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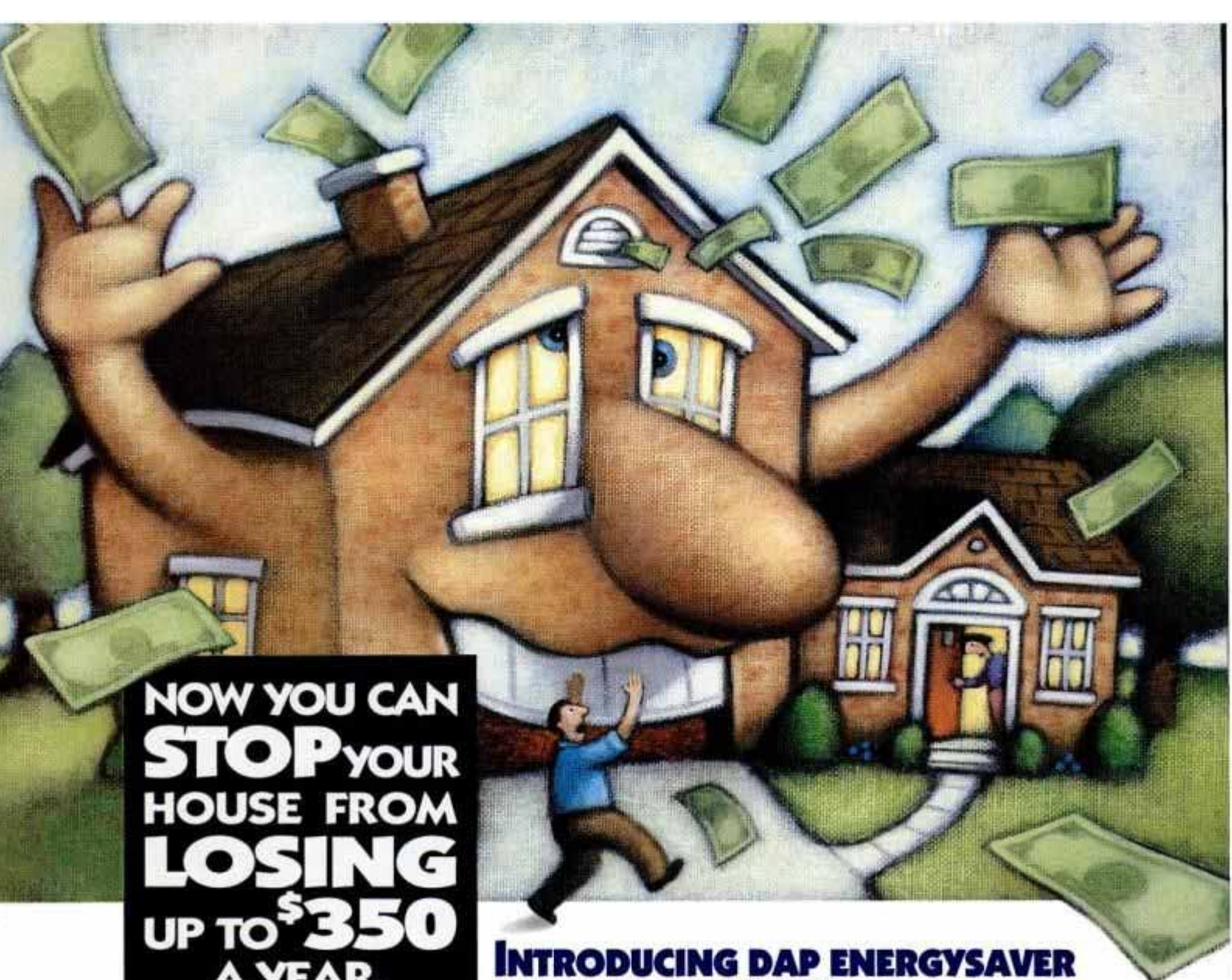
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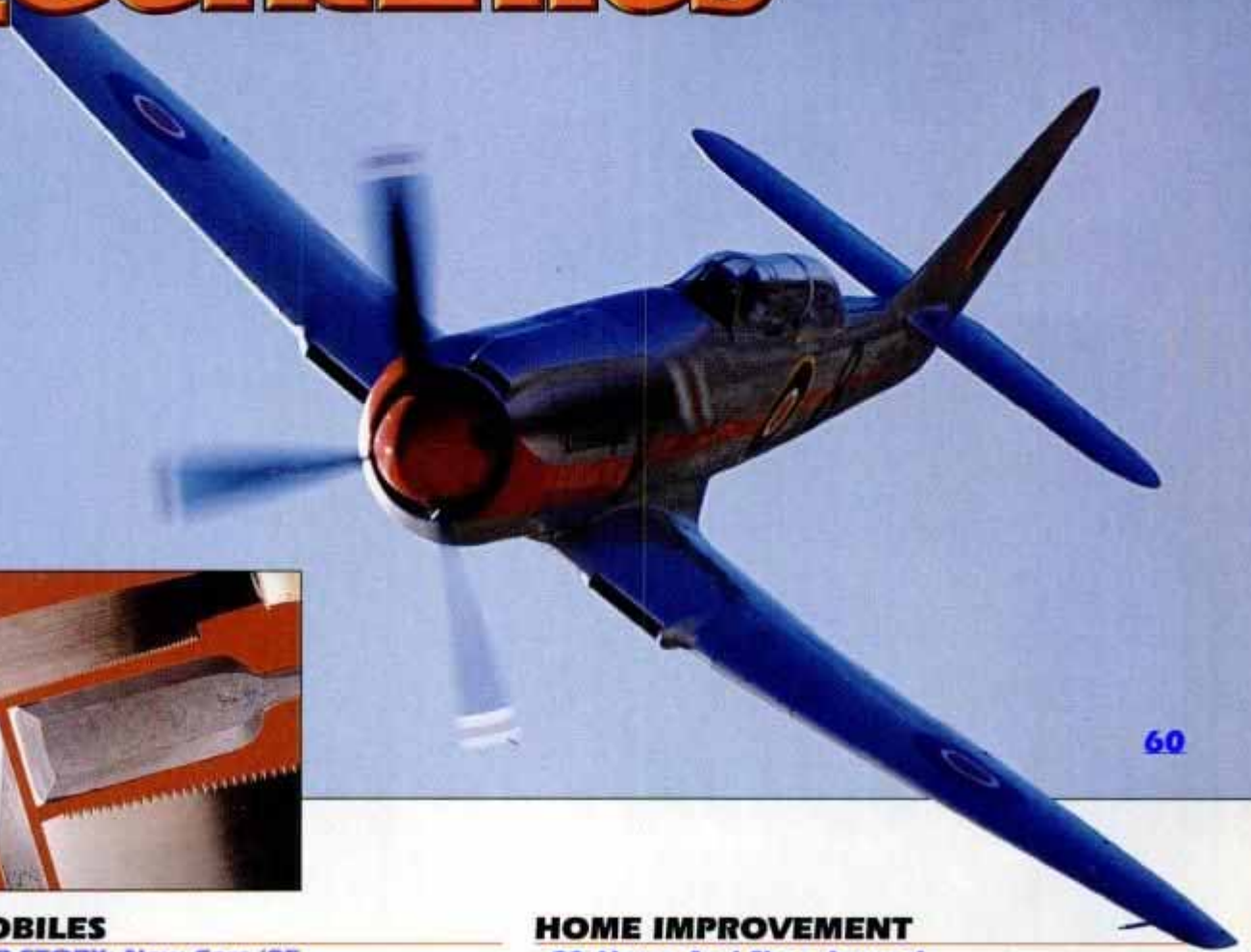


*Source: US Dept. of Energy.



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Popular Mechanics®



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EDITOR'S NOTES

• While Don Chaikin, Jim Dunne, Mike Allen and the rest of the Automotive Department editors were flying all over the world gathering information for this month's issue, I attended a delightful technical program at Phoenix International Raceway, staged by Buick and GM Powertrain engineers. Besides showing off their brand-new version of the 3800 V6, the Buick guys displayed several blasts from the past, including 1987 Regal GNX No. 001 and the Wildcat concept car from a few years ago. It's rare that

concept cars move at all. They mostly just sit on auto show turntables and look pretty under the lights. It's even rarer when you get to actually drive them around. How about a few laps around Phoenix's banked oval? It's really inconceivable, but that's what they let me do. It was unbelievable, the first time I'd ever actually been in a concept car on a banked oval—the same one the IndyCar guys race on. The less said about the getting in and getting out part, the better. Once in and under way, the Wildcat was, well, wild. That huge domed glass roof closes over you like you're in a space capsule and then you're gone. Those few laps whipped by way too fast. And then they were raising the dome and I was climbing out. It was an experience I won't soon forget. In fact, I'm still smiling. . . . **Most people simply walk into a bicycle shop, select a model that looks okay and then leave with their new bike. But that's not good enough for PM. There's another way. A better way, if you're a serious biker. You custom build your bike, component by component, so that it's perfect for you.**



Skorupa and the PM custom bike.

Outdoors Editor Joe Skorupa explores the possibilities in this issue. As you can see, the result suits him just fine. . . . **Confused by all the options** you have every time you sit down in front of your PC? Especially if you want to use on-line services? So were we, so we asked Contributing Editor Steve Booth to sort it all out for us. He does, starting on page 73. . . . **Man and machine.** Nowhere does that age-old relationship become more vivid than at the annual Reno air races, where tough men attempt to control fast planes. It's a great show and you have a front-row seat on the flight line starting on page 60. Till next time.


Joe Oldham

Popular Mechanics

Editor-In-Chief Joe Oldham

Managing Editor Deborah Frank
Graphics Director Bryan Canniff

Home Improvement

Editor Steven Willson
Associate Editor Thomas Klencik
Assistant Editor Roy Berendsohn
Contributing Editors Norman Becker
Rosario Capotosto
Steve Toth

Boating/Outdoors

Editor Joe Skorupa

Electronics/Photography

Editor Frank Vizard
Contributing Editor Stephen A. Booth

Automotive

Editor Don Chaikin
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Contributing Editors Cliff Gromer
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Administrative Asst. Josephine Coronia
Asst. to the Editor Barbara A. Novak

Reader Service Department

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Editorial Offices

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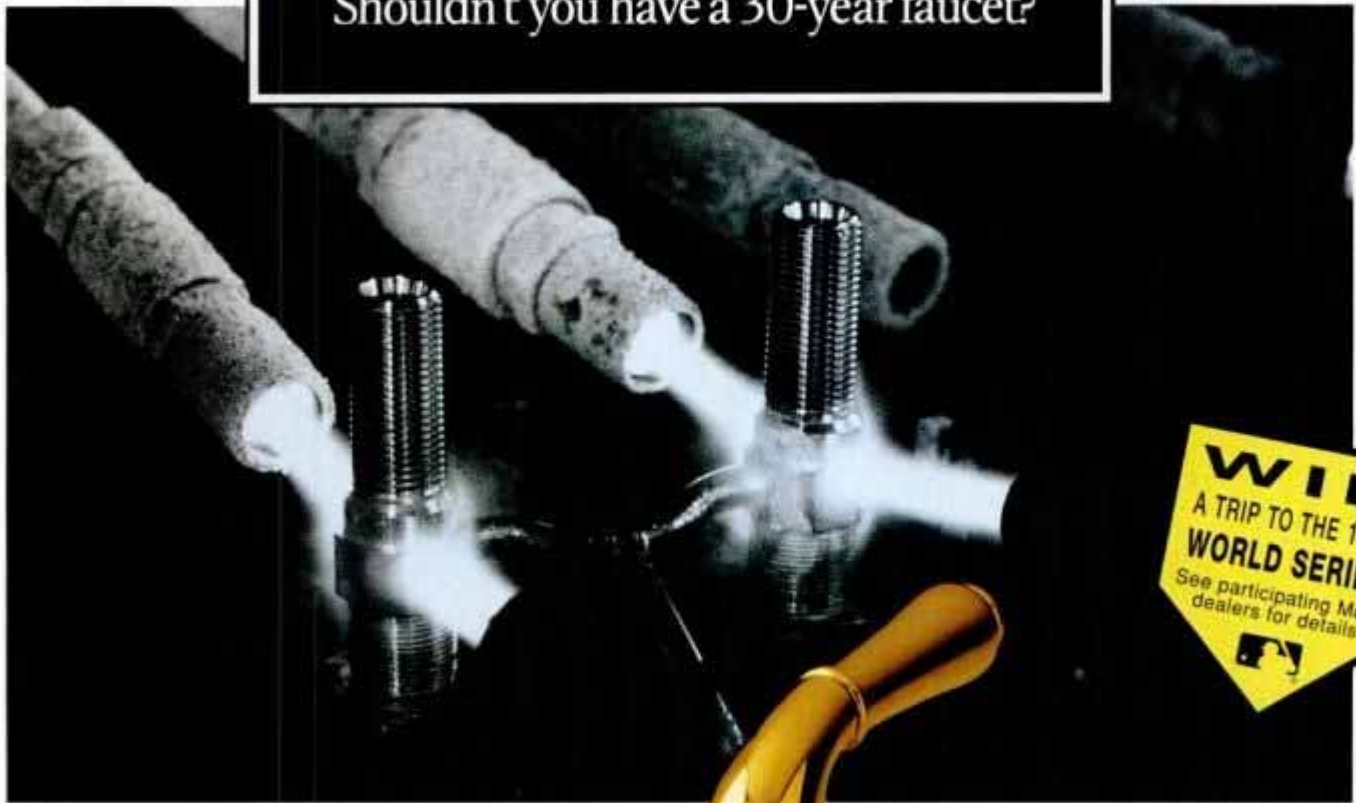
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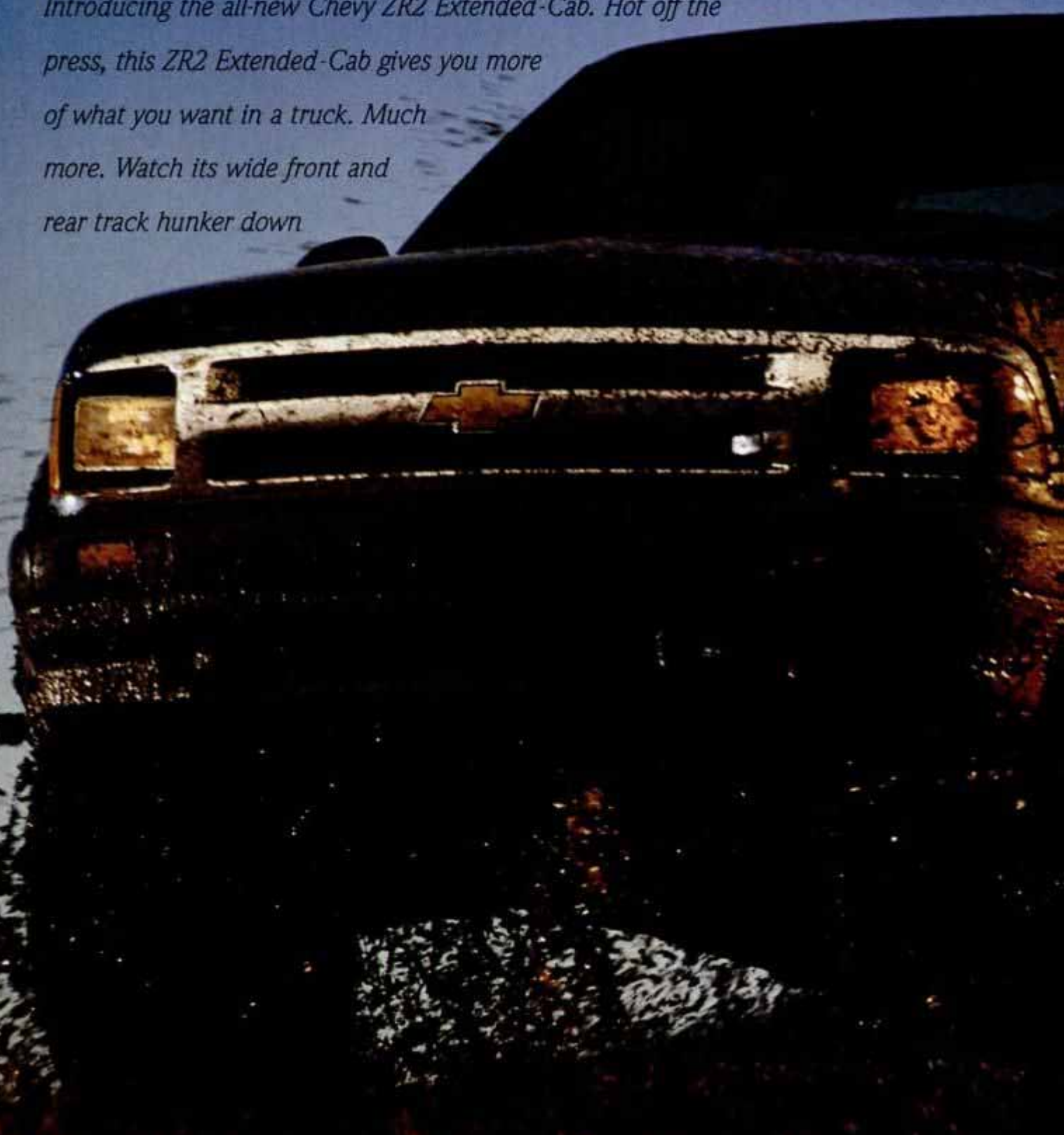
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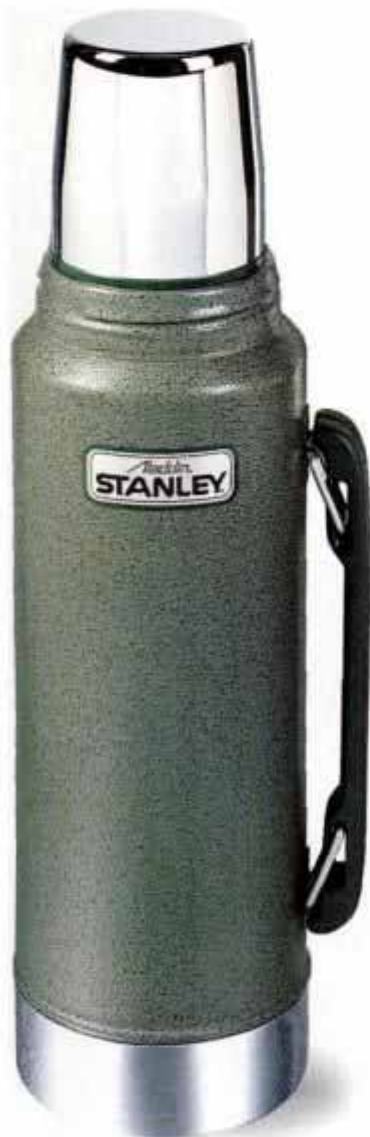
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Popular Mechanics

Publisher Robert B. Dillingham

Business Manager Agnes P. Maillaro

ADVERTISING

Director John A. Pagliaro

New York

224 West 57 St., New York, NY 10019
Philip A. DeCarlo
(212) 649-3141
Paul M. Jowdy
(212) 649-3142

Chicago

1 South Wacker Dr., Chicago, IL 60606
(312) 984-5190

Manager Richard T. Weithas
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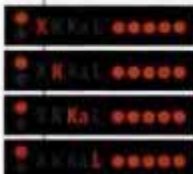
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LETTERS

Zeppelin Fever



The lead paragraph of the Zeppelin story was an insult to the integrity of the engineers who attend the American Institute of Aeronautics and Astronautics Lighter-Than-Air conferences. These meetings are not something where engineers "kick back, cogitate and kibitz" about airships. The Zeppelins are going to be a giant step forward. A National Airship Program would do a lot to salvage our sagging aircraft industry.

ROY P. GIBBENS
MERIDIAN, MS

Your article overlooks a crucial difference in safety between the new Zeppelin and the *Hindenburg*. The *Hindenburg* was filled with highly flammable hydrogen, while the Zeppelin will be using safe helium gases.

RUDY ROSENBERG
WILLISTON PARK, NY

A couple of months ago I caught Zeppelin fever when I happened to come across a book on the *Hindenburg*. Since then, I haven't stopped reading about airships. In your article you mention the AIAA. How can I write to them?

SIMON MAUER
WASHINGTON CROSSING, PA
Letters are subject to editing for length, style and format.

The American Institute of Aeronautics and Astronautics, 370 L'Enfant Promenade S.W., Washington, DC 20024-2518.

In the Editor's Notes of the July issue you claimed that the first nonstop trans-Atlantic flight was accomplished by a lighter-than-air aircraft, namely an airship or a blimp. This is not so. On June 14, 1919, two intrepid airmen, Capt. John Alcock and Lt. Arthur Whitten Brown, set out from St. John's, Newfoundland, in a converted Royal Air Force Vickers Vimy twin Eagle-engined bomber and headed toward the British Isles. And on June 15, they completed their journey when they crash-landed at Clifden in Ireland. The R-34 was then the first nonstop trans-Atlantic, lighter-than-air aircraft flight.

VINCENT MARSH
BARNEGAT, NJ

Reader Marsh is correct. We regret the error.

—Ed.

Clunkers

I applaud your editorial in April on the clunker bill issue. Thank you for speaking out on this fatuous program. What is elective now will become mandatory later. The government will then be telling us how old a car we may drive and, finally, *what* we can drive—if at all.

CRAIG THOMPSON
RAPID CITY, SD

I just read your editorial regarding your position on clunker bills, and one thing I have to say is thank you, thank you, thank you. It is about time the dreaded clunker bills got some press in a magazine such as yours,

exposing them for what they are—a sham and a farce, meant to give some self-serving industry a cheap out when it comes to meeting its responsibilities to clean up the air we breathe. Hopefully, federal and state representatives will read your editorial.

BEN DEUTSCHMAN
ISELIN, NJ

No More Gore

I was thoroughly shocked to see Al Gore's grinning face in the middle of your magazine. I found his praising of another one of Uncle Sam's pork barrel monstrosities thoroughly disgusting. Please, have your articles stick to cars, woodworking, etc., and leave the politics to other magazines.

RICHARD E. STRACH
LISLE, IL

Vice President Gore's commemoration of Apollo 11 was a little hypocritical. While in the Senate, he was critical of the Bush administration's Space Exploration Initiative, which would have sent humans back to the Moon and to Mars. One of the first things the Clinton administration did was cancel SEI. But this same administration is "deeply committed" to the space program?

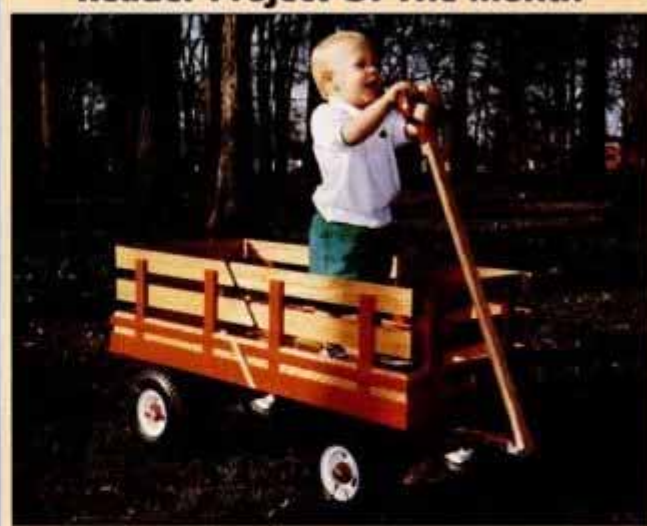
MICHAEL J. GALLAGHER
CORTLAND, NY

Buzz Aldrin's article was magnificent. He's right on track. This is the kind of guy NASA needs at its helm. He discusses plans that NASA should have aimed for long ago.

SHAWN M. HECKMAN
SOUTHGATE, MI

(Please turn to page 14)

Reader Project Of The Month



I wanted to give my son a wooden wagon for his first birthday, but was not happy with the quality of ready-built wooden wagons on the market. I wanted something that would last and look good. I was really inspired by your article "Red Oak Racer" in the August 1991 issue. This picture shows the final result—something I'm very proud of, that I know will last.

JAMES FOBAR
ROYAL OAK, MI



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DRIVE A BETTER CAR



Long Live The Zippo

The article on the Zippo lighter brought back many memories of my time in the military during WWII. Some important facts were not mentioned in the article. First, the Zippo uses an asbestos wick, which will not burn down when the fuel is exhausted. Also, the Zippo can use all kinds of fuel and is great as a pipe lighter.

TOM BONSELLA
RUTHERFORD, NJ

I thoroughly enjoyed your article "American Classics: Zippo Lighter." As a WWII child, it brought back memories of youth, Victory Gardens, collections of aluminum pots and pans and rationing. It also reminded me of the four Zippo lighters purchased by my father and kept in the basement. Thank you for arousing my memories of this remarkable Americana.

HOWARD F. KAPSO
RIVERSIDE, IL

Tool Test Fails

I am sick and tired of the horsepower inflation that companies like Sears claim for their tools. In the case of the router you wrote about, Sears claims it to be a 3.5-horsepower motor. The article rates it at 15 amps and 120 volts. Assuming a 100% power factor

and 100% efficacy and that 746 watts equals 1 horsepower, the maximum output of the router would be 2.41 horsepower. A tool should be rated at its continuous rating, not at a rate that will result in its destruction.

MICHAEL L. STOIANOFF
ANCHORAGE, AK

Home Improvement Editor Steven Willson replies: *Horsepower exaggeration seems to be woven into the fabric of the tool business. Manufacturers can establish both the hp and the amp ratings to suit their own needs with only a passing nod to reality. In their defense, however, these two terms—horsepower and amps—are commonly thought to describe two different things. The amp rating tells what power the tool draws running at normal working speed and the hp rating describes the maximum hp the tool develops just before it stalls. So, we use manufacturers' hp ratings as a way to describe the tools, but otherwise don't take them too seriously.*

Hit Or Miss?

You should feel no obligation to make any antigun comments to appease the powerful antigun pressure groups. Nor should there be any apology whatsoever about guns being used for

legitimate self-defense. As the old saying goes, "The Second Amendment ain't about duck hunting."

JOEL ANDERSON
VENICE, CA

Thank you for running features on firearms. I enjoyed your articles on the Glock and the Winchester Model 94. Your magazine keeps readers on the cutting edge of technology. The "On Target" SHOT Show piece—if run annually—could help keep us on top of firearm technology as well.

GREG NEWAK
CLARKS SUMMIT, PA

We intend to run it every year.

—Ed.

Wind-ful Thinking

The Vehilectrical Power Systems proposal is flawed. Tapping the energy of this apparent tailwind, and thereby slowing it, would cause each car to plow into "deader" air. This back-pressure would raise fuel consumption and pollution. I'm surprised the Wayne State University engineers didn't point out this scam. Several of the students in my high school physics classes caught it.

BOB WARD
LAKEWOOD, OH



Great Balls of

Regarding the Vehilectrical Power System, there is no free lunch! By putting this aerodynamic drag on the traffic wind, vehicles are effectively losing their tailwind velocity and require more fuel, oil, tire wear, engine wear, etc. A more practical approach would be to erect high, smooth walls, possibly curving over the traffic, to preserve the traffic wind flow and thus allow the vehicles to enjoy the economy of running with a tailwind. The wind-farm idea reminds me of the classic example of a fan mounted on a sailboat and blowing into the sail—which way will the boat go? I sure hope some ignorant wannabe ecologically proactive politician doesn't spend my tax dollars for this folly.

