program for computers. The goal is to make computers and display monitors that consume less than 30 watts each.

It's a voluntary thing, and all that the honors students get is a star to stick on their PCs and the kind of publicity good corporate citizens like. The benefits really go to everyone else.

To the automotive world, pollution control

and energy efficiency are familiar topics. Only recently have computer makers become sensitized to these issues. According to the EPA's estimates, computers consume about 5% of the electricity in the United States—some 70-billion kilowatt hours yearly. That's just the computers and

(Please turn to page 124)



IBM's green PC (top) is a small power user.
H-P's OmniBook (left) and IBM's ThinkPad 500 have small price tags.



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RESERVE



their heat-generating video displays—not the extra air conditioning required to keep the brains cool in a typical office. The EPA further estimates that 30% to 40% of the computers remain on all the time, even when they're unattended.

For the record, it's not unusual for today's desktop PCs to consume 250 watts or more. Although the computer population will increase yearly, it is projected that the new green PCs will reduce the load to 45-billion kwh by A.D. 2000. In terms of carbon-dioxide emissions, that's like taking 5 million cars off the road, says the EPA. In terms of money, at today's utility rates, it should lop one-third off the cost of operating a computer—\$12 a year versus \$35 for a typical household whose PC runs 12 hours a day.

Costly savings

Skeptical minds have come to suspect that "green" doesn't come cheap—at least not initially or in the short run. IBM's handsome entry to eco-computing carries a \$6780 sticker for the version pictured on page 122. But a lot of that cost is in the flat-panel, high-resolution color LCD display—just \$2245 would buy you an entry-level PS/2E with a 14-in. power-stingy color-tube monitor.

IBM's PS/2E typifies portable computing's influence on desktop computers. Most obvious is the optional space- and energy-saving LCD screen. It burns 21 watts at full throttle, but just 3 watts in its sleep mode—power on but inactive. Less obvious is the computer itself.

Under the hood, there's a 486SLC2 microprocessor—a high-performance 486 chip in a low-voltage version typically used in portable PCs. The PS/2E's computer, or system unit, measures a trim 12 in. square × 2.75 in. deep. A footprint this dainty is made possible in part by the use of plug-in PCMCIA (Personal Computer Memory Card Industry Association) cards.

These credit-card-size modules, increasingly popular in portable PCs, can perform chores such as mass memory storage, modem and fax communications and more. They're solid-state and use a fraction of the energy needed by electro-mechanical devices, such as hard drives or diskette drives. They also run cool: The PS/2E needs no fan, so it's small—and silent. All told, the computer consumes 30 watts running full-tilt, but enters a 16-watt sleep mode when unattended. IBM's new 14-in. color-tube monitor idles at 8 watts.

Lap it up

PCMCIA cards and smart power-management play a big role in this season's portable PCs too, where energy conservation is a virtue borne of necessity. IBM, Hewlett-Packard, Canon, Panasonic, NEC and Apple are fielding stellar entries, each intriguing in its own way.

The ThinkPad 500 (\$1999) is IBM's first subnotebook portable, and designers at Big Blue really had their thinking caps on for this one. It



Canon's laptop has a built-in printer.

weighs less than 4 pounds, has a backlit 7.4-in. monochrome display and uses the same 486SLC2 powerplant as the PS/2E. But its battery system will get the most cheers from mobile users.

Instead of requiring owners to lug a hefty recharger/AC adapter on the road, the ThinkPad 500's battery has its own 2-prong plug that attaches to a power receptacle for self-charging. Simply slip it out and slip another in, without disrupting operation. IBM claims each battery will run for 4 hours under worst-case conditions. A small AC adapter lets you run on household juice.

The same powerplants and PCMCIA slots are found in IBM's larger notebook-size ThinkPad 350 and 350C (\$1999 and \$2599 respectively, monochrome and color LCD). Power smarts are evident here, too. Each model uses nickel-metal hydride (NiMH) batteries, which charge faster and run longer than standard nickel-cadmium (NiCd) batteries. The recharging takes place internally, in about an hour.

Power options and power savings are the strong suit of Hewlett-Packard's OmniBook 300 Super-portable, a subnotebook that weighs in at less than 3 pounds and measures about 11 × 6.5 × 1.5 in. For mobile users, it offers great flexibility in operating arrangements. Depending on how it's equipped, it will even run 10 hours on four store-bought AA cells.

Much of the OmniBook's magic comes from the use of solid-state memory devices in place of things that spin. For example, its broad selection of top-shelf software pro-

grams is built into ROM (read-only memory) instead of occupying the mass-storage space of a hard drive. You can buy the OmniBook with a removable hard-disk drive (\$1950) or with a PCMCIA flash-disk memory (\$2375).

The flash-disk offers some advantages. It's less prone to malfunctioning from shock. It also consumes less power and can run off easy-to-find alkaline batteries—thereby making you less dependent on an AC source for recharging. With flash-disk, H-P states the OmniBook will run for at least 9 hours on alkalines, ditto for the computer's own NiMH rechargeable and longer on four AA lithiums (sold by Eveready). The hard-disk version can run on lithiums or the NiMH battery for 5 hours.

There are tradeoffs for the OmniBook's size and flexibility. Flash-disk memory capacity is 20 megabytes (MB) versus 80 for the hard disk. But 20MB is still a lot, and you can carry spares. Also, the OmniBook uses a 386 microprocessor, and its monochrome LCD screen isn't backlit. But the 386 chip is still plenty powerful, and the high-reflectivity 9-in. display is very readable. No, you can't work in the dark, but you can work in a wide variety of lighting conditions by manipulating the screen angle, changing the contrast and using larger typefaces—even reversing the display to white on black. For anyone who requires serious portable computing without dependence on AC, H-P's OmniBook is the front-runner.

Canon's NoteJet 486 (\$2499) is another serious contender for mobile users who really need a portable office. At 7.7 pounds and 12 × 10 × 2 in., it's a bit more to carry than other notebook computers. But consider that it has a plain-paper printer built-in—which makes it a mobile fax machine too, with the addition of a PCMCIA card.

The NoteJet 486 takes advantage of Canon's super-compact Bubble Jet printing technology. It delivers laser-like quality (360 dots per inch) for text or graphics, and it has a 10-page automatic feeder. You can insert paper or envelopes manually, too. According to Canon, the user-replaceable print head (\$43) is good for 3000 pages. Ink cartridges print 65 pages and cost \$8 each. The NoteJet has a 486SLC chip and a 9.5-in. backlit monochrome LCD and runs 4 hours on a rechargeable NiMH battery, including the printing of eight pages. Mobile uses aside, it's also a viable option for students tight on dorm space or anyone without volume-printing requirements. **PM**

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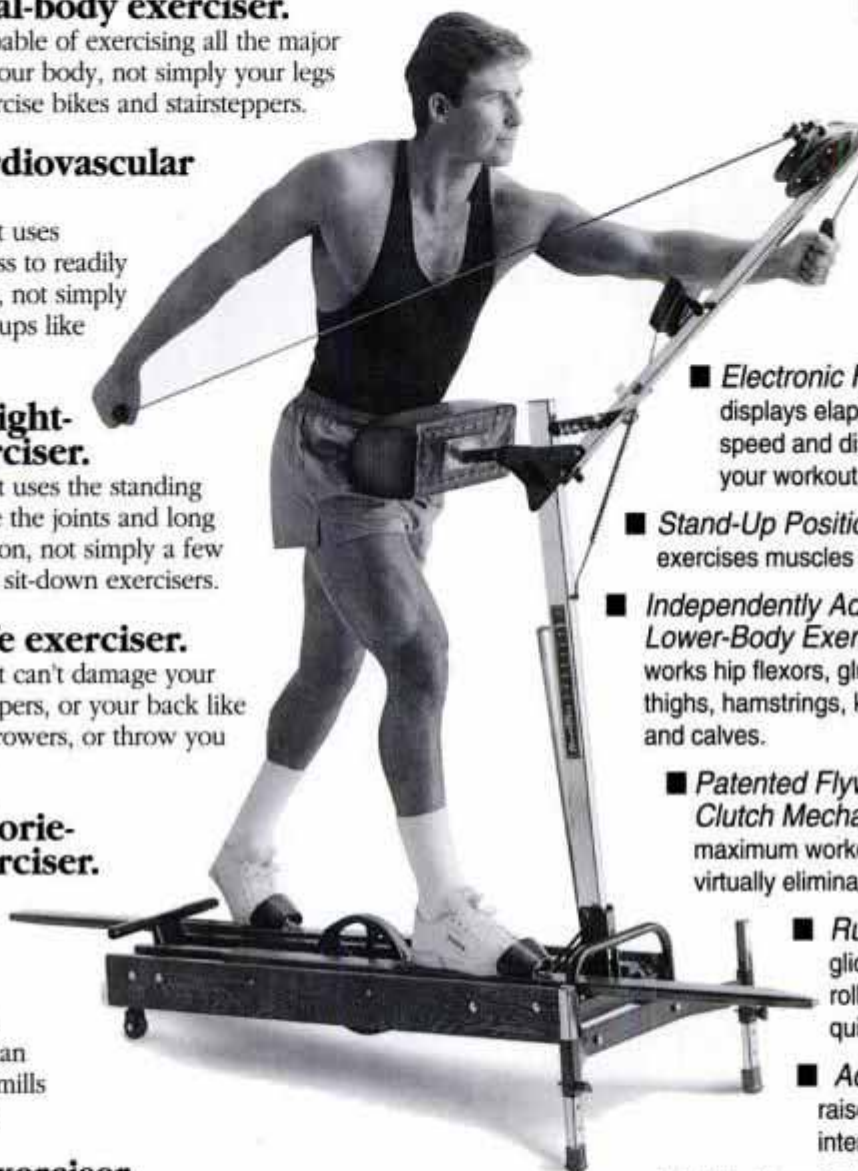
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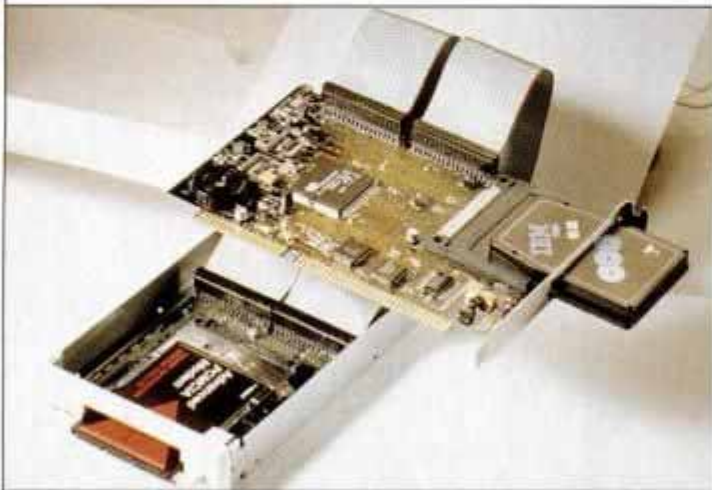
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FLEXIBLE COMPUTING

BY FRANK VIZARD, Electronics Editor



● The day is going to come—maybe as soon as 10 years from now—when people will have as many computers in the house as they now have televisions. There's also little doubt that these computers of the future will be more powerful than present models.

Just how we'll be using our computers around the house may be hard to envision but sometimes the future can be discerned by looking at the periphery. As it happens, a number of peripherals—what hackers call accessories—are making the fogginess of the crystal ball a little clearer.

Clear video and audio is the aim of a stylish accessory called Flexcam made by Videolabs Inc. of Minneapolis. Mounted atop a flexible 18-in. wand is a tiny, high-resolution color video camera that is accompanied by two tiny built-in microphones.

Flexcam is designed to be used for audio/video communication via the PC. This \$600 device also can be used to scan documents and images and is ideal for many desktop video applications. With products like Flexcam, real-time conferences between PC users appear to be an affordable reality.