RONALD L. BALLAST
WHITMORE LAKE, MI

Blurred Reception

Regarding the article "Space TV," it left me with a feeling of nothing more than a sales pitch for a supercharged, expensive form of video entertainment that local cable systems already provide for what I consider to be a nominal fee. Second, wouldn't a satellite dish system from your local company be cheaper? Third, the claim that Castle Rock boasts 150 channels is misleading with so many being pay-

per-view and sports-related. People want a wide range of choices at an inexpensive price from video entertainment. Isn't that why the Cable Act of 1992 came to be? The public won't pay to purchase and maintain such an expensive product when the cable companies already offer it.

JIM SUNDY
HARRISBURG, PA

Electronics Editor Frank Vizard replies: *Yours is apparently a minority opinion, judging from initial sales of RCA's Direct Satellite System for DirectTv and United States Satellite Broadcasters programming. What direct broadcast satellite TV offers that cable TV doesn't is a picture comparable to laserdiscs and audio comparable to compact discs. Also, this high-quality audio/video is available to people in areas not served by cable TV via a small satellite dish. I might also argue from my experience that cable TV bills are hardly nominal. So this new brand of satellite TV may just force the cable TV companies to upgrade their service.*

The article "Space TV" does not do justice to the importance of this technology that is sure to shortly impact billions of viewers around the

world. Not only will satellite TV be available at the most remote corners of the earth, but it is bound to eventually replace cable TV. Within a few years the cost of home STV equipment will be less than cable and with greater reliability. The arrival of STV should have been announced with rousing fanfare.

ALFRED ENGEL
BRONX, NY

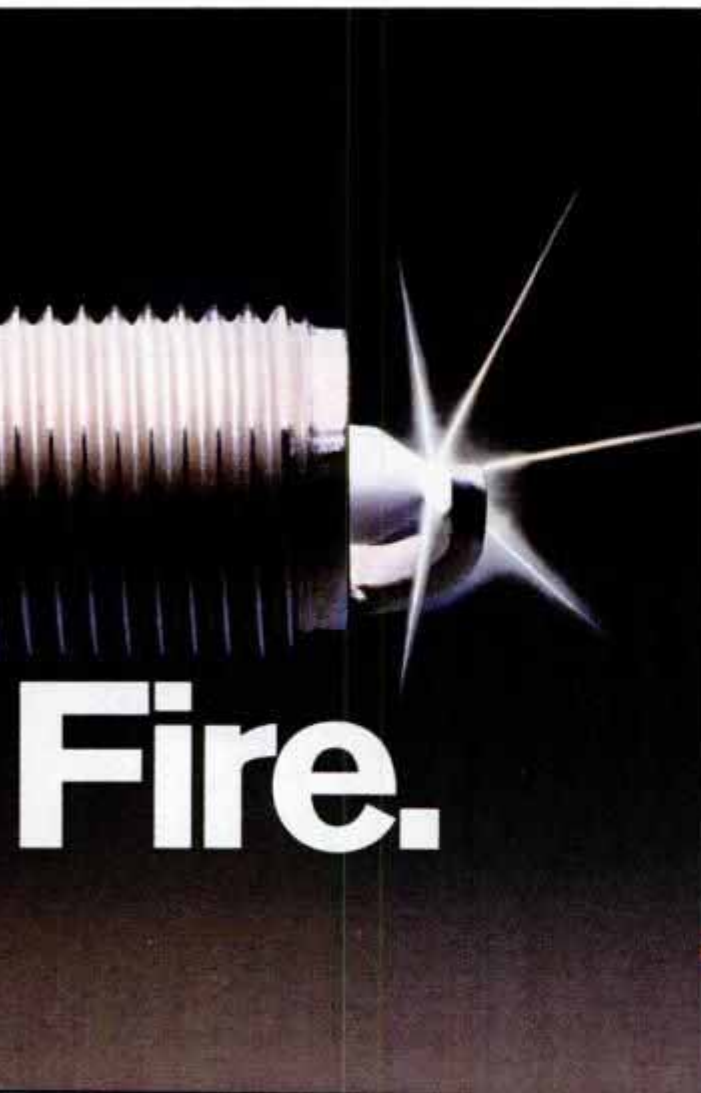
What If?

The several 'nay-sayers' about stories like the Alaska-Siberia bridge fail to understand PM's reason for printing these stories. POPULAR MECHANICS has the prestige of presenting the unique combination of dreams and reality, of allowing thoughts to take momentary shape. It is a literary portal to a world of sights and sounds that exist neither totally in front of our eyes nor behind them, but a mixture of both. The amazement and satisfaction of PM comes not from the steadfast maintenance of daily living but from the loosening of our desires, to be able to dream, to imagine and say, "What if...?"

TERRY L. WILKINSON
ALBUQUERQUE, NM

I say the same thing every day.

—Ed.



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BOSCH
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TIME MACHINE

90 YEARS AGO: OCTOBER 1904

POPULAR MECHANICS

Californian's New Airship Successful



Air America

When pilot Roy Knabenshue did donuts at 600 ft. over Oakland's Idora Park, the United States had its first working airship. Built by Capt. Thomas S. Baldwin, the 52-ft. dirigible was pulled by a bow-mounted propeller. Glenn Curtiss provided the 2-stroke motorcycle engine. Although great crowds gaped at the dirigible's maneuvers in Oakland, it wasn't until Baldwin took the ship to St. Louis that he drew the Army's attention.

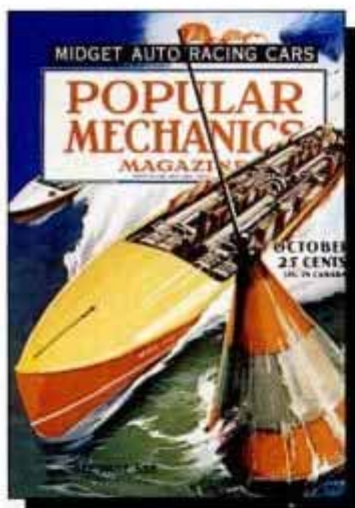
Dredge Naught

Meanwhile, \$40 million worth of useless machinery greeted American engineers arriving at the future site of the Panama Canal. The decrepit dredges and

steam shovels were the legacy of France's failed attempt to split the continents in the 1880s. Now officials faced a daunting task: draining vast swamps to control mosquitoes.



60 YEARS AGO: OCTOBER 1934



Flying Fish

Gar Wood was an inveterate tinkerer. His record-smashing *Miss America X* drew its horsepower from four 12-cylinder engines, arranged as twin, tandem powerplants. To handle the strain from two whirling engine shafts, Wood had to design a unique gearbox for each pair, complete with golfball-size bearings. Those—along with *Miss America's* adjustable plane—made Wood the fastest man on water, a title he salted away for five years.

High Post

Another record setter, Wiley Post, told PM readers how he would ride his *Winnie Mae* to the oxygen-starved stratosphere. Pressurizing the cockpit, Post reasoned, would weigh down the plane with extensive seals. So he designed a spacesuit, fed air from the engine's supercharger below 35,000 ft. and oxygen up high. Two months later, he in fact reached 50,000 ft.



30 YEARS AGO: OCTOBER 1964



Drive-In '65

Beneath clean curves and fastback rooflines, disc brakes and perimeter frames were the '65 buzzwords in Detroit. Now strong enough to stop 4000 pounds of American steel, the discs matched up well with the bigger wheels. Meanwhile, the limber new skeletons replaced stiff X and cow-belly frames. They softened up the road without sacrificing handling. On the outside, vertical pairs of headlights lit up highways everywhere.

Back Lift

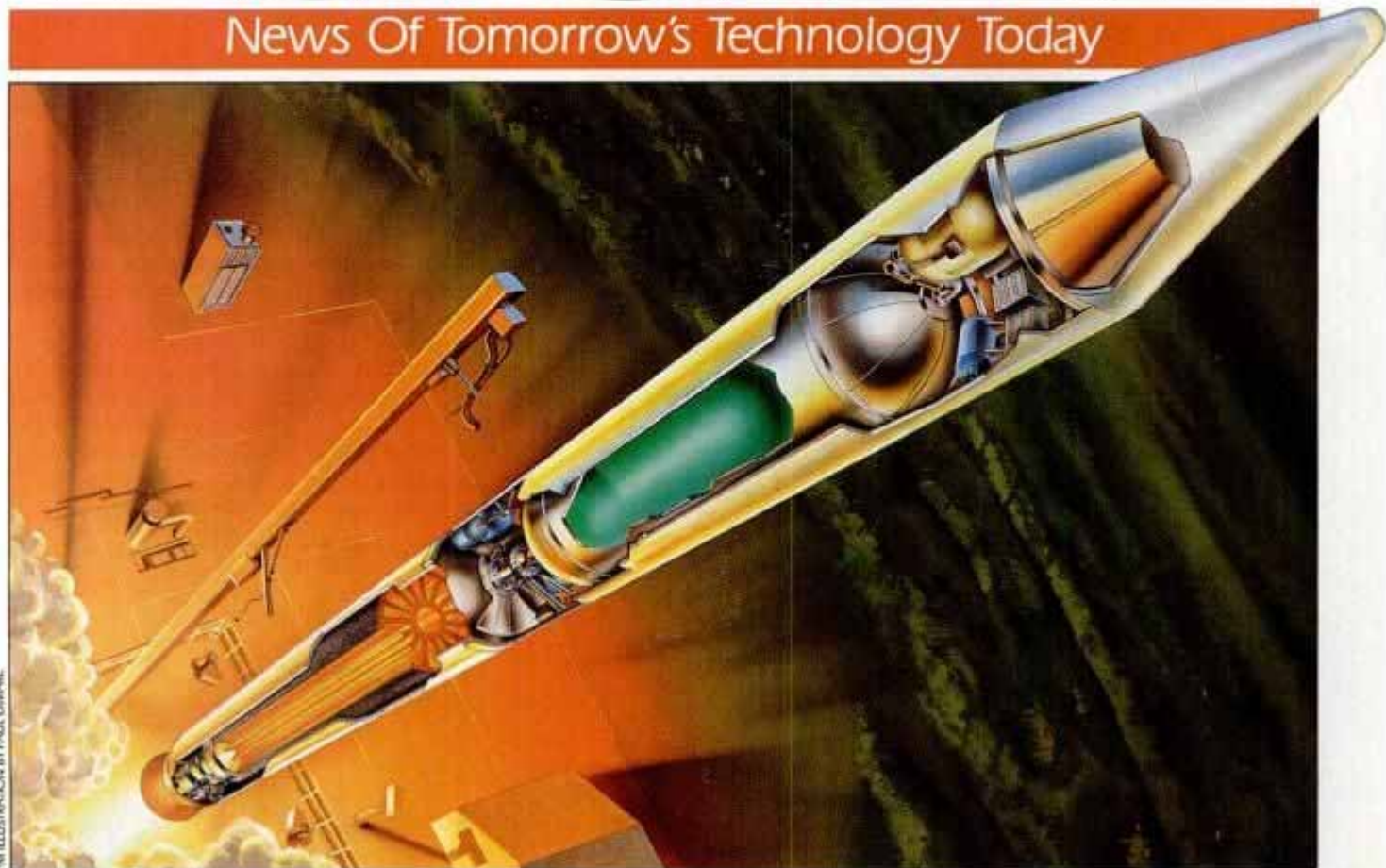
Would rocket-powered jetpacks become as common as helicopters? It looked that way as Bell Aero-

systems tested a new fuel that would give the units 10 minutes of flight. After the New York World's Fair, jetpacks skyrocketed in popularity. **PM**



TECH UPDATE

News Of Tomorrow's Technology Today



TM ILLUSTRATION BY PAUL CHAMBER

Half-And-Half Rockets Promise Total Safety

VENTURA, CA—Every time a countdown reaches zero and a rocket roars and rises, launch controllers feel their pulses quicken. After all, any lift-off can end in catastrophe. Whether fueled by liquids or solids, rockets tend to explode when things go amiss.

But a modest suborbital rocket—designed to climb no higher than 225 miles—may herald a new age of rocket safety when it blasts off in 1996. Called HyFlyer, the 80-ft.-tall vehicle will demonstrate so-called hybrid rocketry on a practical scale.

Hybrid rockets have flown since the 1930s. Back then, pioneers cast about for rocket fuels, trying everything from wood to carbon black. But Wernher von Braun brought energetic liquid propellants to prominence at NASA, while ballistic missile-makers favored solid propellants for their short-notice readiness.

By contrast, hybrid rockets combine solid and liquid propellants (see [Tech Update, page 20, Feb. '91](#)). Hy-

Flyer, which the American Rocket Co. (AMROC) is developing, will burn solid fuel with liquid oxygen. Released from its tank through a valve, the liquid will squirt into the combustion chamber, where solid fuel lies riddled into a wagon-wheel cross section. An igniter vaporizes the oxygen and heats the fuel, which burns as long as the oxygen keeps coming.

Advantages? Plenty. Since fuel and oxidizer aren't commingled from the start—as they are in solid propellant—they stand no chance of detonation in the event of electric discharge or overpressure. Defects in the solid-fuel grain don't lead to runaway com-

In HyFlyer rocket, liquid oxygen rides in upper tank and flows into lower combustion chamber packed with solid fuel.

bustion, because the rate of oxidizer flow dictates the rate of burning. Even if the oxidizer leaks into the fuel accidentally, disaster is unlikely because the two can't readily mix—a safety edge over liquid propellants.

To exploit these benefits, AMROC has teamed with United Technologies and Martin Marietta, the latter supplying an aluminum-lithium liquid-oxygen tank (see [Tech Update, page 21, Sept. '94](#)). HyFlyer will develop 250,000 pounds of thrust, making it the most powerful hybrid ever.

Highlights This Month

- **Orbital Mechanics**—Robots pay house calls on satellites.
- **Looking Deep**—TV gains the third dimension.
- **Double-Barreled**—Machine gun fires bullets and bombs.
- **Look 'Em Down**—Missiles follow the turn of the head.
- **Speed And Service**—New freighters deliver the goods.
- **Fire Monitor**—Cockpit display for aerial water bombers.
- **Phantom Tollbooth**—California's automatic turnpike.

Editor/Writer: Gregory T. Pope
Reporters: Philip Chien, Chris Chinnock, Mike Fillon,
Scott Gourley, David Hughes, Barry Rosenberg,
Bob Scheier, Richard Schrader, Bridget Mintz Testa

UNIVERSITY OF MARYLAND ILLUSTRATION



Satellite Repairbot

COLLEGE PARK, MD—What happens if a critical satellite conks out beyond the reach of space-walking shuttle astronauts? Could a free-flying robot pay a maintenance call?

Ranger aims to find out. In 1996, the 4-armed automaton will rocket into orbit and rehearse a satellite-servicing mission. The University of Maryland is building the unit for NASA.

Once Ranger is spaceborne, remote-control operators will have the robot reach back to the rocket's upper stage and swap some components. If those experiments work out, Ranger will then detach from the upper stage and maneuver freely, performing more repair jobs on the fly.

If time permits, the robot will test a novel propulsion system. Ranger's maneuvering jets spew cold nitrous oxide. To change the robot's orbit, a larger thruster will tap the same nitrous oxide as the oxidizer for a hybrid rocket engine.

Ranger will practice remote-control satellite-repair motions on its own upper-stage rocket booster.

Shuttle's Robo-Checker

PITTSBURGH, PA—Each time the shuttle touches down, a swarm of heavily clad technicians must inspect and re-waterproof all of the spacecraft's 17,000 thermal-protection tiles. It's a long, sweaty, neck-cricking chore—just the sort of task a robot should happily take over.

The Tessellator, built at Carnegie Mellon University, will



Tessellator will wheel beneath shuttle, expanding and contracting, to eye the spacecraft's underbelly.

do just that. Recently delivered to Kennedy Space Center, the robot will scoot about the shuttle, raising and lowering its work platform. Its toolkit includes a scanning laser, an inspection camera and a waterproofing injector. By comparing each tile against records in its database, the Tessellator can pick out defects and erosion.

CARNEGIE MELLON UNIVERSITY PHOTO

Moon First, Then Mars

HUNTINGTON BEACH, CA—We may have landed men on the Moon, but only the Russians have trotted a robot around on the lunar surface, and now they have Marsokhod—a well-regarded rover that's waiting for a ride to Mars. McDonnell Douglas, NASA researchers and several universities believe the time is right to try out Marsokhod on the Moon.

The 6-wheeler would have to undergo modification to handle the Moon's harsher temperature swings. But scientists would gain experience with the virtual-reality telepresence system developed at NASA's Ames Research Center.



MCDONNELL DOUGLAS PHOTO

Marsokhod, built for the Red Planet, would work out on the Moon under new proposal.

Control commands and feedback from the robot would flit between the Earth and the Moon in only 3 seconds.

World's Biggest Mirror Blank

WAMPUM, PA—Corning has done its part. Now Contraves has begun polishing the world's biggest mirror, destined for the Subaru telescope atop Hawaii's Mauna Kea (see "Star Search '93," page 60, April '93).

Last November, a Corning furnace forged the 27-ft.-dia. disc of glass from hexagonal subunits. A grinder then smoothed both faces of the 33-ton blank. In May, engineers reheated the mirror to let it sag over a curved form. After cooling down, the big blank was shipped off to the polishers.

To handle the project, Corning built a new wing at its Canton, New York,

plant and stocked it with unique equipment. Fortunately, glassmakers can reuse this Subaru legacy for their next job—mirrors for the twin Gemini telescopes.



Sprawling mirror, only 9 in. thick, will reflect starlight in Japan's Subaru telescope.



CORNING PHOTO, IAO ILLUSTRATION



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The Model T Of Satellites



Generic F-Sat would power up on solar arrays based on the space-station design.

SUNNYVALE, CA—Whether they watch supernovas or broadcast the Super Bowl, satellites have a lot in common. They all need batteries, telemetry, guidance systems and other standard equipment. So instead of tailoring pricey one-off spacecraft, why not whip them out cheaply on an assembly line?

Lockheed's F-Sat takes a step in that direction. A generic "bus"—the vehicle that holds a satellite's payload instruments—F-Sat would suit spacecraft between 1 and 3 tons. Any satellites built on F-Sat would share 75% of their bus components. The other 25% of the bus would be customized equipment, such as extra computers or power sources.

Crystal Ball Foresees 3D TV



SAN DIEGO, CA—The future of television lies in volume—volumetric imaging, that is. Instead of simulating three dimensions on a flat screen, engineers at the Naval Command, Control and Ocean Surveillance Center are filling big bubbles of glass with 3D images.

The technique employs laser beams scanned with acoustooptical crystals. Under computer control, these scanners vibrate and sparkle the lasers' light to different spots thousands of times a second. The light falls on a helix, a plastic spiral that rotates at 600 rpm, fast



NSO ILLUSTRATIONS

enough to blend all the laser spots into a moving volumetric image.

Neos Technologies, based in Melbourne, Florida, supplied the acoustooptical scanners and is now trying to commercialize the whole system. Federal Aviation Administration officials plan to evaluate the technology for air traffic control. Medical imaging and theme-park amusements represent other applications.



Lasers scan across spinning helix to form 3-dimensional images, viewable from any angle.

Lewis And Clark Of The Sky

WASHINGTON, DC—Make way for the Smallsats. No larger than console TV sets, these new NASA satellites promise big results on budgets under \$60 million—in only two years.

Named *Lewis* and *Clark* after the explorers, the first pair of Smallsats comes from TRW and CTA respectively. *Lewis* will gaze at Earth in 384 spectral bands—by contrast, Landsat sees in fewer than 10 bands. *Clark* will snap photos sharp enough to resolve 10-ft. objects.

The satellites will have the highest payload-to-mass ratio of any spacecraft lofted, thanks to graphite-composite construction. They'll each ride a Pegasus rocket into orbit in 1996.



TRW's *Lewis* Smallsat will explore Earth with hyperspectral imaging.

Solar Dial Tone

CHARLESTON, SC—Although fiberoptic cable may transmit a clean phone signal, it won't yet transmit the power to run phone-line electronic systems. Telephone companies are fed up with maintaining the copper power lines buried next to their cables, so they're digging around for alternatives.

BellSouth is testing a solar-powered pedestal, a curbside box that unloads phone calls from a fiberoptic trunk line onto the copper wires that snake into houses. The pedestal's solar panels feed lead-acid batteries, which can store 10 days of reserve power.



Curbside pedestal draws power from sunlight to run electronic systems for fiberoptic lines.

BELLSOUTH PHOTO



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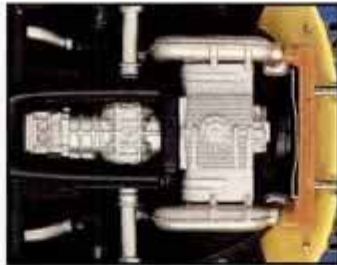
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OICW gun fires bursting munitions triggered via readings from laser rangefinder.

PICATINNY ARSENAL, NJ—Call them the 21st Century Land Warriors. They're the Army's vision of future infantry, and their "lethality component" will derive from a program called Objective Individual Combat Weapon (OICW).

The Army is aiming for big improvements over current weapons. In particular, the gun must carry out precision strikes against both exposed foes and those lurking in defilade.

To that end, two barrels jut from a newly revealed model of an OICW concept gun. One would fire NATO-standard bullets, while the other would shoot 20mm bursting munitions. As these latter rounds whiz through their barrel, inductive coils would send burst-timing data to the bullets' built-in fuzes. The gun's ballistic computer would calculate this data from a rangefinder's distance readings.

AAI Corp., Alliant Techsystems and Olin Ordnance are currently at work under OICW contracts.

Glintfree Glasses

CAMBRIDGE, MA—The flash of sunlight off a lens makes an attractive target for a sniper. One-eyed Israeli general Moshe Dayan learned that the hard way. And today's shiny laser-protection coatings only make



KillFlash antiglnt shield subdues the reflection off infantry goggles.

a glaring problem worse. Tenebraex Corp. has a solution—a honeycomb of short tubes that slips over any optical surface without dimming light intake. This array acts like a giant lens shade, blocking reflections. The tubes' diameter and cross section can be optimized for the lens's field of view. The system, known as killFlash, suits binoculars, goggles, sensors or vehicle headlights.

Sidewinder's Sidelong Looks

LEXINGTON, MA—The days may soon be over when a fighter jock must steer his jet in behind an enemy plane to shoot it down. New seekers on air-to-air missiles can follow the movements of a pilot's



Head-tracking helmet and wide-angle missile sensor team up for revolutionary air-to-air combat technique.

head, even swinging 90° left or right. Cued by radar, today's AIM-9M Sidewinder can only be pointed 27.5° left or right of the aircraft's nose. But earlier this year, a Sidewinder modified by Raytheon pulled 30 g's to intercept a

target drone 67' to the right—and only 1.3 miles away. Inside the F-16 testbed, the pilot wore a Honeywell helmet equipped with a magnetic head-tracking system.

Intriguingly, the United States appears to be playing catch-up in this technology. Russian and Israeli fighters already have operational wide-angle seekers and head-tracking helmets.

Dune Buggies Of The Wasteland

NEWTON, MA—As the military turns over real estate to civilians, it has an obligation to dig out buried hazards, anything from old bombs to barrels of waste. To speed the search, a unique vehicle is now tooling around cleanup sites.



Called the Surface-Towed Ordnance Locator System, the little off-roader putters along at 3.5 mph, driven by a 55-hp VW engine. Behind it trails an array of metal-detecting magnetometers. Positioning data from a GPS receiver convert these sensors' output into a map of magnetic anomalies. Geo-Centers Inc. is now marketing the vehicle for civilian waste dumps.

Sensor-towing car is built of aluminum and composites for low magnetic signature.

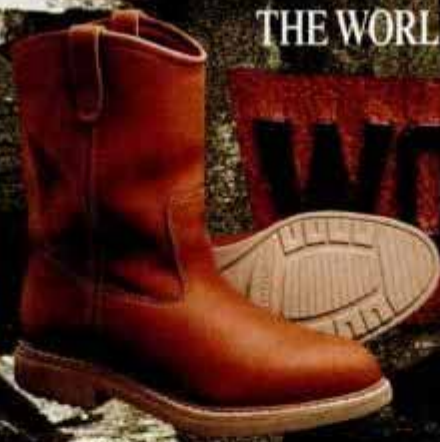


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TIMECOP

1995

COMING IN SEPTEMBER



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You might expect to pay upwards of 20 grand for a car like that. But we're Chevrolet. And for around \$16,000,* you not only get a lot of car, you get to keep the change.

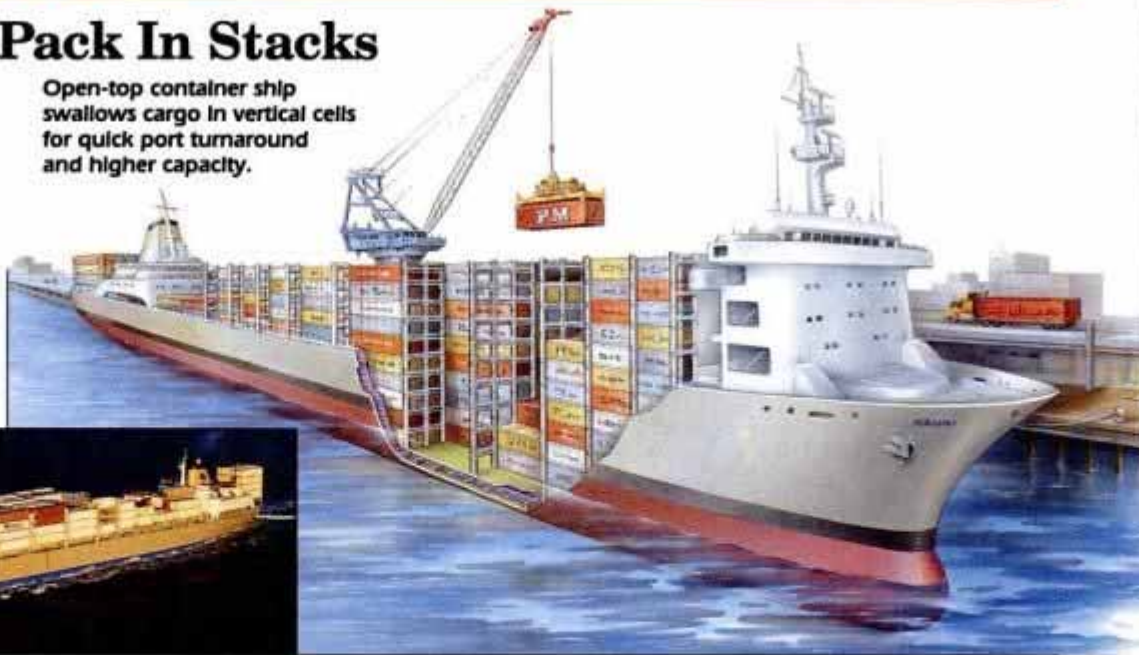
ALL NEW LUMINA  GENUINE CHEVROLET™

Cargo Ships Pack In Stacks

SAN FRANCISCO, CA—Competition rages in the shipping industry, and few American-flag carriers have survived the fight for freight. But Matson Navigation Co. has kept pace by constantly introducing new technology.

Matson recently scored another coup by becoming the first U.S. carrier to operate open-top container

Open-top container ship swallows cargo in vertical cells for quick port turnaround and higher capacity.