Reality of a different sort is the concern of a new PC game controller from Logitech. Called CyberMan, this controller may turn out to be the model for the navigation tool needed to transverse the new cyberspace frontier.

CyberMan melds what previously had been two different products, the mouse and the joystick, and improves on both in the process.

Unlike either a joystick or mouse, CyberMan provides six different maneuvering motions: x, y and z axes, pitch, yaw and roll. A mouse generally works only on an x and y axis, while a joystick offers only roll and pitch.

Secondly, CyberMan offers tactile feedback. Say, for example, you are in a role-playing game. If your character gets whacked by a bad guy, you feel a pulsating vibra-



Cardport provides a PCMCIA bridge for PCs, while Flexcam puts your image on the screen.

tion in your control hand corresponding to the impact of the blow. The tactile response enhances the sense of realism.

Combine this tactile response with CyberMan's maneuvering power and you have a product that practically lets you feel inside the computer world of cyberspace. List price is \$130, and CyberMan is compatible with 386 or above PCs.

A third peripheral of note is a new device that provides a bridge between laptop and desktop computers. Many new laptops employ what are called PCMCIA flash memory cards. These cards can be used for data storage, communications and other specialized chores. The advantage is that all these functions don't have to be stored in the computer, thereby saving space.

Desktop computers are not initial-



CyberMan: a navigation tool for cyberspace.



Put a remote control on your arm.

ly designed to handle PCMCIA cards. Making the world a little more compatible, though, are devices like the Cardport made by CNF Inc. of Morgan Hill, California. This product plugs into an expansion slot inside the PC. Once installed, your PC is now equipped with two PCMCIA card slots, one in the back and the other in a spare drive bay in the front. An external version that plugs into the parallel printer port is also available. List price is \$299 for either the internal model or the external module.

Easy Listening

If you hate the notion of buying a music album without hearing any of the songs, then you'll love an I-shaped kiosk that may soon be appearing in record stores.

Developed by the Intouch Group, based in San Francisco, the I-station lets you listen to 30-second samples of songs and watch a music video if available. A series of icons appears on a touch-sensitive screen so you can rate the song's appeal. You can also locate albums by typing in song titles, check the Billboard Top 50 and find related music by other artists.

Access to the I-station is done by inserting a smart card provided by the store. The smart card contains demographic data provided by the user. You get to be a musical judge, and the record companies get a read on who likes what kind of music.

Wrist Remote

There are probably not too many homes left where there isn't more than one remote control. Relieving remote-control clutter is the job of a universal remote. These devices let you operate a number of electronic components from just one remote.



This remote can switch channels.

While universal remote controls have been around for a few years, some new models bring a different spin to the task.

The Casio CMD-10B universal remote wraps around your wrist like a watch, convenient if you're the type who is always walking around the room looking for the remote. The functions are limited, but most of the heavily used features are available. The Casio Wrist Controller will turn a TV's power on and off, select channels and adjust the volume. For a VCR, you can activate power, fast forward, rewind, play, stop and select channels. For a cable box, power and channel selection are available.

And yes, the Wrist Controller also works as a watch, offering stopwatch, alarm and calendar features. List price is \$70.

Another innovative universal remote comes from Universal Electronics Inc. and is sold under the name "One For All." The VCRPRO4 model, listing for \$80, is very handy in that it will automatically turn on the VCR and cable box for unattended recording. More importantly, the VCRPRO4 will set the proper channel for the recording. This means that if you want to record two or more programs appearing at different times on different channels, the VCRPRO4 will automatically switch to the desired stations at the appropriate time.

Recording information is programmed directly into the VCRPRO4 and relayed via an infrared beam. All you have to do is leave the remote facing the VCR and cable box as infrared works on line of sight only. Up to 21 shows can be programmed into the VCRPRO4. The remote will control up to four electronic components. **FM**

will stretch 4:3-ratio programming ever so slightly to fill their screens. Like JVC, it's a progressive stretch—at the periphery—that respects the eye's sensitivity to geometrical correctness at the center of the line of sight.

Although the new TVs are quite accommodating in a horizontal orientation, only the RCA/ProScan and Philips (\$5995 for a 34-in. direct-view model) receivers do anything to improve a picture in the vertical manner.

These brands offer the only wide receivers that also employ progressive, noninterlace scanning. This means their vertical scanning is double the usual rate. Instead of building a picture by alternately scanning two fields of 262.5 lines, 30 times a second, these TVs create the image progressively, all 525 lines in one sweep, 60 times per second.

As far as your eyes are concerned, it's like doubling the vertical scanning rate. And the payoff comes when you zoom up those letterbox videos that use only 363 of the 484 available picture lines.

From a viewing standpoint, there is nothing objectionable in the picture quality of those models not employing progressive scanning. However, pictures on the RCA/ProScan and Philips models did exhibit a more film-like texture. The same is true of camcorder home movies shot in the 16:9 "squeeze" and letterbox ("Cinema") modes. (Of TV's 525 scan lines, 41 are used for the Vertical Blanking Interval and other chores.)

Progressive scanning, like 16:9 widescreen, will be a feature of the High-Definition Television (HDTV) system coming to the U.S. sometime around the turn of the millennium. Anybody shelling out thousands of bucks for a widescreen TV today ought to wonder how it will stack up to the TVs of the 21st century. The answer is an unequivocal "Somewhat."