MATSON NAVIGATION CO. PHOTO; ILLUSTRATION BY DON MANNING



ships. The freighters SS *Maui* and SS *Kauai* underwent open-top surgery and now sport vertical-cell guides, struts that extend from three of the ship's container holds.

Advantages are numerous. Dock-side cranes can work quickly, loading

or unloading containers stacked 10 high and eight across. Longshoremen no longer need to clamber perilously over the containers to lash them down. And capacity has grown by nearly 50%, from 349 to 518 containers. Powerful bilge pumps keep the

ships seaworthy in rough water.

The Australians reportedly devised the cell guides, which are also in use with Holland's Nedlloyd Lines. But Matson faced the world's most stringent certification process to run the ships under the Stars and Stripes.

Fire Bomber's Flying Map

TUSTIN, CA—This year's wildfires have attracted swarms of aerial firefighters over Western forests. So many aircraft are flying, in fact, that investigators fear that mid-air collisions may become as big a hazard as the pilots' daring treetop maneuvers (see "Fire Bombers," page 52, March '94).

Accordingly, NASA's Ames Research Center has designed an electronic chart



Electronic display will reduce the need for verbal communication between aerial firefighters, cutting potential for human error.

display for the aircraft. The 9-in. color monitors will clue pilots in to terrain contours and the locations of nearby planes and helicopters, based on GPS readings. The displays will also help aerial commanders plot out their assaults on the fires.

In addition, researchers are also developing a flight-environment structure that could apply to any fire zone. The concept resembles the terminal control area around an airport, only drawn up to show pilots flight paths in and out of the blaze's vicinity.

Freight Jets On Water

ALEXANDRIA, VA—By the turn of the century, a fleet of freighters may be streaking across the Atlantic in 3½ days. The jet-powered 770-ft. vessels, blueprinted by naval architects at Thorneycroft-Giles, would hit 43 knots. That's nearly twice as fast as any other cargo vessel on the planet.

Each ship would fly on eight General Electric LM-6000 gas turbines, marine versions of the CF6 engine that lofts the Boeing 747. These engines twin up through gearboxes to drive four waterjets.

Seakeeping is a prime selling point for the ships. At 30,000 tons each, they'd skulk low in the water and wouldn't "catch air" in high seas.

Cargo speedboat would carry containerized goods in two enclosed decks.

Under the Thorneycroft-Giles scenario, Philadelphia and Zeebrugge, Belgium, would construct home ports for the ships. Meanwhile, FastShip Atlantic, also based in Alexandria, would begin building the ships in 1996.



THORNEYCROFT-GILES ILLUSTRATION

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Eiffel's New Elevators



CITE PHOTO: PIRE INTERNATIONAL PHOTO (FOR RIGHT)

Modular Duolift elevators run from the second floor to the observation deck at 11.5 ft. per second.

PARIS, FRANCE—While four Otis elevators have plied the Eiffel Tower since 1889, they typically don't last longer than a decade. Heavy use and exposure to the elements take a toll on the cars.

But the latest designs from Otis should run much longer. Called Duolift, they're designed for easy maintenance. Each car's framework is machine-welded stainless steel, with modular exterior panels composed of an aluminum-plastic composite sandwich. Workers can replace both inside and outside sheathing without dismantling the entire elevator.

The Duolift cars, which took three weeks to install, are reciprocally balanced, with each elevator serving as its counterpart's counterweight. Each car can carry 22 people and has four observation windows.

Flashlight Spots Drunks

FREDERICKSBURG, VA—Next time a state trooper pulls you over and shines a flashlight in your face, the officer may be checking your breath for alcohol.

Public Service Technologies has developed a passive alcohol sensor built into a police-grade flashlight. To use it, the officer holds the device about 6 in. from the suspect's mouth and encourages him or her to talk.

Tapping the flashlight's ON/OFF button activates a pump that sucks in an air sample. Once inside, the air passes through a wafer-thin fuel cell, which gives off varying voltages depending on the amount of alcohol to which it is exposed.



Alcohol-sensing flashlight screens suspected drunken drivers and displays results with LEDs.

PUBLIC SERVICE TECHNOLOGIES PHOTO

The Ultimate Squirt Gun

KENT, WA—What would you do with a hydraulic pulse generator? The device, built by Quest Integrated, spits out water bullets from a vessel that crushes the water under pressures reaching 60,000 pounds per square inch.

Inside the vessel, the pressure builds up behind a poppet valve that seals off the outlet nozzle. When it's time to fire, the trigger throws a servo valve on the water-inlet line, causing a sudden pressure drop that lifts the poppet valve for a fraction of a millisecond.

Because the water packs the same punch as high explosive, the device could tunnel through hard rock. Yet unlike dynamite, which requires evacuation and ventilation, a hydraulic pulse generator can blast away every 5 seconds.



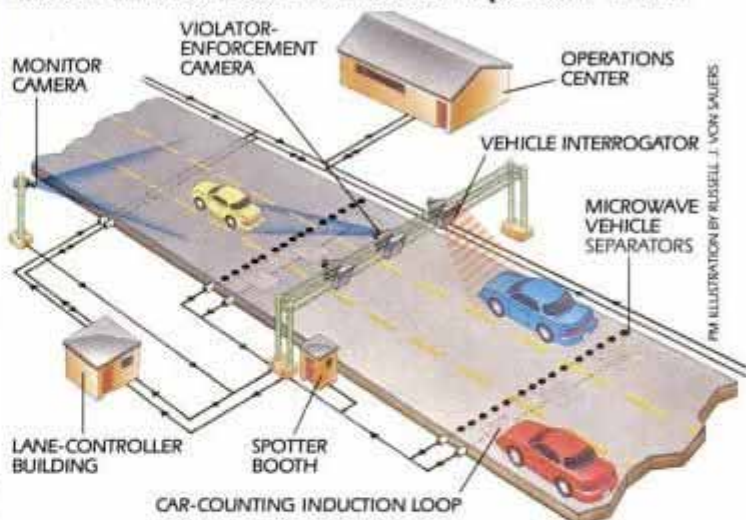
QUEST INTEGRATED PHOTO

Hydraulic pulse generator shows how it could fragment rock-hard materials.

Tolls Without The Plaza

ANAHEIM, CA—When Christmas 1995 rolls around, motorists on Orange County's jam-prone Riverside Freeway will get an extra gift: 10 miles of automated-toll highway that will whisk them past the usual congestion. California Private Transportation Co. is building the express lanes.

Entering these lanes, drivers will pass over in-road devices that count cars and measure separation. This in-



PWA ILLUSTRATION BY RUSSELL J. VON SAUERS

formation flashes over to the toll gantry, to help set the variable tolls—from 25 cents to \$2.50—in a concept known as congestion pricing. A microwave antenna then shines a signal at each car and reads back an identification number from a transponder in the vehicle. If the car carries no transponder, an overhead camera snaps the violator's license plate.

Riverside Freeway's privately run toll lanes will gauge traffic conditions and set tolls accordingly.

What happens to the violator remains an open question. So does the issue of prepaid accounts or monthly billing.

"I earned \$1,000 on just 12 VCR repairs in one week"

A true statement by Paul B.* of San Pedro, California

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Japan Joins Scramjet Club



TOKYO, JAPAN— A proposed Japanese space plane is one step closer to flight after recent tests of its air-breathing engine. The supersonic-combustion ramjet, or scramjet, burned for 6 seconds in a new hypersonic wind tunnel at the National Aerospace Laboratory (NAL). Built by Mitsubishi Heavy Industries, the subscale engine echoes the

modular scramjets that engineers have tested at NASA's Langley Research Center. The Japanese version is geared toward 15 tons of thrust. The NAL's space plane concept recalls early versions of the X-30, the now-canceled American aircraft that would have flown under the National Aero-Space Plane program. Unlike the X-30, how-

Japan has test-fired a scale version of the scramjet designed for its space plane. ever, Japan's space plane would use liquid-air cycle engines (LACE) for both low-speed and high-speed thrust. In between, the hydrogen-fueled scramjets would handle speeds from Mach 5 to Mach 20. Conventional turbojets would power takeoff.

Security On The Go

DUMFRIES, VA—If traveling diplomats set up tents in their hotel rooms, they aren't necessarily lunatics. They may be using the SE-2, a portable enclosure designed to ensure phone security and shield electronic equipment from radio interference. Made by BEMA Inc., the structure takes up 36 sq. ft. of floor space. Its fabric is Monsanto's Flectron, which is metalized with silver and copper, reinforced in spots by ballistic cloth. The com-



Tent insulates phone calls from radio-frequency eavesdroppers.

pany may develop a tent-within-a-tent for outdoor use, to squelch electromagnetic emanations from military communications gear.



Bioengineers use nuclear magnetic resonance to study pancreatic cells for protracted periods.

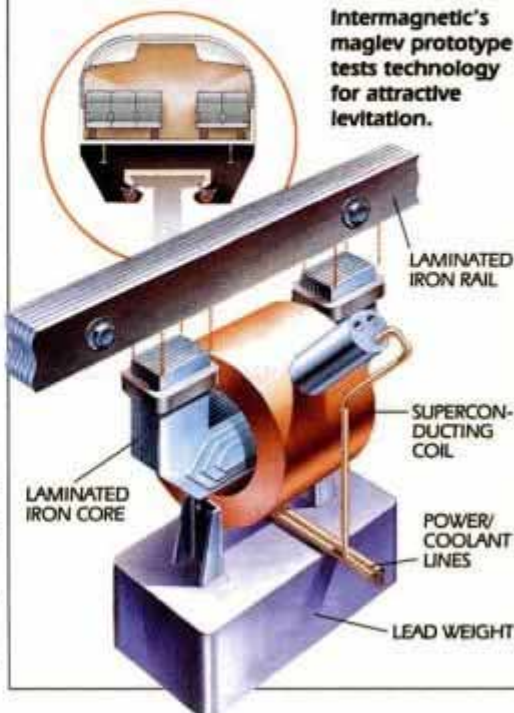


Artificial Pancreas

ATLANTA, GA—Diabetics may free themselves of daily insulin injections if research at Georgia Tech and Emory University pays off. Engineers and physicians are collaborating on a pancreas-replacing implant based on living mouse cells. The insulin-secreting cells would live inside small pouches or microbeads injected into the abdominal cavity. A semipermeable membrane would block out the immune-system antibodies that trigger rejection of an implant. Patients would visit the doctor every six months for a new implant. Keeping the cells thriving for that long is the current research focus.

Maglev's Magnets In The Making

LATHAM, NY—While no one in this country has conjured up the money to get magnetic-levitation trains off the ground, several companies are fine-tuning the superconducting magnets that could provide the lift. Under a contract from the Federal Railroad Administration, Intermagnetics General Corp. is building the first full-scale prototype of such a system. Due to be working next spring, the device previews a production unit that could hoist a 65-ton train 2 in. off a track—while moving at 300 mph. Meanwhile, Northrop Grumman aims to test a high-temperature superconducting magnet this winter. Grumman has a contract to design a maglev test facility at Stewart Airport in Newburgh, New York.



Intermagnetic's maglev prototype tests technology for attractive levitation.

Taking Control

BY FRANK VIZARD, Electronics Editor

● Shoot the TV. Now there is something I've thought of doing once or twice, particularly when I can't find anything worth watching on my vaulted cable system.

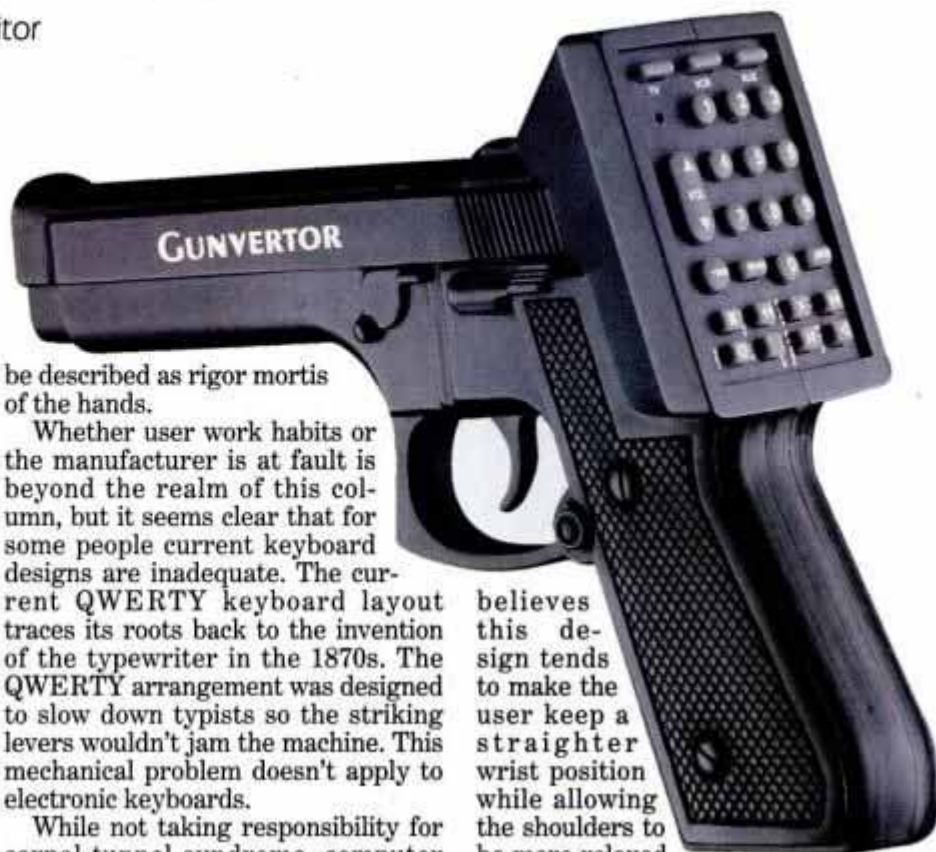
Fortunately, a cooler head prevails. But now along comes a device that a psychologist might say provides a cathartic release. The device is a universal remote control shaped like a pistol. It's called the Gunvertor, and as remote controls go, it is unique.

Pull the trigger and you change the channel. No harm done. The bullets, so to speak, are nothing more than infrared light beams.

Want to cock the hammer? Well, you can't quite do that, but you can use your thumb to manipulate the 25-button keypad. This keypad can be used to control the TV, a VCR and a cable box. It's sort of like converting a single-shot weapon to automatic fire.

The Gunvertor, from Ingenious Ideas Inc. (800-684-3324) of Scottsdale, Arizona, lists for \$70. The company says the Gunvertor is a remote control fashioned into a "practical shape." Well, maybe. But it's kind of fun. And maybe somebody will swap it for some of those illegal handguns out on the street.

On a bit more serious note, taking control of the computer keyboard is becoming more of an issue as more keyboard users are struck by carpal tunnel syndrome, a debilitating condition that can best



be described as rigor mortis of the hands.

Whether user work habits or the manufacturer is at fault is beyond the realm of this column, but it seems clear that for some people current keyboard designs are inadequate. The current QWERTY keyboard layout traces its roots back to the invention of the typewriter in the 1870s. The QWERTY arrangement was designed to slow down typists so the striking levers wouldn't jam the machine. This mechanical problem doesn't apply to electronic keyboards.

While not taking responsibility for carpal tunnel syndrome, computer manufacturers are trying to design more comfortable keyboards.

The latest attempt at a new keyboard design comes from Microsoft, which has designed a new keyboard called the Natural. This keyboard also offers more than just comfort.

The Microsoft keyboard maintains the traditional QWERTY layout but angles the right and left key groups away from the center. Microsoft

believes this design tends to make the user keep a straighter wrist position while allowing the shoulders to be more relaxed.

The angled keys minimize the rotation of the forearms required when positioning your fingers over the keys. The keyboard also slopes upward from the palm rests to reduce the amount of finger extension required to hit function keys.

Initial impressions garnered from several users, including a bona fide "touch typist," is that the Microsoft keyboard is indeed more comfortable and has a nice keystroke. The inside letter keys do require a slightly different motion of the index finger, a change that may become second nature over time.

The Microsoft keyboard, which lists for \$99, also has three extra keys that make it very Windows specific. Two of the keys provide one-touch access to active applications, thanks to a new graphical task-manager program that comes with the keyboard. The task manager allows you to easily switch to any application that is already running or to launch a file or document from the icon bar.

The third key is a programmable applications key designed to work with Microsoft's new Chicago operating system due out next year. From both a design and a functionality standpoint, this keyboard is representative of some forward thinking.

(Please turn to page 38)



Microsoft's new computer keyboard is designed to be more comfortable to use.

Racing's Best Kept
SECRET



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NEW IMPROVED FORMULA



The 32X add-on doubles the power of Sega Genesis.

Power Games

It seems that every time you want more powerful videogame hardware you have to invest in a whole new system. And while this may seem to be the case at first glance, the situation is worth a second look thanks to a variety of new products that will give your videogame system new life.

Perhaps the most widely compelling piece of upgrade gear is a new videogame modem that lets you plug into a network of game players. Called the XBand, this special modem is positioned between the cartridge and the game port. Simply plug the XBand into a telephone jack and the modem does the rest.

As a game network, XBand has some attractive features. One is an Auto-Match feature that automatically pairs you with another player of similar skill. Players get ranked in much the same way chess players do.

The other important feature addresses the issue of parental control. Parents can limit the number of hours and times of day their children can play on the network. Game-playing can also be limited to local calls unless otherwise authorized by the parents. XBand may encourage parents to add a second telephone line. There is also the option of enabling a call-waiting feature.

Privacy is also ensured since players are identified by icons and personal "handles." This way names and telephone numbers are not distributed freely across the network.

XBand also functions as more than just a gaming tool. A feature called X-mail is essentially an electronic mail service that allows users to type messages to each other.

The XBand modem lists for \$70, and the network service charge is \$7.95 per month. The monthly bill covers about 25 connections, says XBand's developer,

Catapult Entertainment of Cupertino, California. Additional connections will cost about 25 cents each. Initially, billing will be done via credit card. In the near future, you will be able to buy debit cards for various amounts of connection time at local retailers.

XBand initially will be available in November for Sega Genesis machines. A Super Nintendo version should be available early next year.

Other devices for upgrading videogame systems are a bit more platform specific. To turbocharge an existing 16-bit Sega Genesis machine, all you have to do is buy Sega's new 32X component. What you get is a 32-bit machine that offers game players faster processing, more colors and 3-dimensional images.

There are actually two 32-bit RISC processors built into 32X and these complement an improved video digital processing chip. Technically, this puts 32X on par with many arcade games as far as scaling, rotation and texture mapping are concerned. This means the game environment looks more realistic.

List price for the 32X add-on component is \$150. Cartridges and CD-ROM games specifically designed for 32X list for about \$70.

Sega will also be the first to utilize a new Video Jukebox for games developed by ASG Technologies of Santa Clara, California. This \$50 stereo-size component lets you easily switch between six game cartridges. Individual Video Jukeboxes can be wired together to create an electronic network of 36 titles.

ASG Technologies also makes an infrared controller that enhances existing control pads. With the "InfraRAD," added features like slow motion and rapid firing come into play. It also works with the Video Jukebox. List price is \$50.



Video Jukebox lets you create a game network.

Censoring TV

Earlier this year, we discussed a proposal by one cable group for TV circuitry that would allow parents to block home reception of specific programs they did not like (see "The Violence Chip," page 114, May '94). This technology, called the V chip, was criticized by TV stations for being too restrictive, since an entire 2-hour show could be blocked because of one 4-second scene.

Another development from within the industry is called Explicit Content Encoding (ECE) from VideoFreedom Inc., a company in San Diego, California, which specializes in signal processing for multimedia entertainment. ECE is designed so that "every viewer has the ability to select their own threshold of sex, violence, obscenity and adult situation, independently," according to the company.

With ECE, each video frame of a program would be encoded before it is shown. That code would correlate to the nature of the image and sound in that frame. Viewers with ECE equipment would program their TV to read these codes, controlling what they want to see or hear from the program.

Once programmed, unwanted subject matter such as nudity, violence or obscene language is altered so it's not as graphic or offensive. For example, if a man is shot in a movie, the blood on his clothes or the entire screen is blurred by ECE—assuming that is the viewer's preference. Once the subject matter is again acceptable, the image on the screen returns to normal. The amount of the image to be altered is controlled by the viewer so that only a portion of the screen is changed and the entire scene is not lost. In addition, the blurred area will track across the screen continually, covering a wounded, yet moving, character.

However, Doug Wells, director of media relations for the National Association of Broadcasters (NAB), says it "is opposed to any government or industry-related entity declaring what content is and is not appropriate." Wells says both ECE and the V chip are in this category since the television industry would originally encode the content in the programs. The NAB instead wishes this decision was left entirely to viewers. NAB opposition to ECE could pose a problem for the long-term success of VideoFreedom.

VideoFreedom says the only cost for television viewers will be for a converter box to bring the necessary technology to the TV, and that would probably be under \$50 and in stores in late 1994. New televisions with ECE built in will only cost manufacturers an extra 50 cents to produce.

—Bob West

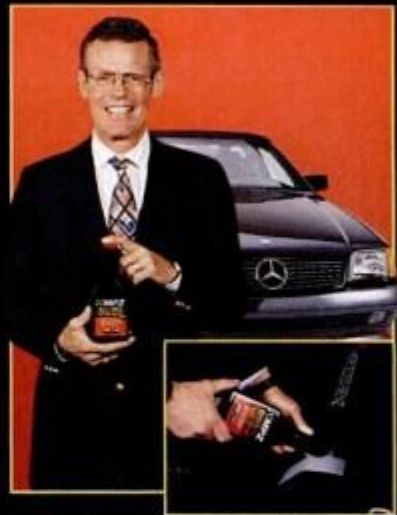
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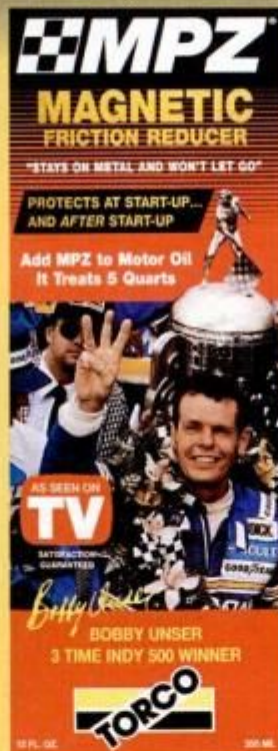
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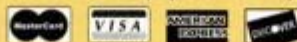
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1. This 12-cylinder, 600-horsepower mid-engine 6-speed, 200+ mph super car will go on sale in the U.S. this fall. Who is the manufacturer?



A) Aston-Martin. B) Lamborghini. C) Bugatti. D) Lotus.

2. The current land speed record for electric cars stands at:

A) 98 MPH. B) 118 MPH. C) 136 MPH. D) 183 MPH.

3. The recently completed 1994 4,300-mile Great American Race was won by a:

A) 1939 BMW. B) 1937 Buick. C) 1935 Ford.
D) 1912 Oldsmobile.

4. What motorsports personality is currently running for the U.S. Congress?

A) Bill France, Jr. B) Don Garlits. C) Roger Penske. D) Richard Childress.

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5. What car company used the name, Direct Connection for its parts and accessories division?

A) Chrysler. B) Ford. C) General Motors. D) American Motors.

6. The last carbureted car model to be sold in the U.S. was the:

A) Chevrolet Monte Carlo. B) Yugo. C) Subaru Justy. D) Jeep Wrangler.

7. The Fiera is car that was built by:

A) Pontiac. B) Ford. C) Oldsmobile. D) Cadillac.

8. For every gallon of fuel burned, an engine uses how many cubic feet of air?

A) 500. B) 1,000. C) 5,000. D) 10,000.

9. Dampers (damper springs) are used inside some valve springs to:

A) Prevent valve spring surge. B) Keep the valve spring attached to the valve. C) Decrease valve spring pressure. D) Retain valve stem seals.

10. What compact pickup truck is available with a V8 engine?

A) Ford Ranger. B) Dodge Dakota. C) Chevrolet S-Series. D) Both A and B.

ANSWERS
1. C 2. D 3. D 4. B 5. A 6. C 7. B (modified)
1968 Ford XL show car) 8. D 9. A 10. B.



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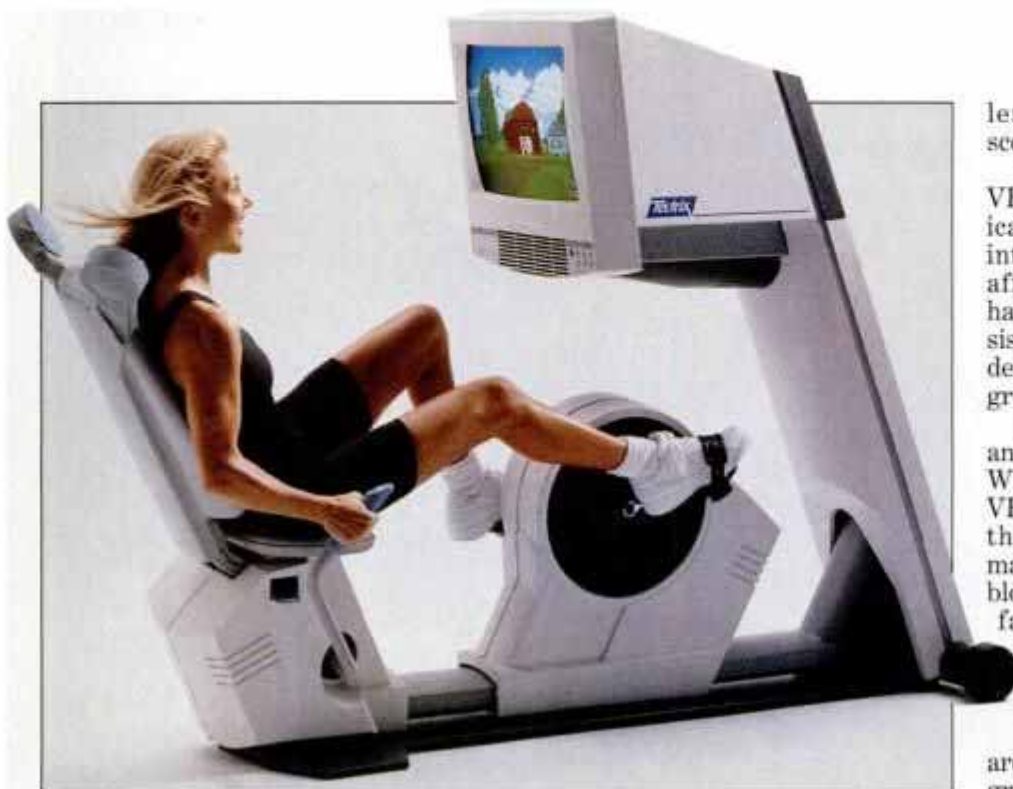
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Virtual Fitness

BY JOE SKORUPA, Boating/Outdoors Editor



● Couch potatoes take heart. The dawn of virtual fitness is here. Two companies, Life Fitness and Tectrix, recently introduced interactive fitness machines that simulate exercise. That's right, soft bodies who have difficulty finishing a Richard Simmons golden-oldies workout will soon be able to compete in the Tour de France or the Hawaii Iron Man Triathlon through the magic of virtual reality.

We're not there yet, but two new machines recently debuted signal the start of a new era in fitness electronics—the Life Fitness Exertainment system and the Tectrix VR (Virtual Reality) Bike.

Before you imagine these units transporting you to the streets of Boston to run in the famed marathon on Patriot's Day or to the Himalayas for an ascent up Mount Everest, a word about the current state of virtual reality.