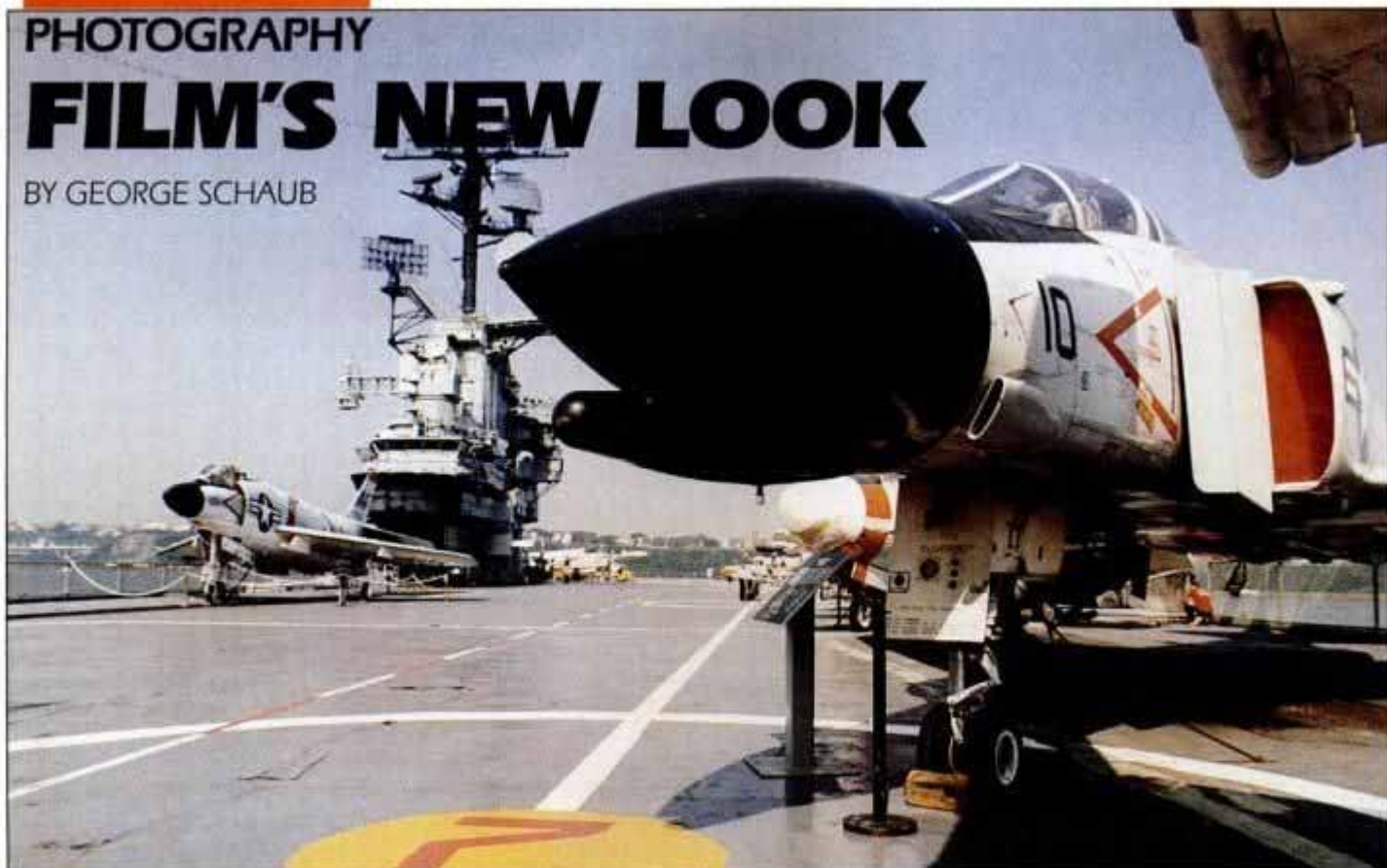
The HDTV turf the U.S. is staking out for A.D. 2000 is all-digital. Today's widescreen receivers employ digital circuitry but display analog signals.

Once again, only the RCA/ProScan and Philips sets differ from the field, offering future compatibility by way of computer-like RGB (red-green-blue) jacks that can handle an adapter for digital HDTV. Both companies honestly state that, although their sets will be usable with HDTV, they won't deliver HDTV quality—whatever that is and whenever it comes. The other brands, with equal candor, declare that their sets are for the here and now, to be enjoyed as widescreen displays for videophiles who want theatrical ambience at home—today. **FM**

PHOTOGRAPHY

FILM'S NEW LOOK

BY GEORGE SCHAUB



● If you walked into your local camera store or film outlet lately and didn't recognize the names on the film boxes behind the counter, it's no surprise. Yes, Kodak films are still in yellow boxes and Fuji film is still packaged in green, but little else has remained the same. Indeed, virtually every film manufacturer has altered, updated or entirely revised its film offerings within the past few months. Though some of these changes may be minor, or merely name changes to differentiate new products from old, there's nary a film out there with the same brand name that it carried only six short months ago.

Keeping up with all this can be daunting, especially when you've come to rely on one particular film for your picture-taking. But fear not—all the changes have been for the better and represent improved technology for even better results. There are even some new films that are linked with a specific subject or picture-taking task—a new trend that may grow in the near future. But change is certainly the name of the film game, and new films are replacing the old as fast as new cameras, camcorders and even computers replaced their fledgling forebearers.

Some people are saying that the reason all this change is occurring is

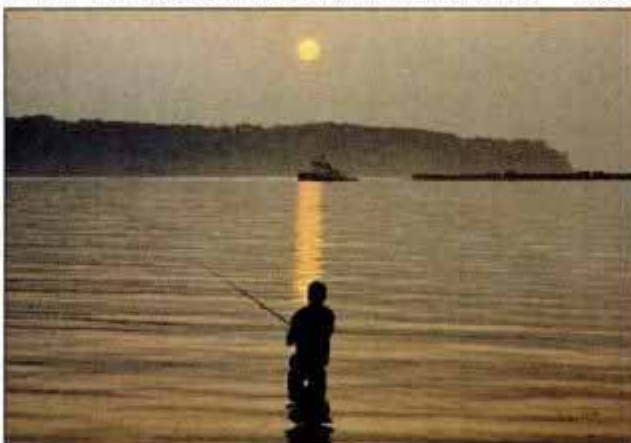
that electronic photography—in the guise of still video, memory cards or some as-yet-unannounced medium—is breathing down conventional photography's neck. Yet every time we see a new improved electronic still device, film technology seems to take a quantum leap forward.