While most people associate virtual reality with bug-eyed helmets and sensor-studded gloves, the truth is that this application is very limited. The images are projected onto stereo goggles, and they give an impression of 3-dimensionality. However, at this stage, they all have the visual impact of a bad cartoon. The computer-generated virtual (read: visual) environment is composed of crudely rendered

shapes. Perhaps even more challenging, the lingering physical effect is generally compared to motion sickness.

As a result, the virtual reality currently being marketed is really nothing more than a 2-dimensional representation displayed on a computer or TV monitor. The operator (in this case, the exerciser) maneuvers through the virtual world by means of pedaling, steering and pushing buttons. This may not be what most people expect of virtual reality, but it can be a lot of fun.

The first of the new units that I tested was the VR Bike (shown above) by Tectrix Fitness Equipment (68 Fairbanks, Irvine, CA 92718). This unit is a recumbent on a platform that integrates a 20-in. color monitor, CyberGear software, an Intel-based processor and a CD-ROM drive.

Riders are treated to an eye-level virtual world that becomes interactive the moment they sit down and start pedaling. The CD-ROM program enables riders to steer in any direction, join a chal-

lenge race or explore interesting scenery on their own.

The most impressive aspect of the VR Bike is the innovative use of physicality. As might be expected of an interactive virtual world, pedaling affects bike speed and moving the hand grips alters direction. Also, resistance increases (going up hills) or decreases (running downhill or on flat ground) in response to virtual terrain.

But more interestingly, the seat and pedals rotate on a horizontal axis. When the rider initiates a turn, the VR Bike leans into it. To complement the effect, the pace of effort is matched by the strength of a breeze blowing in the rider's face (thanks to a fan mounted below the monitor).

Sound effects and music from speakers in the backrest change tempo, too.

The VR Bike's interactive features are controlled by buttons on the hand grips. Using these buttons, riders can shift gears, brake and view various displays (elapsed time, miles traveled and calories burned). Riders can also switch between a ground view and an aerial view of the virtual world.

Most home exercisers will find the VR Bike's \$7500 price tag a little steep. Consequently, the unit is aimed at the health-club market. Dimensions on the unit are 58 in. tall, 25 in. wide and 84 in. long. It weighs 350



Life Fitness and Nintendo team up to create Exertainment.

pounds. To maximize its health-club impact, Tectrix has installed a networking capability (SmartLink) that enables four VR Bikes to link up for competitive races.

About a week after testing the VR Bike, another product made its debut: Exertainment by Life Fitness (10601 W. Belmont Ave., Franklin Park, IL 60131). This unit consists of a Lifecycle 3500X (an upright bike) linked to an interactive Super Nintendo Entertainment System (Super NES). The Lifecycle Exertainment unit is the first product to come out of a partnership between Life Fitness and Nintendo of America.

As expected, working the pedals and handlebars affects the rider's resistance and progress through the virtual world. So does going over graded terrain and encountering obstacles, including other bikers.

Currently, two software packages are available for this Exertainment system. They are *Mountain Bike Rally* and *Program Manager*. Others are planned for future release.

Mountain Bike Rally offers a gamelike scenario based on a rough-and-tumble race. Riders are called upon to make a number of choices at the start of the game. These include assuming the identity of one of eight characters (California Jack, Mystery Rider and Raging Beast, for example), selecting which bike to ride (such as the Trekker or the Cougar) and which route to run (eight different choices).

The *Program Manager* cartridge enables riders to interactively use such typical Lifecycle programs as Fit Test, Random, Manual, 12-Speed Race, Hill Profile and Heart Rate Zone Training. It also enables riders to monitor and store a record of the workout (time, distance, calories burned and cumulative results) while playing *Mountain Bike Rally*.

Interestingly, either the Lifecycle 3500X or the Super NES can be accessed independently. In other words, players can use Super NES without riding the bike or play Super NES while someone else rides.

While the intent of the Exertainment system is to inject fun into fitness, the veteran Life Fitness company makes sure the unit is capable of serious exercise. The unit is health-club tough and equipped with a superb interactive heart-rate monitoring capability (optional).

The Lifecycle 3500X Exertainment unit retails for about \$800. This includes an exclusive Lifecycle 3500X bike and an Exertainment kit containing the Exertainment module to adapt your Super NES controllers, plus the *Mountain Bike Rally* game

and *Life Fitness Program Manager* cartridge.

The Lifecycle 3500X Exertainment system should be in stores by the time this story is printed. A Lifestep 5600 stairclimber Exertainment unit should be coming to stores soon after. Exertainment capability is expected to be available for Lifestride treadmills and Recumbent Lifecycles by next spring.

So, is this the future of fitness? Will health-club and home exercise machines become increasingly loaded with virtual-reality bells and whistles? To a certain segment of the market,

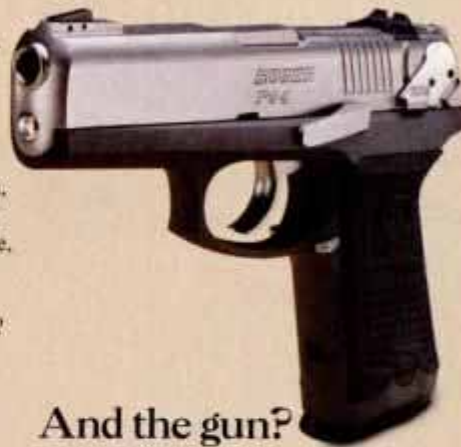
the answer is a resounding yes.

It's estimated that about one in five Americans engage in regular exercise—a number that has remained unchanged for the past 20 years. To break this barrier, fitness-machine designers are looking for ways to counter what marketing studies have shown to be the chief complaint—exercise is boring. The addition of interactive video is one of the entertaining ways to inject fun into fitness. Now, if they could just eliminate other limiting factors—such as the need for heavy breathing and working up a sweat—they'd really have something. **PM**

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To Beam Or Not To Beam

BY GREGORY T. POPE, Science/Technology Editor

● One burns through several inches of steel in a split second. The other uncorks monster blips of light packing more watts than all the nation's power-plants could muster. They are America's mightiest lasers, two megamachines built when dollars poured into defense-related projects. But these engineering marvels now face changing times and uncertain futures.

At White Sands Missile Range in New Mexico, the Mid-Infrared Advanced Chemical Laser (MIRACL) puts out more sustained power than any other laser in the country. Studied first for ship defense, then as a satellite zapper, the device borrows from chemical-laser technology conceived by Soviet physicists during the 1960s. Army laser experts say they're still not sure whether Russian physicists are blazing away with a more powerful version.

Built by TRW for the Navy in the mid-1970s, MIRACL later fell into the Army's hands when the military unified its disparate high-energy laser programs. Now that the Pentagon's budget for laser weaponry has dimmed, the Army wants to turn out the lights

at MIRACL next year.

But the engineers who run the big laser hope to give their machine a chance at a second life. The MIRACL workers are introducing civilian scientists to the device under a program called HELLO—short for High-Energy Laser Light Opportunity. To get to know MIRACL, researchers must design experiments to fit a standard instrumented box, much as small space-shuttle experiments are tailored for a standard canister. During HELLO events, a rack-and-pinion translation table shifts these boxes one at a time into the laser's line of fire.

In operation, nozzles inject deuterium and fluorine gases into MIRACL's combustion chamber, where they react and burn in acetylene. Then, peppered by a starter laser, the gas molecules kick off infrared photons at a wavelength of 3.8 microns. All the while, an arsenal of pumps—develop-



WHITE SANDS MISSILE RANGE PHOTO

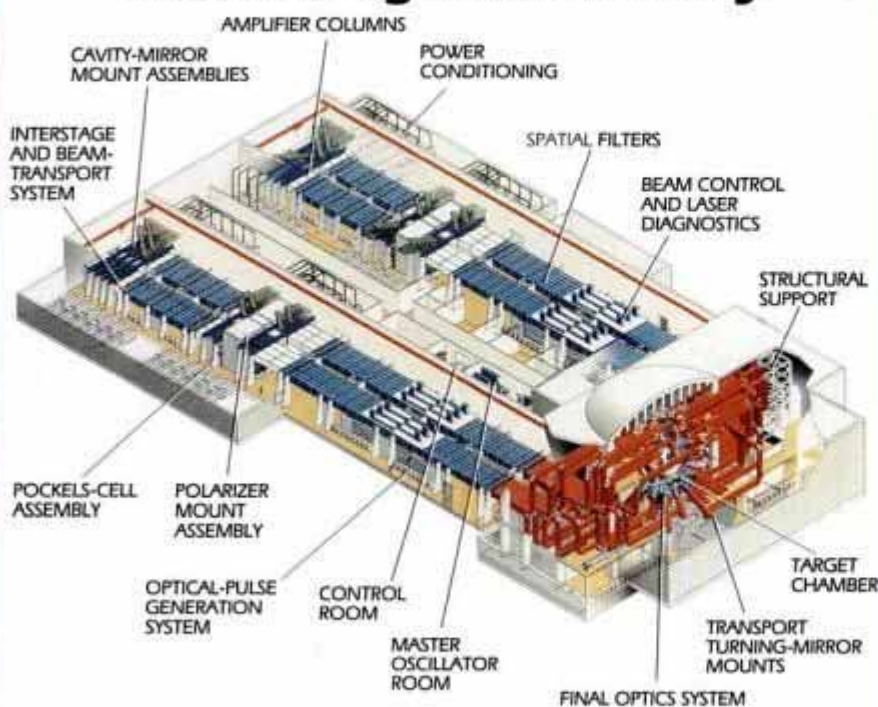
ing thousands of horsepower—keeps the fuel coming and vents the exhaust through a plumbing labyrinth.

Although MIRACL could shine for over a minute before running out of fuel, experiments only last a few thousandths of a second. That doesn't mean the laser can run thousands of experiments on a single tank of gas, however. "You can't just flick it on and off like a light bulb," notes John Hyndman, HELLO test director. Technicians must first bring the laser up to power for 5 to 10 seconds, while a shuttering system dumps the beam onto a water-cooled hunk of graphite. The shutter then winks the beam over to the target for a few milliseconds.

MIRACL's ferocity is the stuff of legend in Army circles. The beam can easily flash-heat targets to 36,000° F. That intensity could make it a valuable national resource for forging new materials, replicating star surfaces and other academic pursuits, says Hyndman. Although the laser's peak power remains classified, it will be throttled to 1.2 megawatts for the civilian experiments. "We have trouble finding things it won't burn through," Hyndman adds with relish.

Meanwhile, at Lawrence Livermore National Laboratory in California, the world's most powerful laser has emerged from the shadows of classification. Dubbed Nova, it shoots

National Ignition Facility



Twice a football field's length, NIF would be 50 times more powerful than Nova.

clipped bolts of energy, as opposed to MIRACL's steady stream. Nova jams trillions of watts of light into its pulses, which last only billionths of a second.

With Nova, physicists study laser fusion, in which a laser's output splits into dozens of synchronized pulses, all converging at once on a frozen pellet of hydrogen. The resulting implosion should compress the hydrogen so sharply that it ignites a tiny thermonuclear blast. While funded under the aegis of atomic-weapons research, Nova has shed light on astrophysics and the possibility of harnessing laser fusion to generate electricity.

Nova lifts a trick from thermonuclear weaponry to touch off fusion. The laser pulses don't slam directly into the hydrogen pellet. Instead, they burst simultaneously into a small gold-lined capsule, called a holmraum, that encloses the pellet. The sudden energy jolt vaporizes the gold lining into a plasma. Then a wave of X-rays radiates inside the holmraum and, like a clenching fist, crushes the pellet into fusion. The technique, known as indirect drive, ensures a uniform confluence of energy from all directions upon the fuel pellet. By contrast, direct drive, under study at the University of Rochester's Omega facility, may offer higher efficiency, but demands meticulous precision.

Although Nova has advanced laser fusion, it doesn't throw a big enough punch to achieve ignition. But Livermore physicists are convinced that indirect drive can deliver the goods—in part because of positive results from a classified experiment code-named Halite/Centurion, which tapped atomic explosions as an energy source. So Livermore is proposing a much bigger laser complex called the National Ignition Facility, or NIF.

To handle energy spikes 50 times stronger than Nova's output, NIF would feature cutting-edge components. These include power amplifiers around which the laser bolts ricochet four times, rather than just once, and exotic new optical switches, called Pockels cells, that use plasma electrodes to release these pulses.

In addition, one of Nova's beamlines is now undergoing surgery to demonstrate a revolutionary technique called chirped-pulse amplification. The process, developed at Livermore and the University of Michigan, essentially condenses a laser pulse, shortening its duration and boosting its power. Using chirped-pulse techniques, physicists hope to load a pulse lasting a half-trillionth of a second with a petawatt—one quadrillion watts—of power. That's 10 times the output of the entire Nova facility.

If successful, the petawatt laser could play a big part in NIF experiments. A recently declassified laser-fusion scheme called fast ignition calls for a one-two punch to trigger ignition. In fast ignition, the phalanx of laser pulses would sweep in first to implode the hydrogen pellet. A split second later, the petawatt laser would bombard the hydrogen, delivering enough energy to push the pellet over the fusion threshold. Though unproven, fast ignition could loosen the requirement for a stringently symmetrical implosion.

With a billion-dollar price tag, though, NIF isn't exactly a shoo-in, and the cancellation of the Superconducting Super Collider has physicists biting their nails over the fate of big science. What's more, since Nova has only a few more years of life in it, Livermore's world-class laser-fusion program will depend on the new facility.

Outside defense laboratories, scientists haven't had wide experience with lasers like MIRACL and Nova. But many feel that these one-of-a-kind light sources could go far to illuminate nature's secrets. Says Michael Campbell, Livermore's laser chief, "High-powered lasers that you'll be able to use as lab tools are part of the process of developing science into the next century." **PM**

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SEA CHANGE

The tide has been turning for several years,
but a tidal wave just hit Detroit.



BY DON CHAIKIN, Automotive Editor

OLDSMOBILE AURORA

• The factories are humming once again. Good people are earnestly and skillfully hard at work. There's a fine glow returning to our land. Yes, my friends, the tide is more than turning. The sea is swelling, sweeping us all up and toward better times, times built upon better cars and trucks.

The Detroit automakers are once more steaming powerfully into a new model year, riding the surging crest. Our mighty auto industry is infusing life into our economy, our national psyche and, happily, into the products that are pouring off the assembly lines.

Perhaps even more heartening than the industry's resurgence itself is the fact that it is no fluke. The domestic carmakers reached down to their roots and shook themselves hard, restructuring, refurbishing and fine-tuning, bottom to top. Their current success is hard fought and well deserved.



PM PHOTO BY CLIFF GROMER
INSET PHOTO BY BRUCE CRABBS/PHOTO



DODGE AVENGER

Oh, there's been some fortunate coincidence with the Japanese yen's climb to the sky versus the dollar. International finance is a complex business, but the simple result is that if the Japanese yen is worth more, Japanese products cost more. That means more people are taking a longer and harder look at what used to be relatively inexpensive Japanese models and comparing them—feature for feature—against their Detroit-bred competitors.

And the cars and trucks from the Big Three have been getting better and better for a while now. So now when people look, they not only like what they see, they buy it.

For 1995, the trend accelerates—there are more, better new cars and trucks to ogle, touch, sit in and drive than there were last year. Here's

a carmaker-by-carmaker rundown of the newest and most exciting of Detroit's offerings.

CHRYSLER CORP.

Those hits simply keep on coming. While an adoring public is still reveling in the wonderful little Neon twins and digesting the awesome Ram pickup, Chrysler is readying four more new cars for '95.

From the same factory in Illinois that brings you the fast, tight new Eagle Talon come the latest sport coupes from Chrysler: the Dodge Avenger and Chrysler Sebring. These front-drivers are the overdue replacements for the aged Dodge Daytona and Chrysler LeBaron coupes. (The LeBaron convertible soldiers on.) The Avenger and Sebring join the Talon to form an exciting trio of shared plat-



PHOTO BY BILL DELANEY

forms. As the Talon shares its platform with the Mitsubishi Eclipse, the new coupes share their basic platform with the Mitsubishi Galant. The potency of performance for the Sebring and Avenger tops out with a new Mitsubishi-supplied V6 engine. The Talon tears through this year with two available dohc Fours, maxing out with a 210-hp turbocharged 2.0-liter

FIRST DRIVE

LINCOLN TOWN CAR

● The Town Car buyer's median age is 66 and rising, so the '95 model targets senior appeal. With a mildly freshened exterior, the Town Car sports an all-new interior. Gone is the squared-off



instrument panel, replaced with the contoured styling now in vogue. You also get a sporty steering wheel with center-blow horn and a premium sound system with fewer—and larger—buttons for the radio.

The Town Car fulfills its primary mission of delivering luxurious comfort with decent performance the traditional way—rear-wheel drive and body-on-frame construction. The latter allows better isolation but trades off chassis stiffness when compared to a unitbody design. Power is ade-

quate with the 4.6-liter modular V8. Let's just say that on our test drive, it was the coffee, rather than adrenaline, that got our blood pumping. The engine is mated to a wide-ratio 4-speed automatic.

An optional ride-control package firms up the suspension a tad and gives you P225/60R16 tires on alloy wheels, along with a 3.27:1 rear-axle ratio (versus 3.08:1), and an auxiliary power-steering oil cooler. The 16-in. wheel/tire combo is also standard on the Cartier, optional on the Signature.

As for innovations, there's a 3-level steering effort switch on the dashboard that works with an electronically variable orifice in the power-steering system for light, medium and heavy effort. But even "heavy" feels relatively light for our taste. A battery-saver feature turns off all the lights after 10 minutes if they are left on inadvertently. The neatest trick: Three small buttons mounted on the sun visor function as garage door openers.

—Cliff Gromer



DODGE STRATUS

There's room inside these cars for five adults and space behind them in the trunk for a lot of their accumulated traveling stuff.

The view forward is superb. The long, sloping windshield ends at a very short cowl and the hood is actually wider than it is long.

Under the hood of the base Dodge Stratus is the sohc 2.0-liter Four that can be found in the Neon or a new dohc 2.4-liter Four. The Cirrus offers the bigger Four or the same sohc 24-valve 2.5-liter V6 that's used in the Avenger and Sebring. All but the base Stratus get a 4-speed automatic. The entry model offers a 5-speed manual.

FORD MOTOR CO.

The big 10-year multibillion-dollar news at Ford for 1995 is that the company has finally replaced the Tempo and Topaz twins. But there's more substance than just the new Ford Contour and Mercury Mystique midsize sedans. For '95, the Lincoln Town



CHRYSLER CIRRUS

that cranks out 214 ft.-lb. of torque.

While all of these coupes share engineering and manufacturing sites with Mitsubishi models, the Sebring and Avenger share their aggressive, hot styling with the other big news from Chrysler: the Dodge Stratus and Chrysler Cirrus midsize sedans.

First shown at the Detroit Auto Show back in January, these sedans—code-named JA—have had an eager public awaiting their arrival at dealerships. As the larger LH sedans and Ram pickup redefined design in their

market segments, so do the Stratus and Cirrus. Clearly the next step in the evolution of Chrysler's heralded "cab-forward" style, the Stratus and Cirrus have very short rear decks, low noses and strong, aggressively sloping grilles. The cars sit on a 108-in. wheelbase—that's 2 in. longer than, say, a Ford Taurus—while the overall length is 186 in., or about 6 in. less than the Taurus. All that room between the wheels makes for a cavernous interior and nice, wide door openings, both front and rear.

FIRST DRIVE

MERCURY MYSTIQUE

• We drove a prototype 5-speed V6 Mystique from San Francisco back to our New York City offices early in the summer, 3200 miles in four short days. Such an intense experience would tend to magnify any vehicle's shortcomings, no? We're happy to report that there's little to report—except a pair of tired but not abused drivers, a high average rate of travel and a very short stack of gasoline chits. We averaged nearly 28 miles per gallon, and that's at speeds that kept us moving with traffic anywhere along the route and the air conditioning on constantly in the heat of early summer.

Mercury wants very much to differ-



entiate this vehicle from big brother Ford Contour, softening the ride and interior appointments to be more in concert with its intended buyer profile. We found the ride to be very

comfortable but not at all floaty or mushy. A well-optioned version comes in under \$16,000, making the Mercury Mystique a truly affordable luxury car. —Mike Allen

NEW '95 CARS



FORD CONTOUR



PHOTO BY BRUCE COBURN/PHOTO

Car has been redesigned, the Ford Crown Victoria and Mercury Grand Marquis wear a new look and, a little down the road, the popular Explorer gets a fresh appearance as well.

Contour/Mystique

Ford reportedly spent more than \$6 billion developing a car that could—with minor variations—be sold in the United States, Europe and Asia. The variants share essential components that are manufactured in various locations around the world and then shipped to the assembly plants.

This "world car," as Ford is calling it, is a 4-door 5-passenger front-wheel-drive sedan that should help Ford grab more of the burgeoning midsize family sedan market.

The Contour and Mystique are different from each other in the same ways that the Taurus and Sable differ—they have different noses and tails, different interior trim and are meant to appeal to slightly different buyers. But they both are intended to appeal to many, many buyers—Ford hopes to sell 800,000 of these cars worldwide a year.

Beneath their rounded metal skin, the Contour and Mystique are much the same.

The Contour/Mystique sits on a 106.5-in. wheelbase that's longer than that of the larger Taurus/Sable. The wheelbase is more than 6 in. longer than was the Tempo's. The new car is also 6 in. longer overall than the Tempo, but about 9 in.

shorter than the Taurus. The result is a spacious, comfortable passenger compartment. The interior is also well appointed. Ford designers strove to include many of those important little touches—like a small hook on the glove compartment door to hang a purse or briefcase from—in the ergonomic design. The interior also boasts an air-filtration system, which removes dust and pollen from fresh air entering through the ventilation system.

The car sits on a fully independent

FIRST DRIVE

MERCURY GRAND MARQUIS

● Grand Marquis and its cousin—Ford Crown Victoria—receive only minor tweaking, both inside and out, for '95. The Mercury is the more attractive of the two, to my eye, with its stronger-character grille.

The basic platform supporting the Grand Marquis and Crown Vic has been around since 1979, and the package has benefited from evolutionary refinement. The new models will haul six adults around in satisfactory comfort, if not plush luxury. The factory focus in competing in the full-size 4-door sedan arena is to stuff as much value into the package as they can before the ever-watchful



bean counters scream to stop.

The sole powertrain is Ford's sohc 4.6-liter modular V8 with up to 210 horsepower (when equipped with an optional dual exhaust) hooked to the Mark VIII's wide-ratio 4-speed automatic. If you like your big car with a more sporting flavor, the optional handling package for both models gives you a quicker accelerating 3.27:1 rear axle, larger antisway bars and firmer spring rates, as well as

dual exhaust, 16-in. alloy wheels with stickier tires and a power-steering fluid cooler.

While slice-and-dice driving or churning rear tires into clouds of blue smoke are not these cars' forte, they are very good all-around workhorses. Available options will allow these rear-drivers to tow up to 5000 pounds, and deliver the added safety supplied by traction control and anti-lock brakes. —C.G.



FORD CROWN VICTORIA

suspension, with MacPherson struts in front and a multilink rear suspension with struts. Brakes are discs in front, drums in rear on 4-cylinder models and discs all around on cars with the V6. ABS is optional on all models. And cars equipped with ABS can also be ordered with a traction-control system.

Traction control could be pretty useful in this car since the optional V6 engine cranks out 170 horsepower—despite its modest 2.5-liter displacement. The brand-new all-aluminum engine has four camshafts, 100,000-mile spark plugs, 24 valves and a 9.7:1 compression ratio. It's the second engine to come out of Ford's modular engine program, which produced the 4.6-liter V8 used in the Mark VIII. The V6's power peaks at

6250 rpm, and the 165 ft.-lb. of torque tops out at 4250.

The base 4-cylinder engine is also new. It sports dual overhead camshafts and four valves per cylinder. The 2.0-liter has an aluminum head, cast-iron block and develops 125 horsepower at 5500 rpm and 130 ft.-lb. of torque at 4000 rpm.

Both engines can be mated to either a new 5-speed manual or a new 4-speed overdrive automatic.

Lincoln Town Car

At just about the opposite end of the automotive spectrum from the Contour and Mystique sits the freshened Town Car. This bastion of the traditional rear-drive luxury sedan gets a new nose and tail, complete with a new grille, new headlamps, taillamps

and bumpers. The exterior of the car also benefits from new body-side molding and larger, repositioned outside rearview mirrors.

The passenger cabin gets new seats—with more travel than before—a new dash and instrument panel and revised door trim panels. The seats have a memory feature that is tied into the outside mirror settings.

Other up-to-date tidbits for the venerable Town Car include a battery-saver function, which shuts off the headlights after they've been left on for 10 minutes with the ignition off, and a retained power feature, which allows the power windows, sunroof and sound system to be operated for up to 10 minutes after the ignition has been shut off.

Under the hood, there's now a

FIRST DRIVE

BUICK RIVIERA

● Heritage is a heavy burden. Cars bearing the Riviera nameplate have to carry a ton. So it is with this completely new 1995 edition. And you know what? This car can stand tall with anything that ever flowed off the pen of Bill Mitchell. Let's start under the hood. A whole new generation of 3800 V6 sits there pumping out a stout 205 horsepower. A supercharged V6 ups that to 225. That's more than the output of some V8s. No, it's not a tire-smoking muscle car, but you won't feel like Mr. Wimp, either, when the light turns green. Zero to 60 comes up in about 8.5



seconds, which is well ahead of Acura Legend times. Balancing the horsepower is one of the best-riding, best-handling cars Buick has ever built. The formula starts with a structural stiffness matched by few cars in the world, which provides a foundation for all the other chassis and driveline components. The end result is an extremely quiet, solid, tight car that doesn't shake and

shudder when the going gets rough.

And don't even think about a squeak or rattle. There's no such thing in this car. This is how a luxury car should ride. And handle. You want to push this car around on a mountain road—and the car feels like it wants you to. The Riv also likes to dress up on a Saturday night and go to dinner. Either way, you're going to enjoy the ride. —Joe Oldham

NEW '95 CARS

power-steering system that allows the driver to select between heavy, medium and light steering efforts via a dash-mounted switch.

Crown Victoria/Grand Marquis

These venerable heavy cruisers take another step toward the future with a new interior as well as new nose and tail treatments. Like the Town Car, these big rear-drive family sedans boast redesigned seats with more travel, new dashboards and revised door panels. The seats have been designed to not only provide more interior room and better ingress and egress than before, but also to provide a firmer, more supportive ride.

The exteriors look fresher thanks to new grilles, bumper fascias and a larger, wider trunk opening compliments of the new rear decklid.

Mechanically, these cars benefit from a wide-ratio 4-speed overdrive automatic transmission. The rear axle ratio has been changed from last year's 3.08:1 to 2.73:1 for reduced highway cruising noise.

Windstar

Ford finally entered the front-drive minivan market last March with its



FORD EXPLORER

Windstar. Launched as a '95 model, the Windstar rolls on through the fall introduction essentially unchanged—with some important caveats. That means that there is one size Windstar on the menu, one with a 120.7-in. wheelbase and 201.3-in. overall length, which makes it just a smidge longer than the Grand variety Caravan/Voyager. Standard equipment still includes dual airbags and 4-wheel ABS.