The main thrust of improvements in this new breed of film has to do

with the structure of light-sensitive silver salts, known as silver-halides. These grains of silver-halide lie suspended in color-sensitive layers of the film, where the scene is first recorded in three separate colors. When prints are made or slides are produced through a reversal process, the colors are recombined to form all the colors of the world.

The silver-halide grains appear like clumps or groups when viewed through a microscope, but when the millions upon millions of grains are combined and viewed on a print or through a slide, they form an image. The entire photographic process relies on this illusion, and creating a more effective illusion is what advances in film- and print-making are all about.

What film makers have done with these grains is nothing short of miraculous. In earlier times, these grains were suspended in an emulsion and allowed to meander and grow in their own way. Working on a molecular level, scientists have bred new grain structures, ones that are more uniform and more efficient in their light-gathering ability. This efficiency translates as the ability to gather the same amount of light in a smaller area than in the past and to deliver much finer grain in the final image in the process.



Konica's Super XG 100 film (top) shows little grain when enlarged. In low light, try Kodak's Gold Ultra 400 film.

with the structure of the film itself. Film makers have made substantial changes in the way light is captured and the way color is formed. Though many of the recent gains are built upon those of the recent past, this generation of improvements seems to be the fruition of much research and what was learned from previous product releases.

Film records the world via a com-

Print films

The newest star from Kodak is its Gold Ultra 400, a film that delivers all of the attributes described above. With brilliant colors and a very-fine grain, it promises to become the "universal" film, which can be used for virtually any type of picture-taking situation.

In the ISO 100-speed class, there's Konica's new Super XG 100, a great film to use when the light is bright and you want big, clear blowups. Fuji's Super G ISO 200 film delivers a combination of rich, vivid colors and excellent pastel and skin-tone rendition. Scotch offers its new ISO 400 Colorprint film, which has the ability to deliver good results in most any camera. And Agfa's new Optima 200 is a solid performer that's great for portraits and landscapes alike.

Which one to choose? That's a matter of personal taste and price. You just have to try 'em and see which one you like best.

Slide films

In the slide-film area, there's even more news. Though Fuji has upgraded many of its slide films, its jewel in the crown remains Velvia, the film that broke Kodak's hold on the professional slide-film market. However, Kodak is countering with a new generation of slide films dubbed "Lumiere," named, we think, after the Lumiere brothers—the late 19th-century scientists and manufacturers who pioneered color photography and who, many say, invented the motion-picture projector, as well.

These new slide films, available in both ISO 50 and 100 speeds, come in both warm-tone (X) and neutral-tone variations. The X-films are made for outdoor use, while the others are made for the studio.

What's the news on Lumiere? First, it offers a credible challenge to Velvia, one of the truly beautiful films of the decade. Lumiere has T-grains (for tabular) in every emulsion layer, which yield a spectacularly fine grain and have an uncanny color sense. The film delivers a sort of super-real color that only Velvia delivered before.

While Lumiere is getting much attention, venerable old Kodachrome seems to be withering on the vine. Could this signal the end of the road for the 55-year-old king of films? Admittedly, problems with some film stock, particularly with processing, has knocked some of the legs from beneath this film. Yes, it's a beautiful film, and yes, it offers more long-term stability than any film on the market, but the Kodachrome process is cumbersome and being offered by an ever-

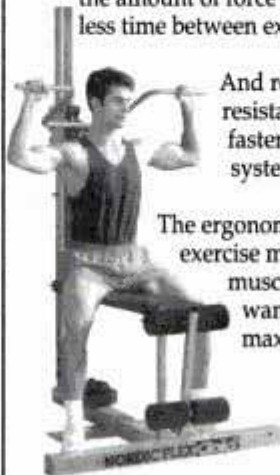
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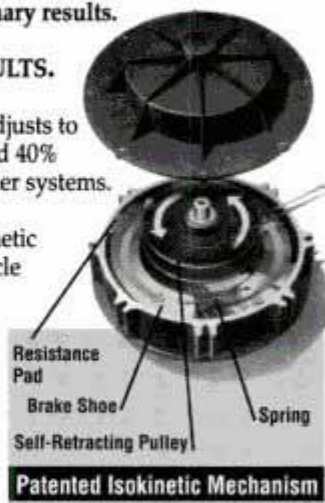
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shrinking number of labs. And yes, Lumiere does seem to offer an acceptable alternative. Will they finally "take my Kodachrome away?" Stay tuned.

Specialty numbers

Last but not least, a new trend in the film world is the so-called "niche" films, or films that serve—or are marketed as serving—a specific picture-taking situation. This goes beyond film merely balanced for daylight or tungsten light. This applies to specific subject matter.

For scuba fans, there's the aptly named Ektachrome Underwater slide film, tailored to yield proper color balance at depths below 10 ft. Shoot it above water and you get a severe red bias, just the color that disappears quickly as you go deeper into the watery depths.

For those who use flash sub-aqua, Kodak recommends using a Tiffen filter, available for various depths. After shooting this film in its proper place, you'll probably eliminate all others from consideration. Of course, you may be used to a certain bluish cast over your dive photos, and seeing the clarity of this film without the veil can, at first, be disconcerting. And, if you have a red subject, such as a bright coral outcropping, in the

foreground, the red may turn out to be a brighter shade than you remember. But the overall results from this film should make it the diver's slide film of choice.

Another new niche film is Konica's "Baby" film—that's right, a film especially made for photographing little ones. Though we know of no reason why you couldn't photograph the kiddies with virtually any film around, Konica claims that the lower-than-normal contrast and the pleasing rendition of skin tones make this film particularly suited to the task. Indeed, Konica has a professional film (SR-G 160) that is excellent for portraiture of all subjects (for all of the above reasons), and this may be a similar, if not the same, film.

Does this foretell the future of film marketing? Will we have a film for football, a film for birthdays or even one for the backyard barbecue? As various brands begin to share the same excellent attributes, and as color-print film becomes more and more a commodity (which means they're all pretty good), we may well be inundated with these marketing techniques. Need a film for tonight's concert? Maybe you'll have a choice of rock, classical or folk film, or even a cool number for jazz. **FM**

a 5-speed manual. Performance promises to be as lively as anything in this class, and better than most.