Soon, there will be a second engine choice. Besides the standard ohv 3.0-liter V6, there will be an ohv 3.8-liter as well. The larger engine ups horse-

power from 147 at 5000 rpm to 155 at 4000 rpm. It also increases torque while lowering the engine speed at which peak torque is available: 170 ft.-lb. at 3250 rpm versus 220 ft.-lb. at 3000 rpm. Both engines drive the front wheels through a 4-speed overdrive automatic. In addition to the added performance, the Windstar gets an important outlet for that performance: an upgraded towing package, which ups the ante from 2000 pounds to 3500.

Other running changes over the Windstar's first year will be an optional integral child safety seat, a leather



FIRST DRIVE

CHEVROLET CAVALIER

● Cavalier, since its introduction in 1982, has remained largely unchanged in the midst of a small-car market segment that's seen some of the most vicious territorial battles since, well, yesterday's 6 o'clock news. And it's commanded a healthy proportion of sales in that segment. Enter the new Cavalier, carrying all the virtues that carried it through previously, as well as a host of improvements. Start with a new, stiffer chassis under the new svelte bodywork,

with 2 in. more track and 3 in. more wheelbase (although overall length is 2 in. shorter). Payoff for that is more interior room, especially hip-and-shoulder room, as well as rear-seat legroom. Suspension refinements include stainless-steel-and-Teflon suspension bushings on some models. That payoff is improved ride coupled with more precise handling.

Next add the hundreds of minor improvements from 100,000-mile spark-plug change

intervals to battery run-down protection to zoned rear-window defrosting. And it's all been done with a 28% reduction in the number of parts for economy and reliability.

Body-manufacturing processes have been improved with innovative manufacturing techniques. Some holes are actually cut with lasers, reducing distortion in the sheetmetal. Tolerances are so close that camber and caster settings are preset in design, obviating the need for adjustment down the road.

Three body styles are available for 1995—a 4-door sedan, 2-door coupe and a sporty-looking 2-door convertible. Gone is the Cavalier wagon, to the distress of some Chevy dealers we spoke to, who felt it was a hot seller. —M.A.



CHEVROLET CAVALIER Z24

upholstery option for the quad-seating interior and the ever-popular convertible seat/bed option.

Mustang

There's now a full regimen of this American original available—coupe and convertible in base, GT and Cobra versions. The Cobras are the work of Ford's Special Vehicle Team and sold through only 750 select dealers. The Cobra gets its motivation from a 240-hp version of the well-tryed 5.0-liter V8. That's a 25-horsepower bonus over the GT. The base model is powered by a 145-hp version of Ford's 3.8-liter V6.



CHEVROLET
TAHOE 4-DOOR

sis in the industry—a distinction and a chassis it shares with its sibling, the new Oldsmobile Aurora.

The stiff chassis is wearing a taut, svelte and head-turning new body. The Riv's stylistic sheetmetal wraps around a large, well-appointed 4-passenger cabin. Under the hood is one of two versions of GM's 3.8-liter V6 engine driving the front wheels through a 4-speed automatic transmission. The standard engine is the 3800 Series II, which puts out 205 hp and 230 ft.-lb. of torque. The faster option is a supercharged version of the 3800, which ups the power ante to 225 hp and increases that all-important torque output to 275 ft.-lb. Buick claims the supercharged Riviera can scoot from 0 to 60 mph in 8.5 seconds—not too shabby for a large luxury car, coupe or sedan.

To provide the ride and handling



CHEVROLET
BLAZER

PHOTO BY JERRY HEASLEY

GENERAL MOTORS

Even during the lean years of a decade ago when a reeling GM had no fresh models to introduce, the world's largest carmaker still made news with each refinement to its broad lineup. Well, for '95 it's a most robust GM indeed, one that has impressive new

models sprinkled nicely throughout its divisions, and the market.

Buick

Among the biggest news from GM has to be its classy luxury touring coupe, the Riviera. New from the wheels up, the Riv boasts one of the stiffest chas-

FIRST DRIVE

CHEVROLET BLAZER

● You'll see a split personality this year in the GM compact sport/utility twins, Chevrolet Blazer and GMC Jimmy. The new models are completely redesigned for 1995, with emphasis on ride quality, noise reduction and exterior styling. The personality split shows up in the difference between 2- and 4-door models. Two-door models are designed to be sporty vehicles, while luxury is the accent in 4-doors.

You don't have to be sharp-eyed to see that the front ends of the vehicles are lifted from GM's small pickup trucks. Hoods sag at the front, grille inserts are identical as the cab section is lifted directly from the small trucks. By copying the pickup-truck styling, Chevy and GMC provide a familiar face for customers and at the same time save gobs of money



PHOTO BY JIM FRIEDMAN

that was not needed for new styling.

From the cab rearward, the body and glass offer a softer, more rounded appearance that sets the new vehicles apart from the stiffer styling of the older models.

Inside, it's more of the same. Instrument panels are copies of S-10 and Sonoma. Driving the new Blazer

and Jimmy, you notice a tighter body and quieter ride. The body stiffness is based on a stronger frame that uses box sections in its rails. Softer shapes to the exterior sheetmetal and more careful sealing in the doors cut down on wind noise significantly. But most noticeable is a quieter engine.

—Jim Dunne



CHEVROLET LUMINA

PHOTO BY KEVIN HANNA

that Riv owners have come to expect, the car has MacPherson struts in front and semi-trailing arms with coil springs in the back. The variable-assist power rack-and-pinion steering is electronically controlled.

The benefits of the remarkably stiff, industry benchmark 25 Hz (see "Engineering The '95s," page 56) chassis are that the suspension can pay all of its attention to keeping the wheels on the road without having to compensate for a constantly twisting chassis.

Standard equipment in the '95 version of the division's flagship includes

4-wheel disc ABS, dual airbags, dual-control automatic climate control, 6-way power front seats, cruise control, power windows and door locks, and remote keyless entry.

Chevrolet

While the advertising campaign may not talk about it anymore, the old heartbeat is quite vibrant these days, thank you. In fact, Chevrolet is showing a stronger pulse than it has for some time. For '95, the bow-tie division has an all-new Lumina midsize family sedan, Monte Carlo coupe, Cavalier, a full-size 4-door Tahoe as

well as a new compact Blazer. There's even a new Metro for the Geo wing of your Chevy dealer.

The new Lumina and Cavalier are news of monumental proportions. These two cars are totally redesigned, reengineered and restyled and they represent Chevrolet's re-entry into two of the most important market segments in the industry. And the cars clearly signify that Chevy's re-entry is a serious one.

The Lumina and the similar-beneath-the-skin new Monte Carlo coupe boast a stiff chassis for a very quiet, rattle-free ride. Power is from



FIRST DRIVE

PONTIAC SUNFIRE

● Don't think of the all-new Pontiac Sunfire as merely a Sunbird replacement. That wouldn't do this car justice. This is a whole lot more car than the Sunbird ever was and it rides that way. The substantial feel comes from a very stiff basic structure and a new suspension that features rear coil-over shocks and 14-in. wheels and tires. The guy who tuned this suspension should get a medal. Even the base suspension rides like a

much bigger car and handles well. Then there are two upgrades with 15- and 16-in. wheels and tires on the SE and GT models.

A brand-new 2.3-liter double overhead cam Quad 4 engine delivers a robust 150 hp at 6000 rpm and 145 ft.-lb. of torque at 4800 rpm, and is smooth as silk thanks to twin balance shafts. (By contrast, a Toyota Celica GT's engine is rated 135 horses.)

It's standard on the GT. Base engine is the trusty 2.2-liter push-rod motor rated 120 hp. Look inside the Sunfire and

you'll find a whole new interior with dual airbags to go along with the new exterior look. We can attest to the fact that the back seat is huge for a car of this size. But beyond the hardware, this is a great-looking car that sits squarely on the edge of the 21st century. And it's priced to make it one of the great bargains of '95.

—J.O.



SUNFIRE GT



CHEVROLET MONTE CARLO

either a 3.1-liter V6 or optional 3.4-liter dohc V6 (standard in the Monte Carlo Z34). The pushrod 3100 puts out 160 hp and 185 ft.-lb. of torque. The overhead cammer cranks out 210 hp and 215 ft.-lb. Both come attached to a 4-speed automatic.

Suspension is from struts at all corners of the car. All but the base Lumina feature 4-wheel ABS as standard equipment. ABS is optional on the base Lumina.

Both cars are available in two trim levels. Lumina comes as the plain, base Lumina or in LS trim. The Monte Carlo starts in LS trim and is also available in the hotter Z34 guise.

Regardless of trim level, all of these cars boast *beaucoup* standard equipment for their price. All have dual airbags, air conditioning, power door locks, variable intermittent wipers, tilt steering wheel, map lights and map pockets in the doors.

The Cavalier steps up into the '90s, more than a dozen years after it was

introduced. The new Cavalier is available as a 4-door, a coupe and a convertible. There is (for now, at least) no station wagon version. Regardless of body type, the new Cavalier boasts a 2-in.-wider track and a 3-in.-longer wheelbase than before.

Like all of GM's new models, the Cavalier has a stiff chassis. With reduced body flex, rattling, shaking and sloppy handling are all minimized.

The sedan is available in base and LS trim. The coupe adds a Z24 model to the other two and the convertible comes in LS or Z24 versions.

All but the Z24 are powered by a 120-hp 2.2-liter Four. The engine cranks out 130 ft.-lb. of torque. The Z24 option brings with it a 2.3-liter dohc Quad 4, and 150 hp and 145 ft.-lb. The base-model sedan and coupe come with a 5-speed manual transmission as standard equipment or an optional 3-speed automatic. The 3-speed is standard on LS versions. A 4-speed automatic is optional on

the LS sedan and Z24 models.

All Cavaliers have MacPherson struts carrying the front wheels and a twist beam with coil springs over the shocks at the rear. All models also come standard with GM's disc front/drum rear 4-wheel ABS. Other standard equipment includes dual airbags and folding rear seats. Moving up to the LS version brings with it air conditioning, variable intermittent wipers and a remote trunk release, among other features.

Besides the family car market, Chevy is taking a renewed run at the heart of the family sport/utility market with an all-new compact Blazer and a 4-door version of its full-size sport/utility, now named Tahoe. Formerly the S-Blazer, the Blazer boasts two totally new bodies—a 4-door and a 2-door. Regardless of the number of doors, the Blazer offers 2wd or 4wd in a choice of trim levels: both the 2-door and 4-door come in base and LS.

(Please turn to page 113)

FIRST DRIVE

GEO METRO

● We've always had a soft spot in our hearts for the Metro after driving one cross-country and getting an honest 56 mpg a couple of years ago. New throughout, the Canadian-built Suzuki-engineered 1995 Metro promises to provide similar thriftiness—and improved comfort to boot. It's bigger outside—2.3 in. taller, 2 in. wider and with a 3.9-in.-longer wheelbase. Interior headroom is up an inch, rear legroom 3 in.

Gone is the 5-door hatchback, supplanted by an attractive sedan, complete with a surprisingly capacious trunk and a surprisingly formal profile. The sedan also comes standard with a 70-hp sohc 1.3-liter 4-cylinder engine, which coupe buyers will have to order as an option—in lieu of the 55-hp 3-cylinder 1.0-liter



that's standard on Metro coupes. You'll have to get the 4-banger before you can check off the box for the 3-speed automatic tranny, too.

Another very welcome change is the 13-in. rims shod with 155/80 rubber, as the 12-in. skateboard wheels that earlier Metros came standard

with were simply too small to cope with potholes.

To address safety concerns, the '95 Metro sports standard dual airbags, daytime running lights (the better to be seen), childproof rear door locks (on the sedan) and optional ABS. —M.A.

ENGINEERING

There are plenty of new wrinkles and innovations on new vehicles and carryover models.

BY PAUL WEISSLER

● As the inimitable Yogi Berra is supposed to have said, "It's déjà vu all over again." As fast, furious and exhilarating as the new-car introductions from the domestic carmakers are these days, the engineering labs are running at close to warp speed—just like in the glory days of yore. It's all fascinating—and ultimately critical to the success of both the new and carryover models. Here's a maker-by-maker rundown.

CHRYSLER CORP.

This is Chrysler's year for containing crash damage—damage to people, to grilles, even to engine parts.

Crash-resistant engine

Overhead-camshaft timing belts are improved, but they still are more likely to fail than a chain. However, since belts are quieter, Chrysler has used belts for its overhead-cam engines for years. Those engines, however, had enough piston-to-valve clearance to prevent the pistons from crashing into the valves should the belt snap. However, because of tighter emissions controls and the need for more performance, that lovely "freewheeling" safety cushion came to an end in '95



Olds Aurora gets a high-tech 4.0-liter aluminum V8 with four chain-driven cams and 32 valves in place of the Buick Riviera's pushrod V6. Olds engine makes 250 hp.

on the new 2.0- and 2.4-liter 16-valve Fours in the Neon, Cirrus and Stratus.

Other manufacturers have built plenty of engines that didn't have that freewheeling clearance—leaving the

poor customer with a ruined engine. Of course, the belts generally don't break until the engine's out of warranty, so what's the problem?

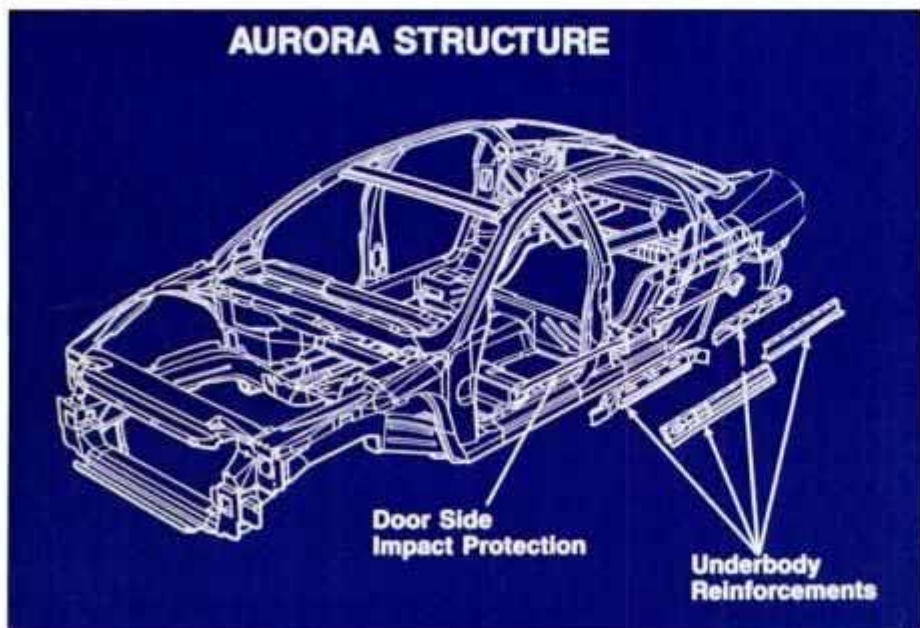
In truth, a belt will often stretch and jump a tooth or two just before it snaps, giving you a clue first. So Chrysler took some additional steps, both mechanical and electronic, to hopefully dodge the problem.

- The belt cover is well sealed, particularly at the bottom. The cover's bottom is a potential entry point for moist road film, which not only degrades the belt, but may freeze on the sprockets, causing a belt to jump time.

- There's a dual-action belt tensioner, a spring that keeps the belt lightly tensioned even with the engine off and a hydraulic piston (pressurized by engine oil) that adds tensioning force with increasing engine speed.

- Slight recesses in the piston head provide enough clearance for a 2- or 3-tooth jump. On-board diagnostics read both crank and cam sensors so the computer knows where the camshaft should be relative to the crankshaft. If there's a change indicating a belt jump of even one tooth,

AURORA STRUCTURE



The Aurora unitbody was designed to be rigid and to "tune out" vibration. This structural integrity improves ride quality, handling and resistance to squeaks and rattles.

THE '95s

the computer turns on the CHECK ENGINE light to warn you.

- Valve stems are thin and light (6mm dia.). Engineering tests show that even if a piston crashes, it will survive. And a wrecked valve can be removed from the guide, the guide serviced and a new valve installed, saving the head.

The crash-resistant grille

Chrysler has also built crash resistance into a more noticeable part than the engine internals. The grille on the nose of its new Cirrus may look like a standard chrome grille, but it's a plastic/metal grille. And it can take a substantial hit and recover fully. The Cirrus grille survived crash tests as high as 30 mph.

The base of the grille is a special General Electric plastic, very flexible but warp resistant so the vertical grille bars will align. A metal powder is applied and the surface is acid-etched, so it looks like pure chrome—even to strong magnification. The

metal particles actually are "islands" in the surface—they don't



Chrysler's Neon and Cirrus dohc engines have sealed camshaft drivebelt housings and skipped-tooth software to reduce the chance of a broken belt trashing the motor.

touch each other—which gives the "metal" grille the ability to flex without dents or cracks. A clearcoat paint goes over the metal. Even a deep scratch through the clearcoat will not "spread," as rust would on a chrome grille. And, unlike chrome, this grille can be painted.

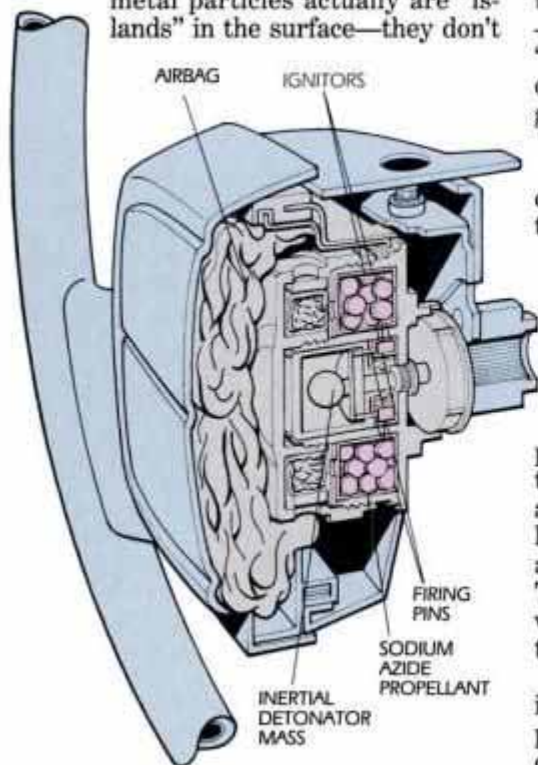
call or write our office asking where to get one—when they're available we'll let you know.

GENERAL MOTORS

Money is tight at General Motors, so the days of throwing dollars at dazzling engineering projects are over. For '95, GM is spending prudently on continuous improvement for high-volume powerplants, including the 3.8-liter pushrod V6 and the 2.3-liter Quad 4 twin-cam.

The Quad 4 gets in-the-oil-pan balance shafts. A high-performance oil pump is driven off one of them. The new shafts are the latest in a laundry list of engine smootheners that GM has been incorporating in this engine for the past several years.

The Quad 4 also gets a power-steering pump that is driven off the rear of a camshaft, eliminating the uneven bearing loads of a belt drive. Eighteen parts (primarily bracketry and hardware) are removed. This is similar to the setup already used for the water pump at the front of the engine. With



Cherokee's mechanical airbag system uses an inertial mass to ignite the propellant.

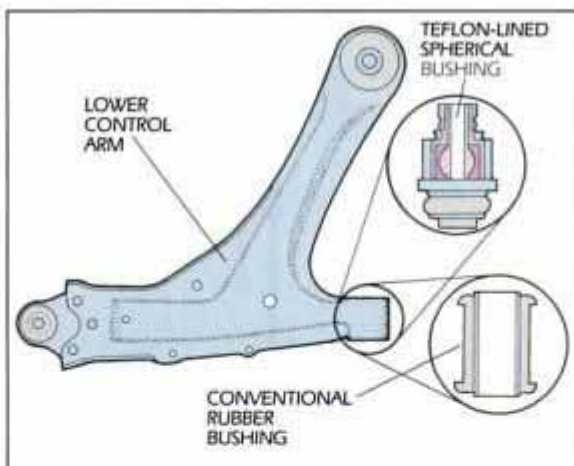
Crash-resistant occupants

The first U.S. application of an all-mechanical airbag will be used on the '95 Jeep Cherokee. The device is contained in a single module in the steering wheel. In case of an impact, the ball-shaped weight that is the airbag trigger/sensor slams into an arm linkage with firing pins. The linkage pushes the firing pins into an ignitor material, setting it afire. The flame spreads to sodium azide, which produces the gas that inflates the airbag.

Aftermarket companies are working with Breed Automotive, which produces the airbag. So although you can't do it now, there's a good chance retrofit packages may be available soon for many vehicles. Please *don't*

this system, GM now prevents a lot of the vibration from engine accessories that used to shake around on the end of rubbery brackets. There's also the added savings of the cost and weight of the brackets, belts and pulleys.

The new version of its 3800 pushrod V6 not only will rev to 6000 rpm, but it will produce a solid 205 horsepower along with its credible 230 ft.-lb. of torque—35 horsepower and 5 ft.-lb. more than the previous edition. Pushrods may not be glamorous, but the 3800 is a lot more compact than its overhead-cam competition, so it fits into less engine compartment space. And the low-end torque is just right for the Buick, Oldsmobile and Pontiac sedans and vans in which it's used. Buick even installs it in the new Riviera.



Teflon-and-steel spherical bushing replaces rubber on Chevy Cavalier upscale model's front suspension.

Even the base Saturn engine is up in '95, from 85 to 100 hp. However, this sohc 1.9-liter Four still is ultra-conservatively tuned at barely over 52

There's no single secret to making a car that won't creak and rattle, but a "tone deaf" chassis is a great starting point. Chassis stiffness is measured in Hertz, and a high-Hertz chassis is sort of tone deaf. That is, more resistant to "humming" or vibrating in response to such inputs as road bumps and driveline vibration.

A high-Hertz chassis also flexes less during hard cornering, and holds its suspension tune better, so the ride and handling are consistent.

GM's new front-drive G-bodies, led by the Olds Aurora and Buick Riviera, are rated at 25 Hertz.

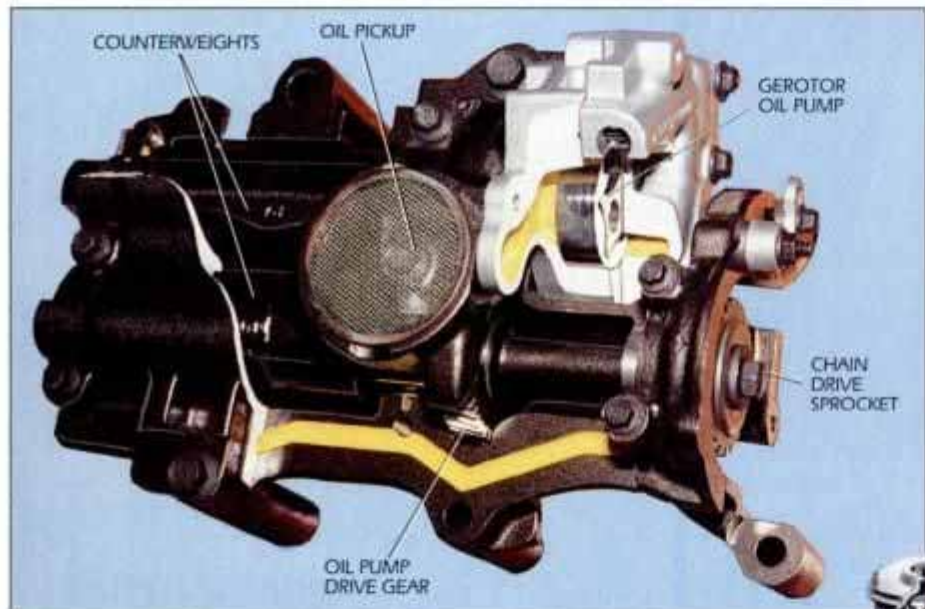
That's equal to what the world leader, Mercedes-Benz, has consistently been able to produce, and substantially better than some of the teens that have borne GM labels in recent years. There are other super-stiff cars, but they generally are much shorter than the 114-in. wheelbase, 205-in.-long GM models, and it's obviously easier to build stiffness into a shorter box.

Yes, there's more metal at some G-chassis joints, but with today's fuel economy standards, you can't just build a tank. Rather, GM's high-Hertz platform was designed to get stiffness primarily with engineered metal shapes, first developed and evaluated on computer.

Also, GM integrated some of the most-needed metal shapes into the styling of the car where necessary. For example, Aurora has exposed roof rails that serve both as structural members and outer surfaces of the car. They can be larger than if they only were structural members, and so add strength with less weight. The G-bodies are big cars, but weigh in at just 4000 pounds.

GM is using a high-tech plant with new metal-forming equipment that can reproduce the high-Hertz shapes precisely. All GM's top-line models will be going onto the G-chassis in the next several years, and you can look forward to continued tweaking to push the Hertz even higher.

Although the Riv is using

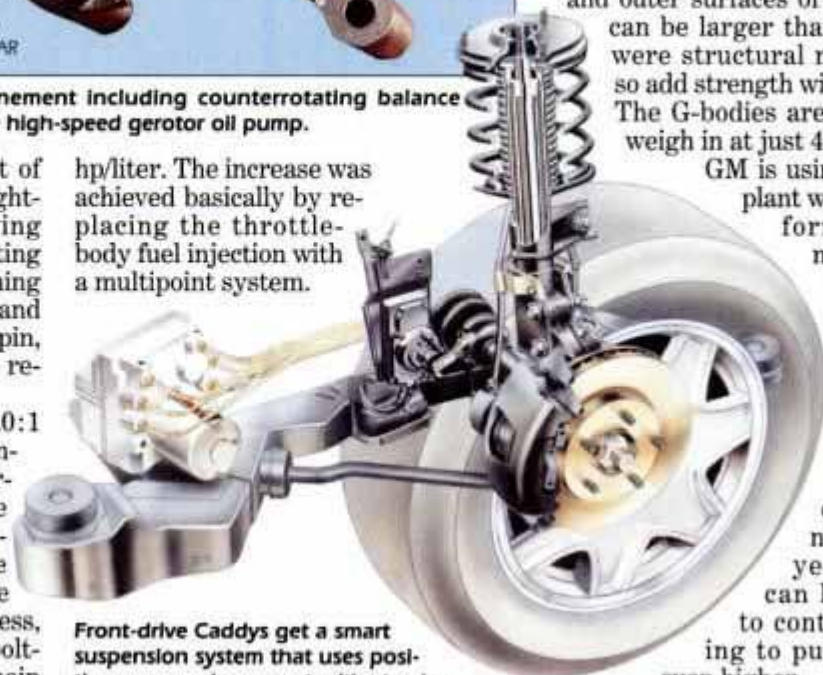


GM's Quad 4 engine gets more refinement including counterrotating balance shafts that share a chain drive with the high-speed gerotor oil pump.

How does GM get so much out of this old design? Yes, it uses its lightest-weight, lowest-friction moving parts—and for '95, adds a full-floating piston pin. This design takes retaining snap rings at each end, a bushing, and more machining than a pressed-in pin, but it lets the pin turn and move, reducing friction.