That's Chrysler's new-car news. But there's equally big news on the pickup-truck front.

For the first time in more than 20 years, Dodge will offer a newly designed full-size pickup, the Dodge Ram T300. Big, brawny and distinctive, the new Ram brings breakthrough he-man styling to the full-size truck buyer. Look for its long hood, oversize cab and sharply defined fender shapes to change the plans of Ford and Chevy truck de-

signers for their future models.

There are strong practical reasons for the new Ram's distinctive appearance. The long, high hood makes room for the optional V10 engine. Lower fenders make engine maintenance easier to perform. And the roomier cab supplies the extra living space that full-time truck drivers need.

Although the Magnum V8s have done a good job in truck duty, Dodge needed a real big-inch gasoline engine to compete with Ford, Chevy and GMC big-block V8s in the pickup market. You could say Dodge took a

giant step in meeting the competition when the V10 engine was developed. This engine—architecturally identical to the Viper aluminum V10 but using a cast-iron block and heads—is rated at 300 hp and a whopping 450 ft.-lb. of torque. Hook that up to a 5-speed transmission and you have the mother of all stump-pullers—or whatever else you may have to pull.

In addition, Ram has a refined Cummins turbodiesel with an extra 15 hp and 10 ft.-lb. of torque—to maintain its edge in the diesel market.

The new truck's other strong suit is inside, where its standard cab offers more passenger space than any of its competitors, more seat travel, reclining seat backs and more storage space behind the seats. A driver's airbag is standard, too.

Elsewhere, Chrysler continues to expand on the success of the LH sedans. The latest versions of the LH platform—the Chrysler New Yorker and LHS—are new-for-'94 models, too, although they were introduced in mid-'93. While the chassis of these luxury sedans is similar to that of the other LH cars, changes were made in the suspension to tailor the ride, and sound-deadening was added to provide a quieter passenger compartment.

Overall length of the New Yorker and LHS is 207 in., between 5 to 7 in. longer than the other LH cars (Dodge Intrepid, Eagle Talon, Chrysler Concorde), but the wheelbase is regular LH at 113 in. Under the hood is Chrysler's premium V6, a 3.5-liter 60° dohc 24-valve that develops 214 hp at 5000 rpm and 221 ft.-lb. of torque at 2800 rpm. Fuel economy is rated at 18/26 mpg city/highway.

Like all the LH cars, the engine rides in a north-south position and drives the front wheels. One transmission—a 4-speed electronically operated automatic—is offered.

Standard leather seats, 5-passenger seating, 16-in. wheels and a more taut suspension calibration help elevate the LHS above the New Yorker model. In addition, exterior styling touches on the LHS feature less chrome for a sportier appearance.

As Chrysler's new cars come on-stream, older models are disappearing, taking the last of the old K-car componentry with them. Two sport coupes—the venerable Dodge Daytona and Chrysler LeBaron—are out of the '94 picture. Full-size sedans like the old New Yorker, the Dodge Dynasty and the Chrysler Imperial are also gone, as is Dodge's full-size sport/utility, the Ramcharger. Look for Ramcharger and the two sport coupes to return in '95. **PM**

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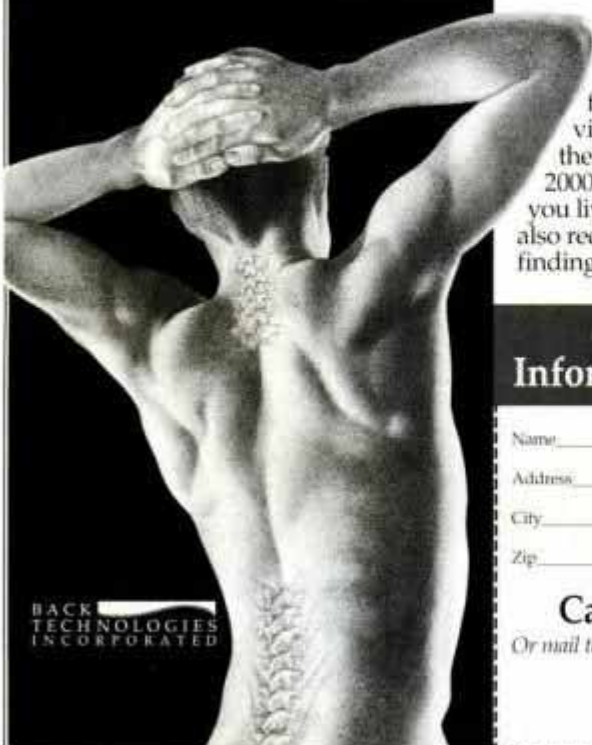
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of berg sightings. Small repeaters at each observation window display latitude, longitude, altitude and ground speed fed from the C-130's Inertial Navigation System.

With 50,000 pounds of fuel aboard, the Herc can patrol for more than 8 hours. A typical Ice Patrol search pattern might cover 1500 "track miles" in a ladder-like series of parallel legs joined by 90° turns. The tracks are spaced to give the Herc's APS-135 side-looking airborne radar a second look at every square mile of water in the search pattern. Pods fixed to each side of the fuselage carry the SLAR's two 16-ft. antennas that scan parallel swaths 27 miles wide.

As we enter the search area, Osborne presses a button to link the INS to the autopilot, which banks the aircraft over to intercept its programmed course. Back at the radar monitoring station, the turn produces a broad white band on the scrolling film of the SLAR's display. "The SLAR can't take more than 3° of roll or yaw," says AT2 Simmons, checking the film.

The SLAR's recorder/viewer has the look and feel of old technology. Inside its heavy, black metal housing, a spool of dry silver film is exposed by two CRTs, then passed over a heater bar that develops and fixes the image. Automatically overlaid with latitude and longitude gridlines, the film scrolls across a backlit panel for viewing.

Overhead, among the moving control cables and mist-spraying ventilation ducts, wave guides snake out to the antennas carrying 200-kw pulses from the radar's magnetron.

As the autopilot rolls the C-130 out of its turn, the white streak on the film is gradually replaced by a finely grained image of the sea surface. "Those are boats, probably fishing vessels," says Simmons, pointing to tiny black lines on the film. Some have visible wakes behind them.

Next to the mechanical bulk of the SLAR's recorder/viewer, the orange glow of a touch-screen plasma display betrays the arrival of new technology. The APS-137 forward-looking airborne radar is in its first operational season with the Ice Patrol.

Developed by Texas Instruments for the Navy P-3 antisubmarine aircraft, the FLAR excels at picking objects out of surface clutter. Advanced imaging capabilities, some aspects of which are still classified, help Ice Patrol operators tell berg from boat.

Simmons uses a track ball to center crosshairs over a large blip on the FLAR's main CRT. On the smaller screen above, a magnified view resolves the blip into five distinct ob-

long echoes—more fishing boats.

"Okay," says Simmons, taping a small piece of paper over part of the plasma display to shield classified information, "now we're going to show you what it's all about." As he instructs the radar to lock on one of the targets, the antenna ceases scanning and pins the ship with a tightly focused beam.

On the main CRT, a ghostly green image of a fishing vessel swims into view. Using the Doppler effect, the FLAR measures the target's rate of roll, pitch and yaw as it responds to wave motion. An iceberg, massive

and low in the water, would appear almost rock steady, quickly giving itself away to the FLAR operator.

As we finish our pattern and head for St. John's, Ezman punches course and sighting data into a laptop computer. Once on the ground, the flight report will be transmitted as E-mail to the Ice Patrol's operations center in Groton.

The chatter on the flight deck turns to the St. John's nightlife as Osborne and copilot Lt. Jerry Dolan set up an instrument approach. Tomorrow, they'll be back up here in the soup, hunting for ice. **FM**

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ENGINEERING THE '94s (Continued from page 53)

stub shaft (which operates the power-steering valve that regulates the flow of pressurized fluid to the rack).

Inside that stub shaft, as on the standard GM steering gear, is a torsion bar that sets a mechanical preload resistance to turning the steering wheel. If you're coming up to road speed (about 40 mph), the computer feeds current through the electromagnet so it adds magnetic force to the mechanical spring load imposed by the torsion bar. If you're at low speed, it feeds current through in the opposite direction (reversing the polarity), so the magnetic force pulls the opposite way, reducing the load of the torsion bar to make the steering lighter. If the torsion bar preload is 20 in.-lb., the electromagnet can raise that to 30 for maximum road feel, and drop it to 10 for parking.

The electromagnetic field not only biases the torsion bar preload, but it is infinitely variable and can make the transitions super-smoothly. This is unlike the light, bumpy feel of a computer-operated stepper motor on the power-steering valve, which is the system others use.

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Rubber does its best job of absorbing loads and impacts when it's being

compressed, but a front-suspension lower control arm presents an engineering quandary. The bushings have to be vertical to control handling loads, but horizontal to absorb the vertical loads of bumps in the road. GM engineers determined that the forward bushing contributes most to the handling, the rear to the ride.

So they're changing many of its front-suspension systems to leave the vertical bushing in the front of the control arm, but putting a horizontal one at the rear location. That would sound like a sure recipe for one or both bushings binding up at some time or another, but GM avoided that problem by making the rear a conical bushing, designed to deform into an open space when the control arm rises over a bump in the road.

The run-flat tire

Run-flat tire designs are almost as old as the pneumatic tire itself, but the '94 Corvette gets the first design that mounts on conventional wheels. Of course, so-called run-flats don't really run flat, just without air. The Goodyear design, which is rated for 200 miles at 55 mph without air, has specially strengthened sidewalls and a super-retention system for the bead area. Of course, it goes well be-

yond even those factors, because the tire also must dissipate a lot more heat without air. The ride is so close to an inflated tire that the tires, labeled "Extended Mobility," are available only with Corvette's optional low-tire-pressure warning system.

R-12 sticks around—barely

GM will have two product lines with R-12 air-conditioning systems at the start of '94 production—the Cavalier/Sunbird and S-10 small pickups and utility vehicles in the Chevy and GMC lines. But they're really R-134a systems in disguise. GM just can't get a whole lot of new production equipment (including R-134a installation machinery) into the plant until winter, but it's installing the R-134a parts. If you ever have to retrofit, it will cost only a few dollars more than a recharge with R-134a.

It's really here, honest

Remember the electric sliding door we told you was an option on the '93 GM plastic-body minivans (Chevy Lumina APV, Pontiac Trans Sport and Olds Silhouette)? That nifty design never made it into '93 production. Now it's on the '94 option list, honest it is, according to a GM spokesman.