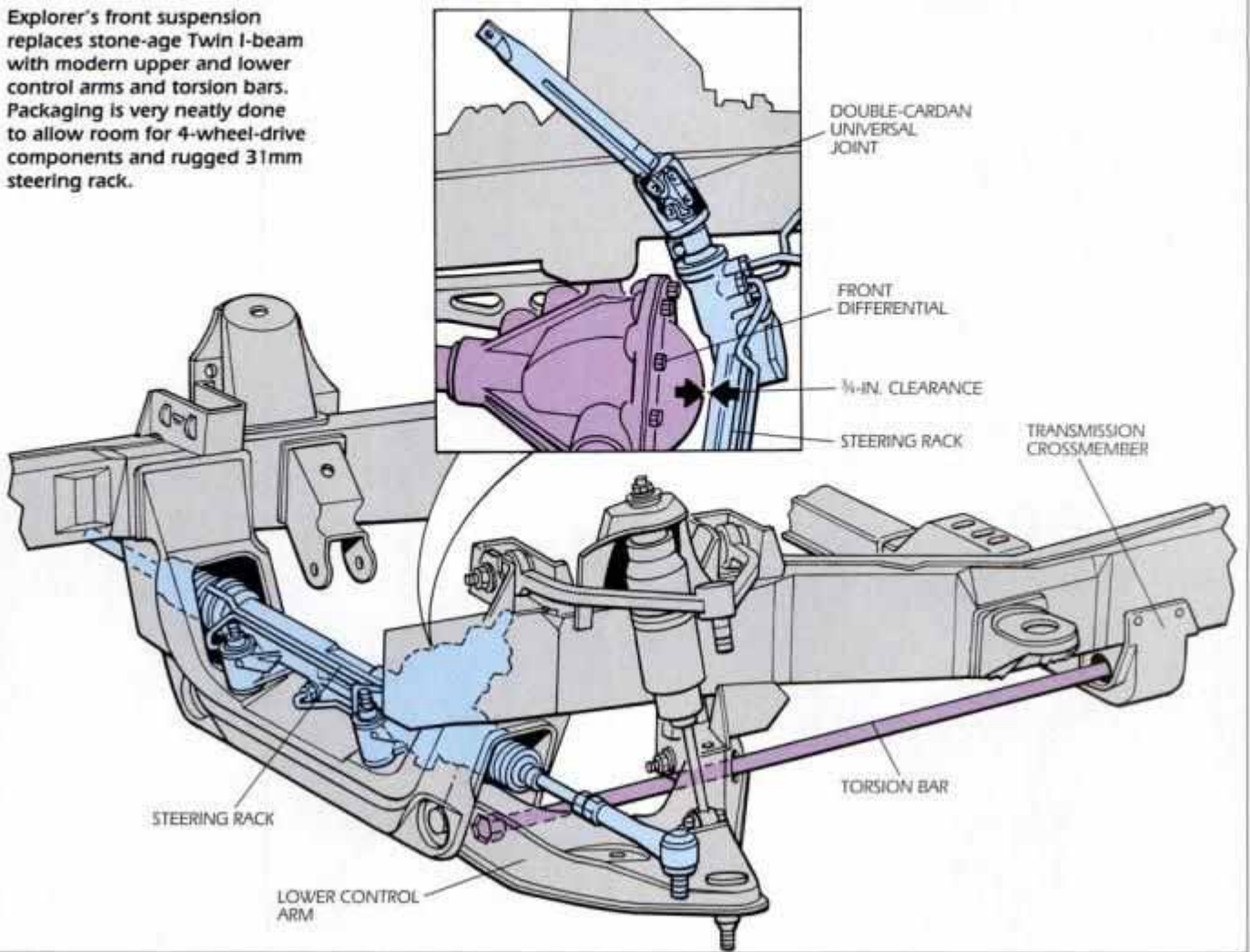
Compression ratio is up from 9.0:1 to 9.4:1, but an additional knock sensor helps stop pinging under marginal conditions. The runners of the ultra-smooth plastic intake manifold were retuned and the throttle body enlarged, to further improve airflow. And for bottom-end stiffness, main bearing caps now are cross-bolted, using four bolts to hold each main cap down instead of only two.

hp/liter. The increase was achieved basically by replacing the throttle-body fuel injection with a multipoint system.



Front-drive Caddys get a smart suspension system that uses position sensors, in concert with steering-angle sensors and ABS data, to refine the ride.

Explorer's front suspension replaces stone-age Twin I-beam with modern upper and lower control arms and torsion bars. Packaging is very neatly done to allow room for 4-wheel-drive components and rugged 31mm steering rack.



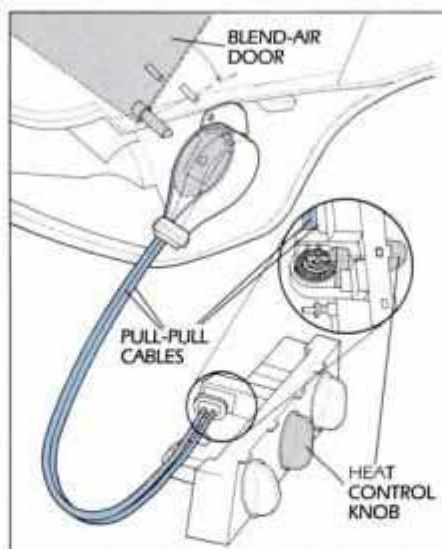
PM ILLUSTRATION BY RUSSELL J. VON SAUBERS

the 3800 V6, Olds went for V8 power, with a 4.0-liter V8 based on the 275-300-horse 4.6-liter Northstar V8 in Cadillacs. It has a 1/4-in. smaller bore, but shares virtually all general characteristics with the Northstar, including four valves per cylinder, direct ignition (no plug wires) and a 10.3:1 compression ratio. The Aurora engine produces 250 horses at 5600 rpm, and 260 ft.-lb. of torque at 4400 rpm. All V8s in the group share the same high-torque electronic transaxle.

Cadillac's Northstar V8 gets a power boost, from 295 to 300 hp for the Eldorado Touring Coupe and Seville STS. The increase is credited to a modest reshaping of the intake manifold. A 275-horse version is used on other front-drive models—except the base De Ville, which continues (for its last year) with the 4.9-liter V8.

Cadillac added stiffening braces to the Northstar and thinks the 4.6-liter V8 is so smooth that it's wired in an electronic module to prevent that annoying buzz-saw noise you get when someone tries to start an engine that's already running.

The '95 Northstar-equipped models



Pull-pull cables and geared knobs mean smooth operation of Ford F-150 heater control mechanism.

get a chassis control system that finally matches the performance of the engine. It's called Integrated Chassis Control, and it combines Caddy's road-sensing suspension (which has electronically controlled shocks) with antilock braking/traction control. It's

sophisticated and takes the chassis controls to a logical next level.

There's a steering-wheel sensor, so the computer knows when the car is in a bend, and combination wheel sensors that signal road-texture changes and lateral acceleration. Along with readings from the wheel-speed sensors for the antilock/traction system, the ride electronics know enough to control the shocks and ABS more precisely under hard handling conditions. For example, the electronics now can maintain close control of traction and ride when the driver pushes the car hard into a turn and is on the hairy edge of losing it.

There's also a lot of change that reflects modest investment in some new approaches. Some developments finally solve old problems.

- The defogger grid on Chevrolet Cavalier and Pontiac Sunfire has three zones. The juice first clears the center of the rear window, so you can see something. Next, a second zone "frame" enlarges the first, and finally the rest of the glass is cleared. It's done simply by tailoring thicknesses

(Please turn to page 124)



PM PHOTOS (TOP) BY BOB COOK

PISTON-PACKING SHOWDOWN

Monster machines and monster machismo collide at the National Championship Air Races.

● The sound is unlike any other. A menacing, mechanical howl that results only as a high-octane river of gasoline ignites within a huge aluminum block, thereby unleashing stupendous energy that, channeled through canoe-size blades, propels the whole assemblage forward. Rapidly.

Once this sound filled the air during the Battle of Britain. Today it echoes over the high desert outside Reno, Nevada, during the Battle of Speed. Although formally titled the National Championship Air Races, those who care abbreviate the four days of piston-powered glory to "Reno."

Race week at Reno/Stead Airport is a full-sensory spectacle of big engines, big money and big ego without a wink of pretension about advancing motive science or mankind or whatever. What Reno is about is going fast, and no mechanized competition comes

BY WILLIAM GARVEY

close to it in terms of sheer balls-out zoom. When Reno's celebrated Unlimited racers stampede down the straightaway, the much-modified P-51 Mustangs, Sea Furies, F8F Bearcats and even an ex-Soviet Yak-11 are pushing 450 mph. And their prop tips are blaring a supersonic song.

Welcome to the fastest motorsport on Earth. And one of the last great amateur motor contests in the world. For despite the speed and color, the passions

and rivalries, the Reno air races have yet to attract big-time media and sponsorship, and quite likely never will.

As one racer observes, "It's a hard sport to televise, and it doesn't attract sponsors like car races. After all, if you're driving a Ford, that sells Fords. But if you're flying a P-51 or a Yak... well, who wants a Yak?"

Consequently, the pilots, owners and crews invest small fortunes and



Revitalized warbirds—all endangered species—rendezvous at Reno.

PISTON-PACKING SHOWDOWN

years of labor—and put priceless equipment and lives at risk—knowing full well that they'll never be compensated with finance or fame. First-prize money for the Unlimited champ is about \$60,000—maybe half the cost of a blown engine.

These races are not about money. They're about something else. Try to imagine sitting alone, barely in control of a screaming, trembling machine. Sagebrush is shooting by like rockets, and you're a burp above the dirt with a pylon dead ahead and rivals a few feet above,

behind and below you. The controls are stiff as concrete. You can't hear a thing above the din. And all indications suggest your mount is about to explode. Having fun yet?

"Well, yeah." So says longtime racer Bob Yancey. "It's a different world when you're close to the ground and motoring. I'm nervous when I go down there. The turbulence will scare the devil out of you. But it definitely gets the adrenaline going. It's a rush. There's no question about that."

Ditto from 3-time champion Bill "Tiger" Destefani. "There's a lot going on in that cockpit and it takes

1000% concentration." Indycars have their appeal, says Destefani, but "I just got hooked on racing airplanes."

Out of the past

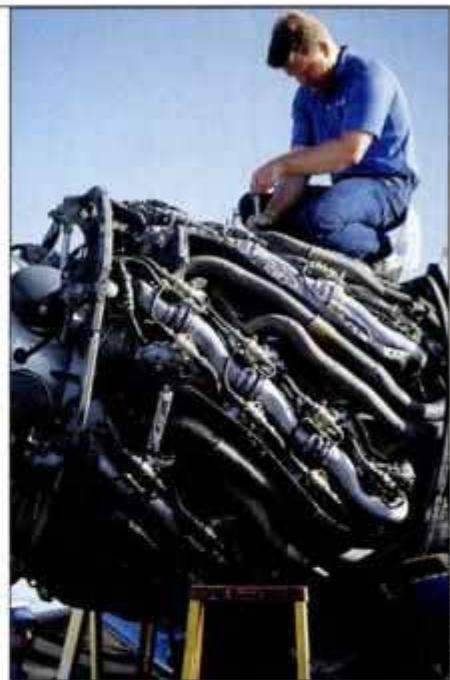
The addictive sport goes all the way back to the Wright brothers and reached its peak during the 1930s. World War II put an end to it all: Suddenly high-speed planes were everywhere, and there was nothing sporting about them. It wasn't until 1964 when Bill Stead, a Reno rancher/pilot/hydroplane racer, decided it was time for the lions to roar again. And when the checkered flag dropped on the Unlimited finals—Czechoslovak defector Mira Slovak took first place in Stead's own Bearcat—40,000 spectators cheered.

This year, organizers expect 150,000 people to visit between Sept. 15 and 18. The racing comes in four categories, every one of which is piston-powered. The Formula Ones weigh in at a minimum 500 pounds, packing fixed gear and 100-hp Continental engines. Next are the baby Biplanes, all powered by 180-hp Lycomings. After that come the AT-6/SNJ's, fat WWII trainers pulled by 650-hp Pratt & Whitney radials. And at the head of the flock fly the Unlimiteds, whose only requirements are that they be piston-powered, prop-driven and able to withstand 6 g's.

Of the four groups, the little Formulas and the big Unlimiteds boast the most variety and draw the most interest. Design ingenuity is the hallmark of the former. This year, Jon Sharp hopes to reassert the dominance of his *Nemesis*, an all-carbon computer-sculpted Formula One sprinter. The reigning 3-time champ in its class, *Nemesis* is the fastest 4-cylinder machine on the planet. Its clean-slate design may herald racing in the century ahead.

Top of the props

But while every category has its fans, the machines that attract the most devotion are those that make the most noise—the Unlimiteds. To witness the belch-blating, blue-smoke awakening



PM PHOTO BY RICH COX

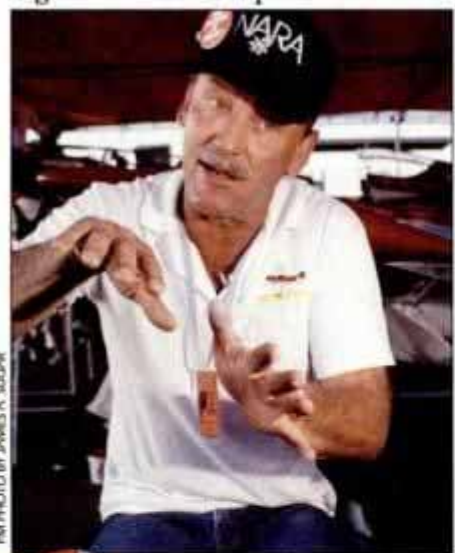
Air-cooled radials are tuned up to the max.

of a V12 Rolls-Royce Merlin is a jaw-dropping experience. Consider this: When sent to war, a Merlin was rated at 1400 to 1800 hp and had a maximum allowable manifold pressure of about 67 in. At Reno, pilots run those same engines at 135 in. of pressure, pulling upward of 3800 hp. The Unlimiteds blow a lot of engines, but oh, what a sound before they go.

This year's Gold Sunday—Reno's climactic race—promises an honest-to-goodness duel between two extraordinary dinosaurs. The title fight at Reno '94 is a grudge match, pure and simple.

The showdown has its roots in the 1992 Gold race. Lyle Shelton had won the crown four straight years in his Grumman F8F-2 Bearcat *Rare Bear*. He wanted five. Bill Destefani, owner and pilot of the North American P-51 Mustang *Strega*—and the man from whom Shelton snatched the crown—was determined to win it back.

Shelton laid down the gauntlet with a qualifying speed of 483 mph—still a Reno record. Although Destefani couldn't match that performance, days later



PM PHOTO BY JAMES A. SUGAR

Bill Destefani and his bewitching Mustang *Strega* are the team to beat this year.





and halfway through the 8-lap final, it was *Strega* out in front with *Rare Bear 2* seconds back and challenging. At that moment—with the lead almost in hand—the Grumman's mill began to bang. Shelton pulled back the throttle, but it was too late. Nine of his engine's 18 connecting rods snapped. He was done and had to dead-stick it back down. Destefani was king that year and the next while Shelton rebuilt his broken Bearcat.

Now, having invested \$135,000 in rebuilding his engine—he says bad gas scorched his cylinders, and he's still mad about it—Shelton is ready to climb back on top. "It's going to be close," he predicts, and Destefani seconds that.

Fading glory

That these men and machines are Reno's giants underscores the tentative status quo of the sport. Lyle Shelton, an airline retiree, is 61 years old. When Grumman delivered his Bearcat to the Navy, Harry Truman was commander-in-chief. Similarly, Destefani and his Mustang were both created about the same time—1945.



Unlimiteds (top) reflect racing's past, while Formula One *Nemesis* looks to the future.

Don't misunderstand. These are superb pilots with the stamina to withstand the punishment unique to low-level flying in high-torque machines. What's more, the airplanes have been modified

and rebuilt so often that every part is virtually new.

But every year the warbird population dwindles. It's inevitable. And two of the boldest attempts to circumvent the problem—the Bert Rutan-designed *Pond Racer* and the P-51 lookalike *Tsunami*—were themselves lost in separate fatal accidents. While there's talk of new categories, such as T-28s and Unlimited Homebuilts, there's no clear successor to today's fire breathers. Says Shelton, "It's possible that Unlimited racing with warbirds may have peaked out in the last year or two."

Perhaps. But over two dozen of the beasts are mustering again this year. And the fact remains that as long as two are left, to quote the Reno starter, "Gentlemen, you have a race." **FM**



Lyle Shelton's record-smashing *Rare Bear* could recapture the crown.

IS STEREO

The new sound of music isn't traditional 2-channel stereo. Advanced recording technologies are making compact discs sound like live performances.

BY STEPHEN A. BOOTH, Contributing Editor

- The sound of music at home is about to blossom beyond the familiar 2-speaker stereo to something more like the aural ambience that surrounds you at a live performance. And the beauty of this new listening experience is that it comes built-in on the CDs, tapes and other sound sources that play through your existing home-entertainment gear.

One approach to this new 3-dimensional sound experience hails from familiar Dolby Surround. Another route is being newly mapped by Spatializer Audio Labs. Fortunately, both paths lead to the same place and actually complement one another, so rather than forcing you to choose between them,



DEAD?

they'll actually expand your options for enhanced musical enjoyment.

For nearly a decade, electronics manufacturers have been offering Dolby Surround decoders, either as stand-alone products or built into audio amplifiers and receivers. So-called audio/video components perform double duty. You can use them to hear music in 2-channel stereo, yet enjoy a movie in surround sound at home by connecting your TV and VCR to the Dolby-equipped stereo gear and adding loudspeakers for the rear "surround" channel and front "center" or "dialogue" channel.

According to Dolby and other sources, the surround-sound home-theater concept has sold well. Some 10 million Dolby Surround components are in homes worldwide—nearly a million shipped during a 3-month period in 1993 alone. In the United



IS STEREO DEAD?

States, four out of every five receivers purchased last year had Dolby Surround. Entry-level models from many brands sell for as little as \$250. Lately, even the hassle of running wires to rear speakers has been addressed. JBL's Magic 2 SoundEffects package uses radio waves for the job. Other companies, such as Arkon, transmit wireless on infrared light.

With Dolby home-theater gear so widespread, record labels are now beginning to issue CDs and tapes in Dolby Surround. The elegance of Dolby encoding is that it's compatible with equipment that lacks a decoder. If you play a videotape in a monaural VCR, you hear mono through your TV's speaker. Play a Dolby Surround CD on a regular stereo and you hear the music in stereo through the left- and right-channel speakers in front of you. The Surround information resides quietly in the left and right

never been quiet: Three-dimensional ambience is too much of a good thing. Witness the success of Dolby Surround systems for movie theaters, introduced at about the same time as quad sound. To date, more than 4200 movies have been produced with the Dolby system.

Hoping to equal the success of Dolby is a sound process breaking onto the recording scene that delivers 3-dimensional ambience through conventional 2-channel stereo gear—another no-lose proposition for the music labels and music fans.

It's called Spatializer, and it accounts for the depth and atmosphere you hear when Bonnie Raitt's *Longing In Their Hearts* plays through your car or home stereo system. Ed Cherney, who engineered the album, says he used the Spatializer technology selectively and sparingly.

"For percussion, I spread the sound

gineer Michael Bishop notes that the processing has to suit the material, and he makes a distinction between ambience recording and what he calls cinematic surround sound.

"On the *Lerner & Lowe Songbook* with the Cincinnati Pops Orchestra, you just want to capture the ambience of the hall. You don't want trumpets running around your head—that doesn't happen when you're sitting in a Broadway musical," says Bishop.

"On the other hand, we've used effects more extensively when recording *Great Fantasy Adventure* because the music comes from movies like 'Jurassic Park,' 'Terminator,' 'Robin Hood' and 'Hunt For Red October.' With cinematic surround, you look for multilayered sound and maybe have some fun with spectacular effects."

Indeed, on the CD's *Robin Hood* track, arrows whistle past your left and right ears, then slam into a target behind you while a third Spatialized arrow scores a stunning bull's-eye.

Spatializer is the brainchild of Stephen Desper, veteran recording engineer for the Beach Boys, who spent 20 years researching and developing the psychoacoustic techniques it employs. Actually, there are two kinds of Spatializer.

One is a piece of studio equipment used in the recording and mixing process. This is the Pro Spatializer, and the ambience and special effects it captures will be reproduced intact when the recording plays through any 2-channel gear. In other words, no decoding gear is needed. Whether a tune is broadcast on your car stereo or you play a CD through your home system, you'll hear what the Pro Spatializer engineer recorded. If you were making a tape copy of the music, you'd get the Pro Spatializer effects on the dupe, too.

The other kind of Spatializer is a circuit built into home and portable music gear, which is slated to make its debut later this year. This user-selectable feature will give Spatializer's ambience effects to anything you play—that is to say, even music that hasn't been engineered with the Pro Spatializer. If you were making a tape copy with the Spatializer circuit switched on, you'd get the effects on your home recording.

Don't worry about overkill—it's a smart circuit, according to the company. If you play a Pro Spatializer CD with the Spatializer switched on (or even if it's coming in on the radio), the circuit will sense the already-Spatialized music and bow out temporarily. It won't double-Spatialize—whether you're just listening or making a recording.



Engineer Ed Cherney using Spatializer (right) on Bonnie Raitt's latest album.

stereo tracks, and only appears when it passes through a Dolby Surround decoder on its way to the surround-channel amplifiers and the extra "ambience" or "effects" speakers at the rear or sides of a room.

Because of this hardware compatibility, music labels face none of the risks of the multiformat quad days.

Quadraphonic sound never took off in the 1970s because music lovers were asked to choose among three competing and incompatible systems. As the record companies learned, people were not about to invest in one manufacturer's system and four speakers when favorite artists were spread out among three formats.

Quad was also gimmicky. Some recordings had too much sonic silliness. Nobody expects a drum set to pick itself up and race around a room or a guitarist to play alternate riffs behind each of your ears.

Though quad died, the grave has

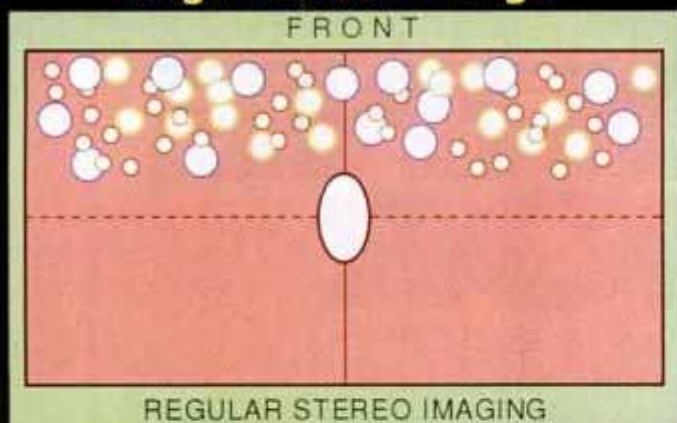
out so it seems to come from beyond the left and right speaker boundaries," explains Cherney. "I used Spatializer on Bonnie's vocals to make them appear to come forward and create a different dimension from the other instruments," he adds, noting that the vocals appear louder yet don't overpower the background vocals.

Cherney's use of Spatializer is illustrated on the album's first song, *Love Sneakin' Up On You*. In the middle of the song, Cherney took the mono feed from one instrument, the harmonium, panned it forward and widened its sound. Cherney later collapsed the stereo image to add drama to Bonnie's solo on slide guitar.

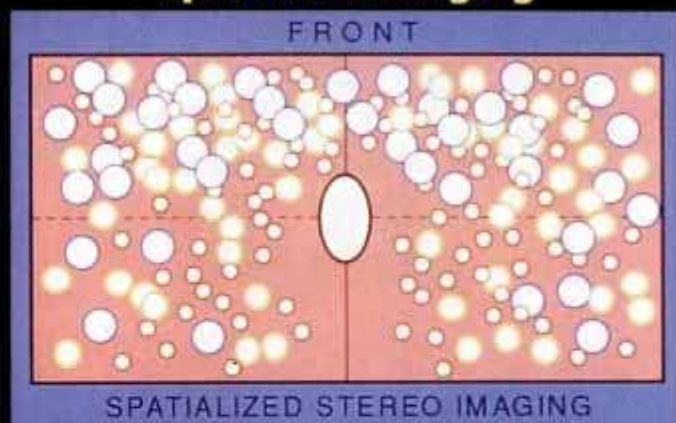
"It was very effective because I could get more space and definition in the mix, but it wasn't noticeable that I was doing anything," explains Cherney.

Spatializer has seen considerable use at Telarc Records, a classical label known for its superb recordings. En-

Regular Stereo Image



Spatializer Imaging



With standard stereo recordings, the music comes from either the left or right channels and the sound remains in front of you.

Spatializer creates more depth and allows the sound to reverberate around you as in a concert hall.

Spatializer even makes a provision for Dolby Surround. At first, it's likely the Spatializer circuit will be incorporated only in 2-channel (read non-Dolby) equipment. Accordingly, the chip would read Dolby Surround material like any other 2-channel program, then apply Spatializer processing. Because the surround channel of the Dolby recording hasn't been decoded, the circuit can't Spatialize it.

Nor will it, should a manufacturer eventually put a Spatializer processor in a Dolby Surround component. As in the case of Pro Spatializer material, the Spatializer chip senses the presence of existing surround-sound information and steps out of the signal path to avoid overprocessing it. As for playing Spatializer material—Pro or home-grown—through a Dolby Surround system, Spatializer says the multichannel reproduction will only enhance the experience.

In addition to music, Spatializer processing has applications for computer multimedia and videogames. It's already been used for telecasts and videos, as in MTV's awards programs and a variety of animations from Warner Bros. The company notes that the process even yields a less-constricted sound when played through monaural equipment.

As far as equipment goes, Dolby Labs says that a surround setup for music is the same as for video home theater. It doesn't matter that the bandwidth of the rear "effects" channel is limited to about 100 hertz (Hz) to 7 kilohertz (KHz)—compared with 20 Hz to 20 KHz for the front stereo channels—because this range is adequate for reverberant sound.

Recommendations for amplifier power remain the same, too. Given similar loudspeakers for all channels, Dolby asks for equal power to the left, center and right channels in front and the same wattage divided between the speakers for the rear channel. Receiver manufacturers seldom

supply equal amplification to the rear—usually it's a fraction, on the assumption that people use smaller, less power-hungry speakers in the rear.

Spatializer doesn't place many demands on equipment manufacturers—all that's needed is good stereo channel separation. This means sound intended for one channel shouldn't leak into the other. According to Spatializer, 25 decibels of separation is adequate, and most home and portable equipment and FM stereo radio deliver at least that.

Dolby says some 400 music recordings are available in Dolby Surround. Pro Spatializer, meanwhile, has been in the studios for about a year now and the recordings are just beginning to hit the CD racks.

Of the Dolby Surround titles, about 150 come from the RCA Victor label alone. Besides *The Celtic Harp*—this year's Grammy winner for traditional folk, by Ireland's The Chieftains—the bulk of these CDs come from RCA's deep vault of movie soundtracks, stage musicals and classical recordings.

Much of the theatrical and show-tunes music was originally produced as Dolby Stereo movie soundtracks. Other catalog titles come from older multitrack recordings deemed suitable for remixing in surround.

By and large, there isn't a lot of pop music yet in Dolby Surround. This has as much to do with creativity as economics. It's easier to issue classical and jazz in surround because they've

always been recorded with an ear for the acoustics of the performance space, or at least for simulating the aura of a smoky jazz dive or an orchestra at Carnegie Hall. But rock is a victim of its own success—electronics—be it the electronics of a stadium PA system or the electronic vacuum of the studio. If rock ever had an acoustic of its own it was the garage or basement where groups like the Beach Boys and the Lovin' Spoonful wrote the book on open-reel.

In Dolby Surround, probably the biggest pop noise to date is Emerson, Lake and Palmer's *Pictures At An Exhibition*, re-recorded in surround last year for the 4-CD anthology *Return Of The Manticore* (PolyGram), and also available as a CD single on the Kore label.

The K-O in Kore stands for Keith Olsen, the legendary producer who is surround's most passionate apostle to the pop field, and with some 85 million record sales behind the brag. One point that Dolby Labs, Olsen, artists and labels seem to agree on is that surround should be used only where it enhances the music—not as a sales gimmick.

For example, on The Chieftains' *The Celtic Harp* the only audible effect of surround processing is added richness. Telarc's Bishop, who works with both Dolby and Spatializer, echoes the mantra of every other proponent of multidimensional sound.

"If the processing is properly done, you don't notice it's there until you take it away." **FM**



Rear speakers such as JBL's Magic 2 model avoid wires by using radio waves.

AIRBORNE ARMOR

Lightweight but lethal, the Armored Gun System will throw new muscle behind America's rapid-deployment punch.



BY GREGORY T. POPE,
Science/Technology Editor

● War sounds like a tank. From a cannon's thunderclaps to the jackhammer chatter of a coaxial machine gun to the throaty blare of engines, mechanized cacophony is the voice of armored combat.

But for America's airborne regiments, tank warfare is adding a new racket to its repertoire. To hear it, take the gunner's seat in the XM8 Armored Gun System. Let your finger stab at the white fire-control computer. A sudden racket will erupt at your left ear. Loud, clean and fast—like a confident drum flourish—it's a sound that has rocked naval gunners for years. But the slam-bang of an automatic loader is a novel noise for an American tank crew. Then again, the Armored Gun System is a novel piece of equipment.

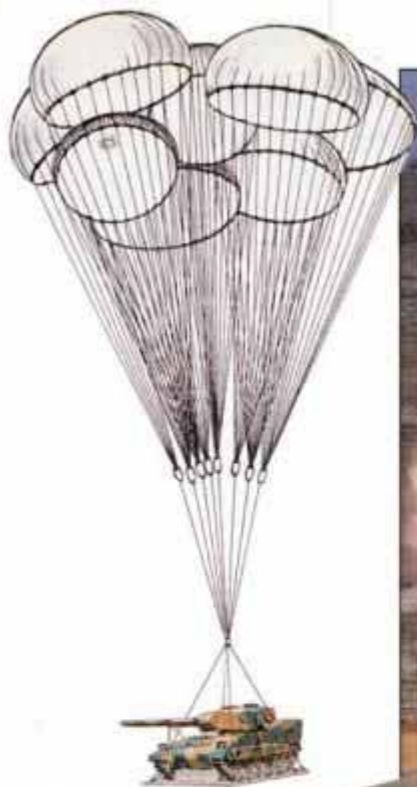
A blend of seasoned components and fresh technology, the AGS may finally silence a question that has long nagged at Pentagon planners. As the Army now shrinks and seeks to airmail firepower from American soil,

the issue has gained urgency: What kind of tank can fight head-to-head against armored adversaries, yet still float to the battlefield on a parachute to bolster rapid-deployment troops? Since 1966 the answer has been the

M551 Sheridan, and even before it slid into obsolescence, the bug-plagued Sheridan had won few enthusiasts.

So starting in the early 1980s, the Army mounted a campaign to field a replacement (see "Tanks For To-





AGS airdrops in at 36,900 pounds, thanks to a pastiche of armor plating. Beneath the skin works a familiar drivetrain. A 550-hp truck diesel engine, channeled through the M2 Bradley's transmission, propels the tank to 45 mph.

every complaint voiced against the Sheridan.

Too thin-skinned? The AGS skydives into action with an aluminum-alloy hull augmented by ceramic on flanks and turret. But troops can then bolt on two additional tiers of modular passive armor—one level to withstand frontal cannon shots, the next to deflect handheld antitank rockets. "The weight constraints really drove us to innovative concepts," says AGS project manager Col. Richard Knox. "We came up with an exotic recipe of titanium, ceramic, Kevlar liners and expanded metal."

Heavy gun mismatched with a flyweight body? The AGS fires the 105mm XM35, a long-recoil cannon developed specifically for light vehicles at Watervliet Arsenal, New York. Kick softeners include a muzzle brake—barrel-tip perforations rarely seen on a modern tank gun—and shock absorbers. Thanks to these, the XM35 delivers a 20% gentler backlash than the 105mm cannon on the original M1 Abrams.

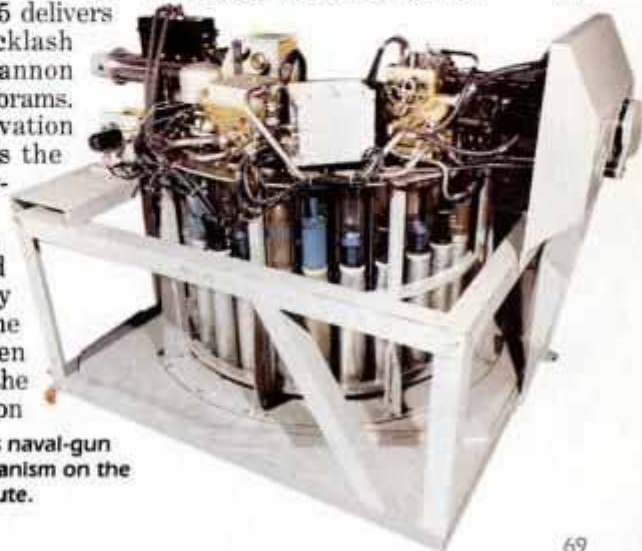
The standout innovation—the autoloader—fills the right side of the AGS turret, isolated from the commander and gunner by a bulkhead. A crescent-shaped magazine holds 21 ready rounds, each indexed by the fire-control computer. When the gunner picks a round, the magazine whirls the selection

A scaled-down version of FMC's naval-gun autoloader, this hydraulic mechanism on the AGS can fire 12 rounds per minute.

into alignment with the gun's breech. A loading arm then seizes the round and a ram tray pounds it into the breech. After firing, the spent casing ejects through an aperture in the turret's rear. The gun, which must return to zero elevation to accept a new round, can then automatically reacquire its target. The mechanism trims a tank crew from four to three and whittles down the vehicle's silhouette, saving volume and weight.

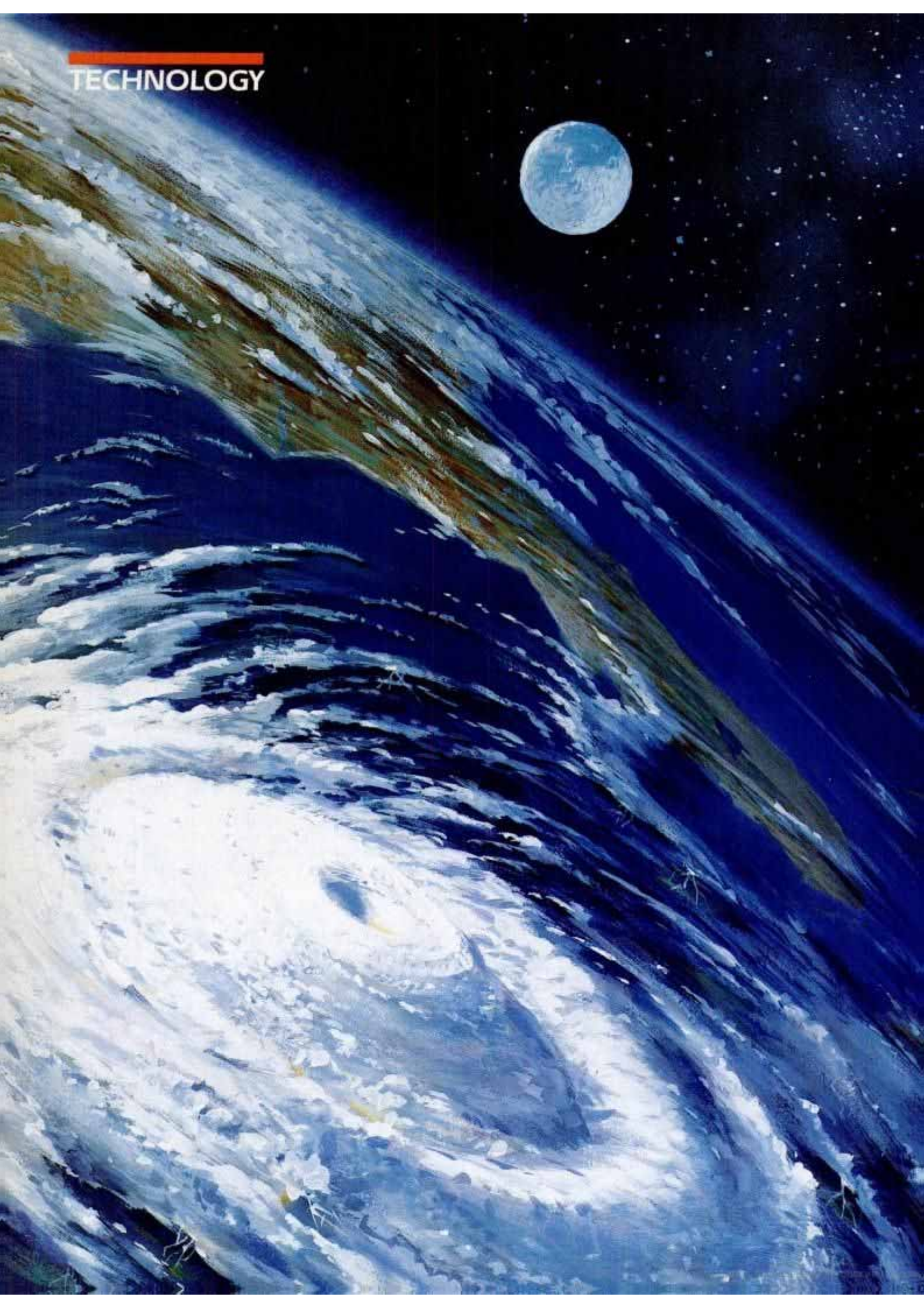
Right now, four preproduction AGS tanks are prowling the Army's Aberdeen Proving Ground, running cross-country against technical specs. By this time next year, officials should be set to authorize initial low-rate production. Ultimately, the Army wants 237 of the tanks.

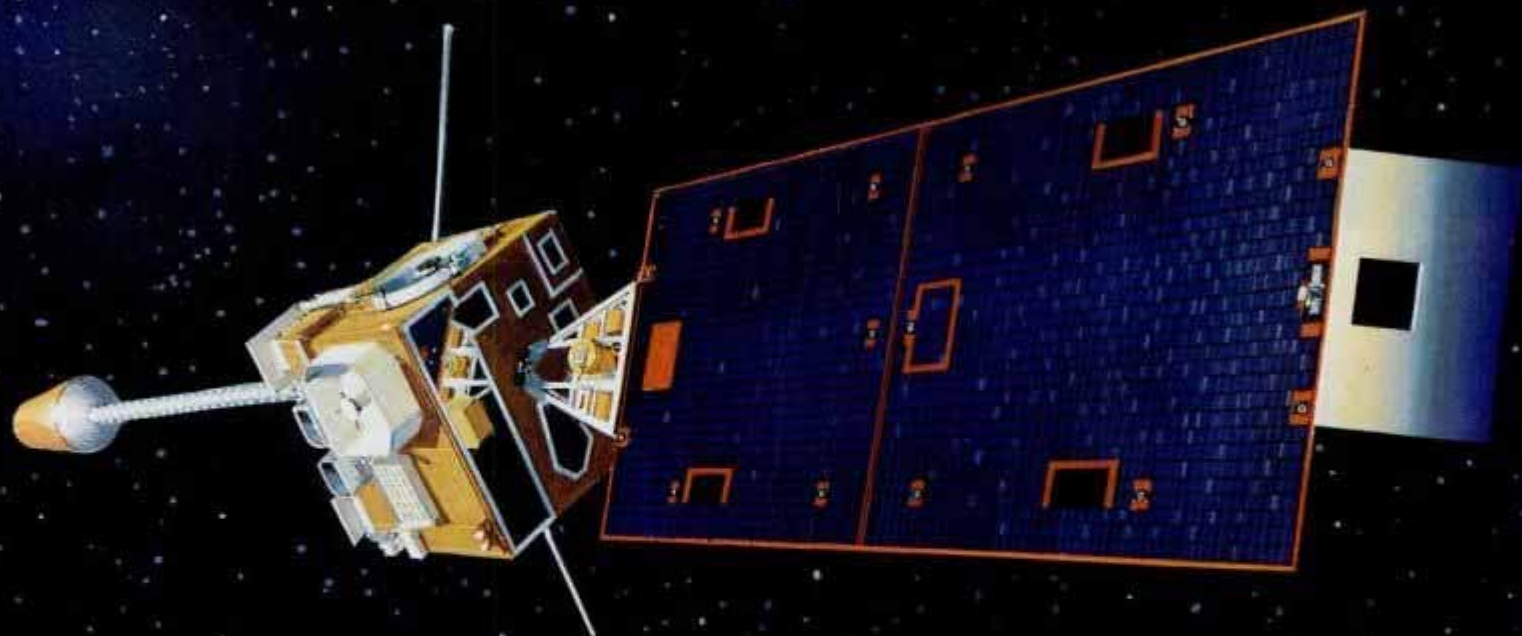
Compared with high-profile, high-production-rate items like the RAH-66 Comanche helicopter, the AGS program is one of the Army's quieter new efforts. But for troops who must dive headlong into a clash, the AGS will supply welcome thunder. **PM**



morrow," page 68, May '88). FMC Corp. (now half of United Defense, LP) snared the AGS contract with a variant of its Close Combat Vehicle-Light demonstrator. Designated the XM8, the light tank stands to answer

TECHNOLOGY





FINER FORECASTS

A new satellite promises faster storm warnings.

BY PHILIP CHIEN; PM Illustration by John Berkey

• When you're talking about the weather—as we all do—the question to ask is: What comes next? The answer, starting this fall, is GOES-Next, a new class of weather satellites that will make tracking storms and other atmospheric conditions much more precise and, by extension, make weather forecasting more of a sure bet.

The new GOES-Next class of satellites being launched by the National Oceanic and Atmospheric Administration (NOAA) has a specifications list that reads like the window sticker on a new car. The first of these new weather birds, the GOES-8, weighs in at 4641 pounds. It features a clean 3-axis stabilized design, which gives a much smoother ride than the previous spinning models. It gets 7.1 million miles per gallon on the space lanes, which is comparable to its competition. The manufacturer offers a 5-year warranty, but it has enough supplies to last seven. Audiophiles will appreciate the 15-channel radio, covering the UHF and S-Band frequencies. Cold-climate users will appreciate the dual nickel-cadmium batteries with 12-amp-hours capacity and 1057-watt solar array. Cargo capacity on the new model includes three sets of instruments for monitoring the Earth and space environment.

And like every new car, this one is supposed to be much better than the existing 1970s model that it will replace. And all of this is available at the manufacturer's suggested price of \$220 million, plus dealer prep and delivery services. How's that for sticker shock!

GOES, the Geostationary Operational Environmen-

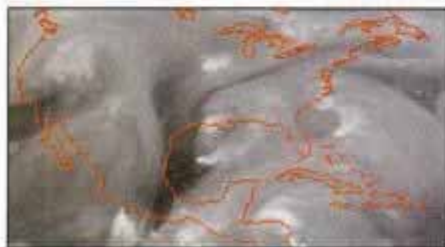
tal System, is so much a part of our daily lives that we take it for granted. The orbital weather images distributed by television news broadcasts and newspapers come from the GOES satellites, viewing the Earth from their vantage point 35,888 km (22,300 miles) above the equator. GOES-8's 3-axis stabilized design is a major improvement over the existing GOES-7 spin-stabilized spacecraft. GOES-7's sensors only view the Earth for 5% of the time because of the spacecraft's spin. By comparison, GOES-8 constantly faces the Earth, permitting continuous observations.

In addition, GOES-8's imager, used to produce high-quality images of the Earth, and its sounder, used to make temperature measurements at different altitudes, can be used simultaneously. GOES-7 could only use one instrument at a time.

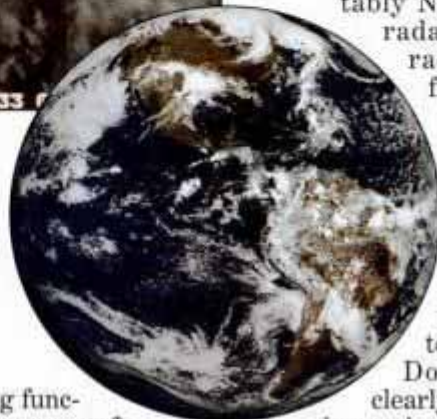
The most important new instrument aboard the new satellite is the High Resolution Radiometer, the spacecraft's camera. The new imager will be able to view cloud patterns over an entire hemisphere, or zoom in for finer observations of a storm region.

The new design is also more stable than those used on previous GOES satellites, and will be able to track storms more accurately. When major storms threaten an area, local officials will be able to receive more detailed information to help determine which areas need to be evacuated. The imager has an infrared resolution of 4 km (2.5 miles) with 1024 gray scales, much more than the 64 gray tones available on the existing GOES-7 spacecraft. Meteorologists want the finer resolution to examine storm details and continuous images to

FINER FORECASTS



The new GOES-8 satellite produces finer pictures as this simulation demonstrates (above). GOES-8 tracks water vapor patterns (left) and offers a world view (right).



track storms better. The result will be more viewer confidence in forecasts and warnings.

Other instruments include a sounder that can plot temperature profiles, and the Space Environment Monitor, which measures the Earth's magnetic field and solar disturbances that affect the weather. While not a

weather-forecasting function, recent GOES spacecraft have also included Ultra-High-Frequency Search and Rescue receivers, which can receive signals from downed aircraft and ships.

The GOES satellites produce excellent full-globe continuous images for daily forecasts, but higher-

resolution images are needed for long-term trends.

GOES-8 won't be the only weather bird in space, however. NOAA also operates a pair of satellites in low polar orbits. The satellites are timed to pass over each spot on the Earth in the morning and afternoon at the same time each day.

GOES is a "big picture" spacecraft looking at the world's weather system as an entire entity, while the lower-orbit NOAA satellites take more detailed images over a smaller area. The two systems are complementary, each filling different forecasting needs.

Big improvements also have been made to conventional forecasting with ground-based instruments, most notably NOAA's new Doppler radar systems.

Doppler radar listens to the frequency of radar returns from clouds to determine which direction they're moving. The Doppler shift is similar to how a train's whistle seems to change in frequency as it moves toward you. False-color Doppler radar images clearly show where weather

is moving, while conventional radar devices only show the locations of storms.

One of the key aspects of weather forecasting is to get warnings of dangerous conditions out to the public. While it is possible to purchase your own weather satellite receiver, most of the public finds out about weather information through newspapers, radio and television news. The National Weather Service is working with local communities to improve weather alert radio transmissions. Currently about three-quarters of the U.S. population is within range of VHF weather alert transmissions. Many communities now require inexpensive weather radios to be installed in public meeting places. Inexpensive home receivers that automatically turn on if there is an alert or warning are available for about \$25.

Weather satellites have already proven their usefulness. With better predictions and advanced warnings, the number of hurricane-related fatalities has been drastically reduced, for example. But the economic impact of lost business revenue caused by putting an area under a hurricane watch can be \$50 million. It's hoped that GOES-Next will give more notice to a storm's course, reducing the areas that have to be put under hurricane warnings and ultimately reducing the lost income because of a hurricane watch.

PM

Storm Warnings At Home

• While the GOES-8 satellite keeps an eye on the weather from space, you can get some on-the-ground backup from a number of new devices specifically designed for weather monitoring.

One such product is a warning system for tornadoes called Final Alert. Developed by physicists at the University of Mississippi, Final Alert works by detecting the characteristic frequencies or pitches generated by tornadoes. The system mounts on the southwest eave of a house and provides both a visual and audible warning. Final Alert lists for \$139 and is marketed by KBA Inc. of Peachtree City, Georgia.

General weather forecasting is the job of what's billed as the first electronic forecasting barometer. Developed by Oregon Scientific Inc. of Portland, Oregon, the BA-212 claims 75% accuracy based upon the rising and falling of barometric pressure for a 25-mile area.



This warning system for tornadoes has an audible alarm.

The \$90 tabletop device, about the size of a portable radio, displays five weather symbols, indoor and outdoor temperature and the time. Storm warnings generate an audible alarm.

Of course, if you want to monitor GOES-8 directly, you can use a computer to do so. All you need is a VHF receiver with a weatherfax demodulator, a rig that costs as little as \$400. Computer online services also offer weather data from satellites as well.

—Frank Vizard



GOING ONLINE

Here's a road map
for cruising the
Infobahn.

INTERNET
AHEAD

COMPUSERVE
NEXT LEFT

EXIT FOR
PRODIGY

AMERICA
ONLINE
THIS WAY

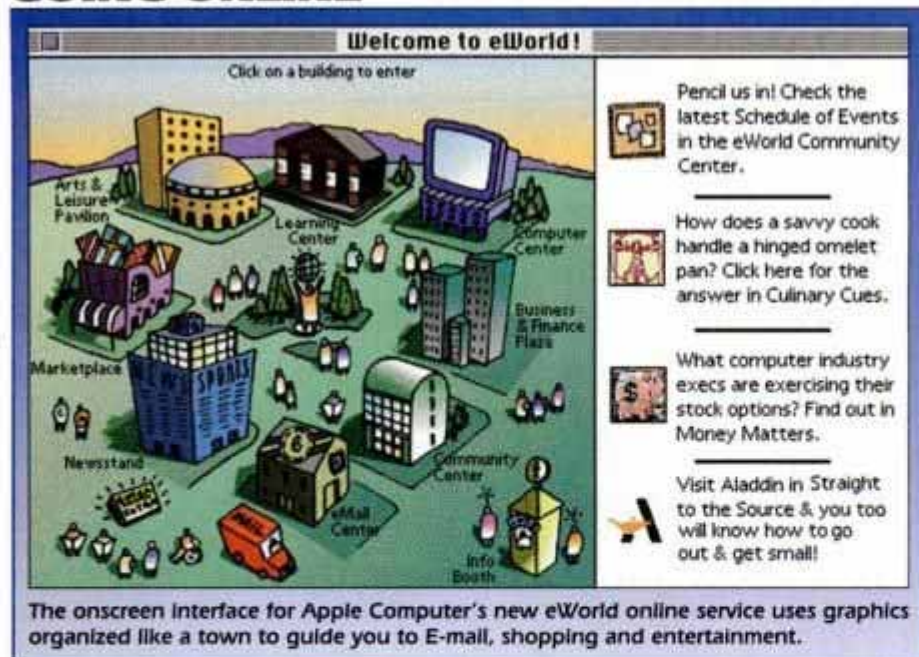
BY STEPHEN A. BOOTH, Contributing Editor
PM Illustration by Don Wieland

- Somebody call Missing Persons: More than 5 million people are unaccounted for, and the number keeps growing.

Re-invasion of the Body Snatchers? Not likely. Yet those millions of beings have been slipping off to a parallel universe, where they assume different identities and commune invisibly with disembodied strangers. The portal to this new dimension is a telephone line. The magic carpet is a personal computer. That's all you need to explore the wonders of cyberspace through online computer services. Maybe you're next.

Going online is easy. The difficulty is choosing among the services you'll encounter.

Don't underestimate the lure of the cyber-sirens. Online computing for many people is endlessly fascinating. Cyberspace often exerts an increasingly stronger pull, as online services seem to offer fresh attractions almost daily—a big-city newspaper here, the hot new game du jour there, up-to-the-minute



stats elsewhere. So whether you're scorching your keyboard in a political discussion group, checking out tunes from the latest CDs, researching through a college library across the ocean or swapping home-brew recipes with your cyber-neighbor across the state, be warned: Once you enter that wire-line tunnel, it's hard to pull away.

With online computing, even the names of the services sometimes get exotic. There's GENie and Prodigy. Delphi connotes the divine fortune-teller of Greek mythology. Marvel is the code name for a service yet to be launched. More matter-of-fact but no less intriguing are America Online, CompuServe and eWorld.

Each of the services has its own personality and atmosphere, much as clubs and restaurants do. This character has a lot to do with their so-called front-ends—the interface that appears on your computer screen to guide you through the activities and options. It's a menu of sorts, and though the house specialties differ from service to service, what they all serve is food for thought—either

through stimulating interaction or no-nonsense data.

For example, all the services offer forums for special-interest groups—you can chat via keyboard with fellow hobbyists, debate health-care reform, or Monday-morning quarterback the NFL results. And you'll be mentally armed with all the latest info, as each provider offers some kind of wire-service-style news, sports, business and entertainment update.

Research has always been the strong suit of online services. Reference works from academic and commercial libraries can be accessed and downloaded. When you're looking for nothing more cerebral than a movie review, you can check out what the critics say about current and past attractions. You can catch up on the music scene, too—and in some cases hear sound clips of the latest releases.

Don't like shopping in malls and megastores? You can buy almost anything online. Want to interact with people? You'll find multiplayer competition in arcade-style games online. It's said that the telephone killed the

art of letter-writing, but ironically, online computing might revive it. You can send E-mail (electronic mail) to the E-mailbox of a relative or friend on the service.

Besides losing the kids to the Pied Piper of PC-dom or creating the cyberspace equivalent of football widows, there are some practical considerations regarding online computing. Read: money.

There are no free rides on the Infobahn. It's a tollway. You subscribe to online services. Each has a variety of rate schedules, and while some features are included in the regular cover charge, you purchase others à la carte. You'll pay the bill monthly, just like your telephone bill—which is the other consideration.

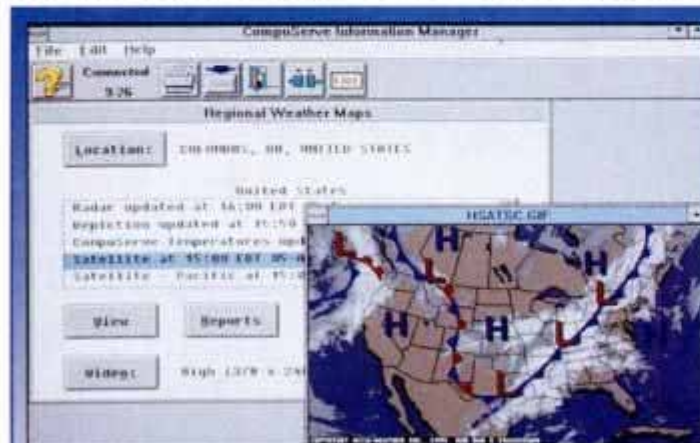
Above and beyond the online fees, you'll be paying for the phone call that gets you online, and the meter keeps running for all the time you're on the line. Fortunately, from most places in the United States, the connection to the online service is a local call. It doesn't matter that you live in Arizona, GENie's in Maryland and you're talking (typing) shop with a vintage-car buff in Vermont. All the transcontinental traffic is on GENie's nickel after you've dialed into the network's local access number.

Before profiling the online services, let's look at what else you need to get connected.

Any brand of computer will do the trick, but it has to have a modem in order to communicate via telephone. Your phone line's RJ11 jack plugs into the modem. A second plug runs a line back out to your telephone handset, so you can use it for regular voice-calls when you're not online.

Modems come in two styles: internal and external. The former is a circuit board that fits in a slot inside the PC. The latter is a small box that accepts the phone lines and connects to a port on the PC.