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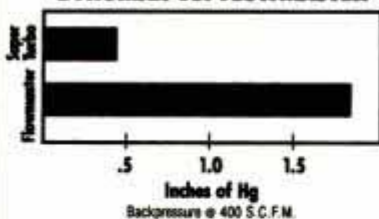
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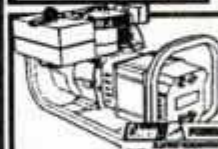
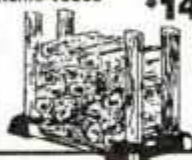
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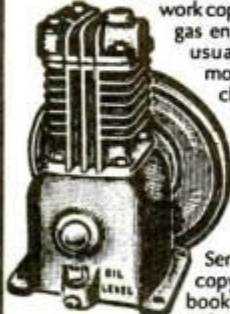
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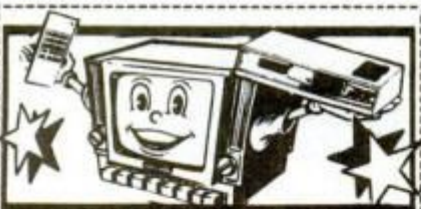
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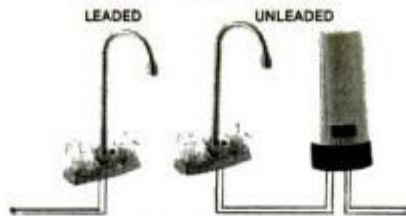
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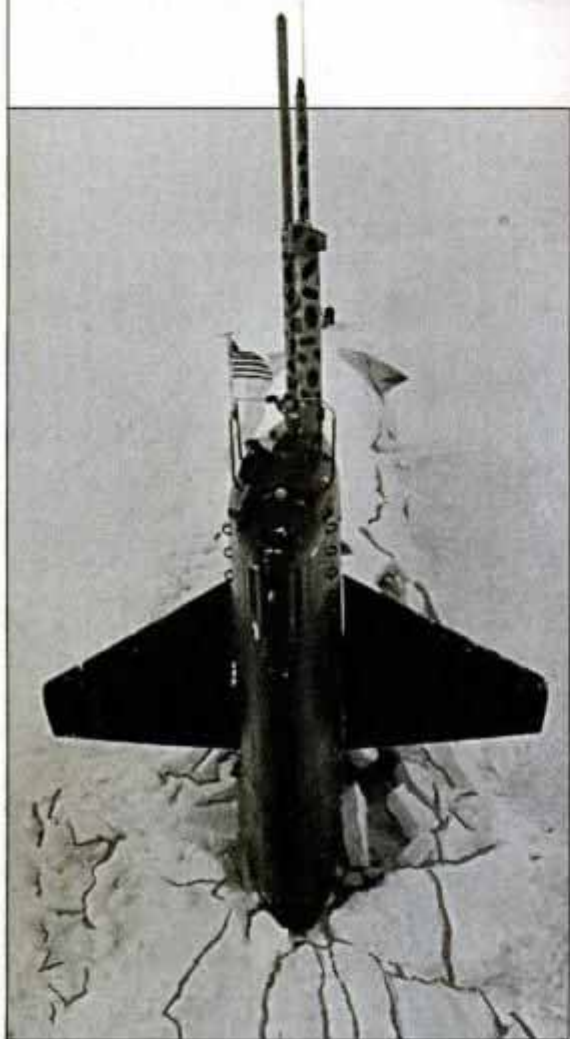
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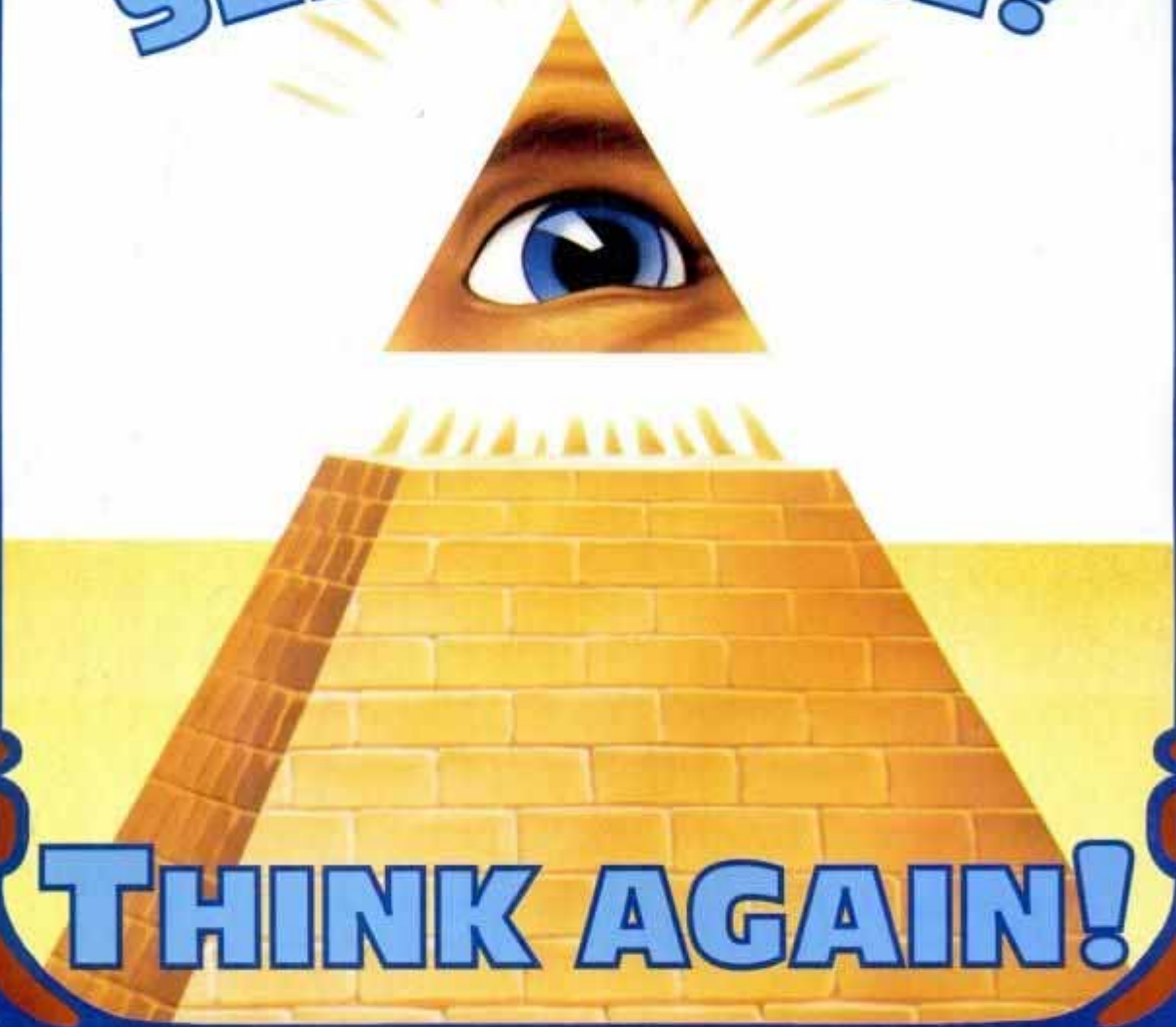
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