If your PC doesn't have a modem,



Weather info is just one of hundreds of services from CompuServe. You also can read news releases from NASA.



Chatting with like-minded individuals on specific topics is a big attraction as this CompuServe automobile forum demonstrates.

you can add one for a modest price. Lately, most new PCs come with a modem built-in, as well as the so-called communications software that lets you program the phone numbers and modem settings for the online services and other computers—the office, for example—you might want to call. One setting is for transmission speed, usually referred to as baud.

All modems run at speeds of 300, 1200 and 2400 baud. Some more expensive ones also handle the faster 9600 and 14,400 (called 14.4) rates. Some online services offer transmission at the higher rates, but usually for a higher fee. The reasoning is that you're incurring lower phone charges by communicating data much more quickly.

Word to the wise: The extra fee and costlier modem only make sense if you will regularly upload or download vast amounts of data through the system. For most cyber-surfers, 2400 is plenty fast. Even at that speed, text zooms across your screen more quickly than you can read it (and unless you're Superman, you can't read anything at 9600/14.4). In time, as multimedia audio/video data becomes more available online, the faster baud rates will make sense. The question is, will they be fast enough? Some systems already are experimenting with delivery via coaxial cable-TV lines, which absolutely smoke compared to telephone's thin copper wire.

Once you subscribe to any service, you get a user ID and a password that must remain confidential. You use both to sign on—and this is the only time during a transmission that you'll be asked for the password.

The services emphasize that you never reveal your password to anyone, online or otherwise, and especially not to strangers claiming to be employees of the service. If, during an online session, there seems to be a break in the transmission followed by a new request for your ID and pass-



Despite its origins as a noncommercial service, the Internet appears destined to be a place for shoppers as well as chatters and data seekers.

word, just hang up. It means some hacker's trying to boost your keys and inhabit your psyche for no good. Call the service's toll-free assistance line—by voice, that is—and report the incident.

The current roster of online services includes America Online, CompuServe, Delphi, GEnie and Prodigy. Apple Computer's eWorld is a recent newcomer to the group, and software giant Microsoft intends to launch its own service, code-named Marvel. Then, there's the Internet.

The Internet is a loose federation of computer networks that somehow manages to link some 20 million users worldwide on the strength of a telephone wire. And like the web of some monstrous Amazon spider, it keeps on growing.

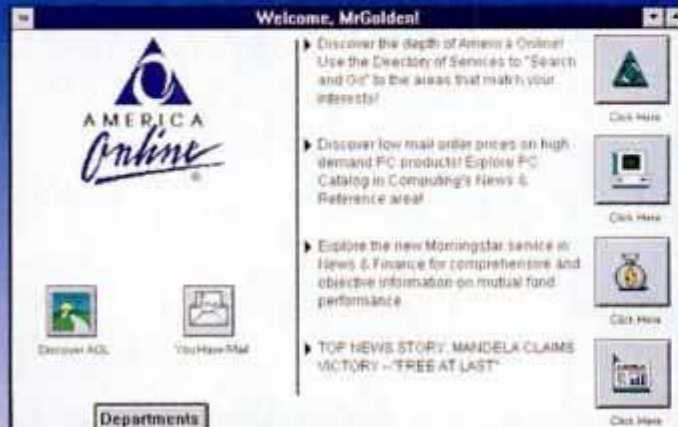
Internet isn't exactly an online service, in the sense that it's not commercial. Actually it's free, but you can't get there from here. You have to enter through a special node or gateway—a local service-provider with the acceleration lane to get you onto this freeway at speed—and for a fee.

But your thrills haven't even begun until you're on it.

This road wasn't built for casual motorists, but for academic and corporate researchers. When it was first built, there was no road map to guide your way, and communication is in the Unix computer language—used in professional workstations but foreign to home PCs. The Internet has evolved, however, into a de facto information highway. And although not originally intended as such, this highway—just like a real one—can even connect you to an electronic shopping mall called CommerceNet. Internet "addresses" are provided by the online service or a connecting node.

Luckily for cyber-tourists, several sources are developing easy-to-use shell programs or interfaces for negotiating the Internet. Some, like Mosaic and Cello, are free programs but require some computer competence. On the way for sheer novices are simpler, commercial programs that will let you use plain language and symbols to execute commands, then translate

(Please turn to page 120)



America Online gets high marks for easy-to-follow interface—including a connection to the worldwide Internet.



Prodigy makes the most of color photos and hi-fi sound in its news and other features. Cable delivery augurs video.

OUTDOORS

HAVE IT YOUR WAY

Want a cutting-edge mountain bike exactly to your specs?
Build it yourself. Here's how.

BY JOE SKORUPA, Boating/Outdoors Editor
PM Photos by Bill Ashe





● Not long ago American bike builders didn't really build bikes. They simply ordered what they needed from offshore manufacturers. Their reputations rested on ordering and assembling. Fortunately, the pendulum is swinging the other way, and some U.S. manufacturers are now actually building frames, handlebars and other components.

But if cutting-edge bike builders could simply order and assemble parts, why couldn't I? Why couldn't I create my own monster mountain bike by ordering outrageous components and then wrenching them together? Think of the awesome performance. Think of the envy. Think of the trouble I could get into. Sounds like a perfect PM story.

The first thing I needed was data. Lots of it. Component by component. Since I prefer backcountry scenery to pavement, I focused on mountain bikes. This involved analyzing parts for compatibility, performance, reliability, availability, durability, reputation and price. It meant talking tech to shop mechanics and serious enthusiasts, reading current mountain-bike magazines and performing hands-on tests whenever possible.

To help compress my time, I concentrated on finding top companies that provide component groups. This is basically what most manufacturers do to achieve economies of scale. You get a better deal if you order parts in groups, so that's what I did.

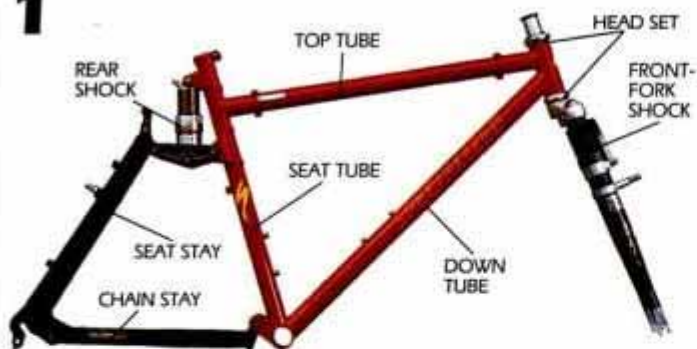
In the end, I settled on three main companies: Specialized, Shimano and Ritchey Design, each of which offers race-proven equipment. From Specialized, I chose the dual-suspension S-Works FSR frame. From Shimano, the high-end Deore XT drive and brake systems. And from Ritchey Design, a group of handlebar components and racing rims, spokes and tires. Two other important components were made by Suntour and Dia-Compe USA.

The next step was to get bike-specific tools. These included a bottom-bracket tool, chain whip, crank wrenches, head-set wrench, free-

HAVE IT YOUR WAY

Step-By-Step Bike Assembly

1



Out of the box, the chromemoly Specialized S-Works FSR frame comes preassembled with the top-of-the-line Ahead-Set unit and state-of-the-art front and rear suspension systems.

2



With the head set in place, it's an easy matter to install the titanium stem. However, a trip to the shop must be made to prevent stripping the bottom bracket during installation.

3



After installing the shifters/brake levers and front and rear brakes, it's time to run the brake cables. Take out the slack, but leave some extra cable at the brake arms before snipping.

4



The first part of the drivetrain goes on with the wheels and cranks. The 8-cog freewheel cassette screws onto the rear hub. Removable chainrings go onto the righthand crank.

wheel remover, spoke wrench, a chain-rivet tool and an adjustable bike stand.

The final step in preassembly was getting a local bike shop to perform several procedures that I couldn't do without help. These included using a bottom-bracket die to remove paint from the frame's bottom-bracket threads, using a high-powered compressor to adjust the shocks (especially the rear), and using a truing stand (complete with skilled technician) to install the spokes. These procedures can be done in a single visit, and can be arranged when ordering the tools and parts. My shop was Metro Bike Midtown, located in New York City, where manager Carlos Dall'Orso rescued my butt several times.

Now, with parts and tools in hand, begin with the bare frame and install the bottom bracket and head set (Fig. 1). As mentioned, this requires a trip to the bike shop. Prior to installing the bottom bracket, a steel die must be screwed into the frame to remove obstructions from the threads. If the chromemoly frame won't smoothly accept the softer aluminum bottom bracket, the bracket will strip.

Most bikes require a head-set press to install the head set, but the Specialized S-Works FSR frame comes preassembled with Dia-Compe's cutting-edge Ahead-Set unit. This integrated

unit simplifies the job. However, it's a good idea to check the Ahead-Set so that it's properly lubricated and installed before wrenching on the Specialized S-Works titanium stem. (In addition to the Ahead-Set unit, the Specialized S-Works frame also comes with carbon-fiber/titanium front fork shocks and a 4-point rear-triangle linkage fitted with a Fox ALPS shock.) At this point, all the frame bearings are in place (Fig. 2).

Now, move to the handlebar group and brake system (Fig. 3). The handlebar group includes the bar itself, plus the shifters/brake levers, and grips. The bar ends (forward handlebar extensions) belong with this group, too, but they can be installed later. Right now it's more important to access the shifter/brake lever units.

Use a razor knife to cut holes in the ends of the grips and hair spray to lubricate the inner surfaces. This pro-

Tools And Tips



● The best tip any bike builder could get is to make friends with a mechanic at a local bike shop. Some professional help and tools (such as a high-powered compressor for the shocks, shown above) are required by virtually everyone. Two other good tips are to use an old bike as

a model and buy a recent maintenance/repair book.

As noted, cost of buying components can be reduced by buying in groups. The PM bike was intended to test the latest high-end equipment, and it priced out at about \$3000. If not for the cutting-edge parameters of this story, I would have saved money by ordering a less expensive frame and components.

Tools required for this project include: Future Shock Air Inflator, 15mm crank wrench, 36mm head-set wrench, screwdrivers (flat and Phillips), Allen wrench set (5mm to 8mm), socket wrench set (8mm to 10mm), bottom-bracket tool, bike stand, chain whip, chain-rivet tool, freewheel remover, cassette tool and heavy-duty wire cutters.

—J.S.

Parts And Components List

Ritchey Design

- Logic Racing Spokes
- Logic Bar Ends
- True Grip Lite Grips
- ProLite Bar
- Vector Plus Rail Saddle
- Bite 2.1 Alfa/Omega Tires
- Ritchey Rock 395 E/415 E Rims

- Deore XT Derailleurs
- Quick-Release Clips
- Sealed-Cartridge Bottom Bracket
- Wheel Hubs
- Dura-Ace Uniglide Chain
- SPD Dual Cleat-Lock Pedals
- SPD Shoes

Specialized

- S-Works FSR 19-in. Frame
- Future Shock FSX Front Shocks
- Fox ALPS 4 Rear Shocks
- Seat Post
- S-Works Titanium Stem

Other

- Suntour Power Hanger
- Dia-Compe USA Ahead-Set

5



Front and rear derailleurs, chain and derailleur cables complete the drivetrain. Check derailleur and cable tension by turning the cranks and shifting through the gears.

6



The seat post, saddle, bar ends and pedals complete the bike. Make final adjustments and keep tools handy during initial rides. Cables stretch and bolts loosen until bike is broken in.

vides temporary lubrication, and then dries to keep them in place. At this point, it's a good idea to coil the derailleur cables and let them hang loosely out of the way.

Next, loosely install the cantilever brakes on the seat stay and front forks. When you run the cables between the levers and brake arms, keep in mind that bikes are traditionally set so that the left lever controls the front brake and the right lever controls the back.

To beef up the Shimano Deore XT front cantilever brake, I chose to install a Suntour Power Hanger. The Power Hanger is a V-shaped cam arm located between the brake cable and the brake arms. A short, removable cable connects the hanger to the second brake arm.

Use heavy-duty wire cutters to snip the ends of the front and rear brake cables, and leave several inches of runover for later adjustment. In the front, make sure there's enough cable to allow unrestricted motion of the handlebars. In the rear, make sure the cable maintains a nice, rounded curve as it leads to the brake arm.

Now, move to the wheels and cranks (Fig. 4). The wheels are composed of hubs, rims, inner tubes, spokes and tires. Of all the skills required so far, none compares in difficulty to installing the spokes and truing the wheel. In fact, this skill requires training, practice and use of special tools. Consequently, most bike experts recommend leaving it to the professionals. For me, installing the wheels was a swift matter of identifying the front and rear tires and inserting the quick-release clips. First, how-

ever, I wrenched on the 24-gear, 8-sprocket (or cog) Shimano Deore XT freewheel cassette. This is a simple matter of assembling the cogs in the correct order and screwing the assembly onto the rear hub.

The cranks are a swift installation, too, requiring only a 15mm socket wrench. However, the right crank is part of the drivetrain and requires correct placement of three chainrings.

With the wheels in place, this is a good time to dial in the brake pads. The pads must be adjusted so they make contact only with the rim. Ideal placement is parallel to the rim and toed inward (front end is 1 to 2mm closer to the rim than the back).

Now finish installing the drivetrain (Fig. 5). The rear derailleur bolts into

(Please turn to page 115)



HOME IMPROVEMENT

Topping Off

New roofing materials are more durable and more attractive than ever.

BY ROY BERENDSOHN, Assistant Home Improvement Editor

● Most people give little thought to their roof until one of two events occurs: It starts to leak or it looks so shabby it needs to be replaced.

In one sense, this is how it should be. There's enough to maintain in a home without worrying about your roof. Still, it is worth remembering

that a roof can go a long way toward improving or changing your house's appearance, and this has never been more true than today. There are more roofing materials than ever—you don't have to settle for simple black asphalt shingles. You have your choice of color, texture and, of course,



Architectural asphalt shingles are thick and have shadow lines like red tile (top) or like slate (above). They come in a range of colors, including blue and green.



CEDAR SHAKE & SHINGLE BUREAU PHOTOS

Cedar roofing is available as a rough, thick shake that gives a roof a rustic appearance, or as a shingle, a thinner and smoother product that appears more finished. Cedar roofing can be chemically treated to make it fire resistant.

price. Furthermore, there's no reason your roof can't be worry free. Today's roofing products combine durability with good looks.

If you're in the market for new roofing, what follows should at least point you in the right direction. And if you plan to have your new roofing installed by someone else, then contact the National Roofing Contractors Association, 10255 W. Higgins Rd., Suite 600, Rosemont, IL 60018, for tips on choosing a good contractor.

Asphalt roofing

Asphalt shingles are the most common roofing material, and they come in two broad categories—organic base and fiberglass. Organic base means that the shingles are made of a cellulose mat saturated with asphalt and covered with mineral granules. Fiberglass shingles have a mat of woven glass fiber saturated with asphalt and covered with mineral granules.

Organic-base shingles have a Class C (the lowest) fire rating, while fiberglass shingles have a Class A (the highest) rating.

An important difference between the two types of shingles is that organic types are more flexible in cold weather than fiberglass ones. A good deal of controversy surrounds the installation of fiberglass shingles in cold climates. Some roofers refuse to install them, while others just won't install them in cold weather. These roofers cite the shingles' premature failure caused by their stiffness. Manufacturers, however, say that a properly installed fiberglass shingle is as good as any.

The two most common types of asphalt shingle are 3-tab, also called a strip shingle, and architectural, also called a laminate shingle.

A 3-tab shingle is a rectangular mat with two slots cut in its front edge. The slots provide stress relief as the shingle expands and contracts with the weather. An architectural shingle has a heavy base mat and another mat or sections of mat applied on

top of it. Aside from making the shingle heavier and more durable, this construction gives the roof shadow lines and character like a tile or wood roof.

A standard 3-tab shingle can be organic or fiberglass based. Most architectural shingles have a fiberglass mat, although some are organic.

Finally, there are regional and specialized forms of asphalt roofing, such as a highly wind-resistant shingle called a T-lock. This is a slotted T-shaped shingle that locks to the shingle below and to the shingle above. Some manufacturers also offer asphalt shingles without any tab cutouts—appropriately called "no-cutout" types. Roofs with a shallow pitch are often covered with a continuous sheet of asphalt called roll roofing.

Cementitious roofing

Cementitious roof tiles offer traditional looks combined with the benefit of modern materials. These products are made from steam-cured cellulose fiber-reinforced portland cement or concrete. They are available in red,



GEORGIA PACIFIC CORP. PHOTO

T-lock shingles are a regional product that is used in areas with high winds. Each shingle is attached to the one above and to the one below.



MASONITE PHOTO

A comparatively recent form of wood roof is a wood composite shingle that is molded and colored to look like a weathered cedar shake.



Barrel-top clay tile is among the oldest roofing products (above). These tiles are also available in blue and green. Lightweight flat clay tile achieves strength from molded ribs (left).



A relatively new product is southern yellow pine shakes (above and right). They are $\frac{3}{4}$ in. thick and are chemically treated to make them decay and insect resistant.

black, white, green and gray, and they can be molded to look like wood shingles, barrel-shaped tiles or slate.

The strong suit of cementitious roofing tiles is their durability. Because they are a masonry material, they resist weathering, insects and fire. Their nearly impenetrable surface also resists the formation of fungus, and because they are heavy, they resist wind uplift.

Clay roofing tiles

Clay tile is among the oldest and most durable of roofing materials. It gains its weather-resistant, fireproof and insectproof qualities from being made out of kiln-fired clay. Most people think these tiles are limited to the barrel-shaped type common in the West, but clay tiles can be flat, and they may have a glossy surface. They

are also available in blue and green, aside from reddish brown.

Your curiosity is justified if you're wondering how roofers attach what is essentially a ceramic product to the roof deck. Tiles are fastened with a variety of clips and fasteners, but among the most interesting methods is a tie-wire system in which the tiles literally hang from wires suspended from the ridge of the house.

Metal roofing

Metal roofing is available in the widest range of materials, combination of materials and configurations. It is fastened in a variety of ways and comes unpainted or factory finished with various coating systems.

The most common types of metal roofing are: steel panels with exposed fasteners, steel panels with hidden

fasteners and rust-resistant aluminum panels that look like shakes, shingles or tiles. Less common types of metal roofing are copper and terne-coated stainless steel (terne is an alloy of lead and tin). There are also steel panels finished with stone granules that are resin-bonded to the panel surface.

Regarding rust, steel panels achieve corrosion resistance with a coating of zinc (galvanized) or a mixture of zinc and aluminum (known as galvalume or galfan). Top-quality steel panels have both zinc and a factory-applied coating.

Steel panels attached with exposed fasteners tend to be used on agricultural and utility buildings, but they are being more widely used on houses. Panels with no exposed fasteners are known as standing-seam types. The panels are joined with crimped



Fiber-cement tiles offer the look and color of slate while providing comparable durability and fire retardance.



Concrete roof tile looks like slate, and uses aggregate instead of fibers to add strength. It comes in a variety of colors and patterns.

ROOFING CHOICES

The chart below represents premium grades in each category. Estimates include complete cost of installation per 100 sq. ft. (1 square). Wide price variations on some products indicate that labor costs mount drastically with complexity of installation.

	COMMENTS	INSTALLED COST (per 100 sq. ft.)
Asphalt 3-tab organic shingle:	Lifespan of 10 to 15 years depending on climate.	\$50
Asphalt 3-tab fiberglass shingle:	Lifespan of 15 to 25 years. Shorter lifespan may occur in cold climates.	\$50-85
Architectural asphalt shingle:	A heavy, laminated shingle with a 20- to 30-year lifespan.	\$150-200
Aluminum shingle panels:	Lifespan of 30 to 40 years. Panels look like tile or wood shake.	\$350-450
Galvanized, utility steel:	In relatively mild climates, roof has 20- to 25-year lifespan. Expect fewer years in coastal climates.	\$200-250
Standing-seam steel, painted:	Factory-applied coatings extend lifespan to 30 to 50 years.	\$600-700
Concrete tile:	Very long lasting, with lifespan expected to be 40 to 50 years.	\$500-600
Fiber-cement tile:	Lifespan expected to be in the 30- to 50-year range. Some types cannot be used in cold climates.	\$400-600
Slate:	Best grades of clear slate make a nearly permanent roof with a minimum expected lifespan of 50 years.	\$600-1000
Cedar shake:	With maintenance, roof can last 30 years.	\$215-255
Cedar shingle:	With maintenance, roof can last 30 years.	\$225-265
Fire-retardant cedar shingle:	With maintenance, roof can last 30 years.	\$335-375
Southern yellow pine shake:	Pressure treatment reduces maintenance. Its expected lifespan ranges from 20 to 30 years.	\$330-350
Wood composite shingle:	A relatively new product that has been on the market for 15 years, so lifespan of product is not known.	\$150-160
Glazed clay tile:	Very long-lasting roof with a vitreous surface. Its expected lifespan is at least 50 years.	\$700-800



Standing-seam steel roofing is available in a range of colors, including gray, green, blue and red. It can be factory-coated so it won't need to be painted, or it can be unpainted.



Another option in metal roofing is aluminum shingle panels. These are formed to look like wood shakes.

or snap-together seams that stand vertically from the roof.

Wood roofing

In the old days, wood roofing came directly from the tree with no enhancements. Today's wood shingles and shakes are more sophisticated.

For example, cedar roofing can be factory treated with chemicals to boost its fire rating from unrated to Class A, B or C. Southern yellow pine shakes are pressure treated to help them resist rot and decay, and although these shakes have been on the market for only five years, their manufacturers expect the product to have a 30-year lifespan. Likewise, a composite wood shingle has been on the market for 15 years, and its manufacturer says it has substantial weather resistance.

In case you are wondering about the difference between a shingle and a shake, shingles are smooth and uni-

formly shaped while most shakes have a rough, uneven texture. Shingles are 1/2 in. at the thick end, while shakes can be 1/2 in. to 3/4 in. thick. To get maximum durability out of a cedar roof, roofing contractors recommend you clean it with a pressure washer once or twice a year to remove moisture-holding debris and apply preservatives to help it resist sun and weather. For more information on wood roof maintenance, contact the associations in the Source List.

Slate roofing

Slate roofing comes in two types—premium clear pieces and ribbon slate. Ribbon slate is not as durable as the premium clear product. It is distinguished by the ribbons of light color that run across its surface. The ribbons are high-carbon-content areas. They are an impurity in the slate and are weaker than the dark areas.

Slate comes in gray, purple, green

and red. Properly installed it has incredible durability. It doesn't require much maintenance, although an old slate roof might need a little tender loving care, such as fixing the occasional cracked piece.

PM

SOURCE LIST

For more information about roof maintenance, contact the following:

- **Asphalt:** Asphalt Roofing Manufacturers Assn., 6000 Executive Blvd., Suite 201, Rockville, MD 20852
- **Hardboard:** American Hardboard Assn., 1210 W. Northwest Hwy., Palatine, IL 60067
- **Steel:** American Iron And Steel Institute, 1101 17th St. N.W., 13th Floor, Washington, DC 20036
- **Tile:** National Tile Roofing Manufacturers Assn., P.O. Box 40337, Eugene, OR 97404
- **Wood:** Cedar Shake & Shingle Bureau, 515 116th Ave. N.E., Suite 275, Bellevue, WA 98004; Southern Forest Products Assn., P.O. Box 641799, Kenner, LA 70064

TOOL TEST

Sears Plate Joiner

TEXT AND PHOTOS BY
 ROSARIO CAPOTOSTO,
 Contributing Editor

● Everyone agrees that a plate joiner is the fastest and most error-free tool for assembling and reinforcing woodworking joints. Up until recently, however, upgrading your power-tool arsenal with one of these modern production tools could put a real dent in your woodworking budget. Some models cost more than you'd expect to pay for a decent table saw.

Now, thanks to Sears, there's little reason why you shouldn't jump on the bandwagon. With features comparable to the more expensive versions, Sears' new Model 17501 plate joiner weighs in at just under \$100.

Unlike most of the original, angle grinder-based plate joiners, the Sears tool is redesigned from the ground up. It has a vertical motor whose housing is integral with a sloped and contoured handle. The tool is well balanced, and the handle contains a well-positioned on/off trigger switch. To hold the tool securely on the work, the faceplate is covered with a nonskid pad in contrast to the sharp pins on many other models.

The Sears joiner has an adjustable front fence that tilts from 60° above and 45° below the normal 90° setting. This allows you to reference the joint slot to either the inside or outside of most miter joints (Photo 1). The fence also adjusts 2 in. vertically to suit stock thickness. For cutting slots in the middle of a panel, as required in shelfmaking, or when using the bottom of the tool to reference slot positioning, the adjustable fence can be removed (Photo 2).

The 6-amp motor drives a 4-in.-dia. 8-tooth carbide-tipped blade at 10,000 rpm. To keep the dust at bay, this plate joiner has a handy dust-collection box mounted under the handle. We found that it collects most of the dust generated while cutting (Photo 3). To set the depth of cut and accommodate the three standard plate sizes, the joiner has an adjustment knob on the side (Photo 4).

We tried this joiner out on a variety of joints in softwood, hardwood and



The Sears Model 17501 makes plate joinery affordable to budget-conscious woodworkers. The removable fence is fully adjustable and a dustbox collects sawdust.

plywood. In all cases, the tool performed well with results comparable to those obtained with costlier makes. Although the housing and fence are plastic and the tool lacks some of the finer detailing its competitors offer,

when it comes to doing its job, you can't beat this tool for value.

The Model 17501 plate joiner is available in Sears retail stores and through the Sears catalog for \$94.99. To get a catalog, call (800) 377-7414. **PM**



1 To cut plate slots in a miter joint, set fence at matching angle. Fence tilts up and down to cover a wide range of angles.



2 Remove the adjustable fence to cut plate joint slots that fall in the middle of a panel, such as in bookshelves or cabinets.



3 The Sears plate joiner has a dust-collection box mounted under the handle. To remove it, simply slide it back.



4 A knob on the side of the base controls cutting depth. Depth can be set at three preset positions for standard plate sizes.

TOOLS

Tools Of The Rising Sun

Traditional tools from Japan offer new techniques for the Western woodworker.

BY THOMAS KLENCK, Associate Home Improvement Editor
PM Photos by Rosario Capotosto

● Imagine a country covered with tall, straight-grained softwoods. Then, make it an island, removed from the influences of mainland cultures and technologies. Populate it with craftspeople who combine a religious reverence for wood with a sense of artistry and tradition. Then, take a look at its tools, and don't be surprised if they look a little unusual to you.

To most Western woodworkers, the tools of Japan do look unusual. Although they're designed to do the same thing as the tools we're familiar with—sawing, surfacing, paring and chopping—they often go about the job in an entirely different way. When combined with a traditional toolmaking industry that's rooted in

local small-scale craftsmanship rather than mass production, the tools, from their details to their overall shape, take on a character and sense of purpose that's unlike anything you'll find in your local hardware store.

The last 10 to 20 years, however,

have seen an awakening in the North American woodworking community to both the tools and techniques of the Japanese woodworker. In fact, some American manufacturers now offer handsaws with tooth configurations that are inspired by Japanese saws.

Construction differences

While utility plays an important role in tool design, the manufacturing process has an equal effect. Like their

Western counterparts, traditional Japanese woodworkers often made their own tools, and metalworkers hand-forged the cutters and blades. In both the West and the East, plane cutters were made

from soft, tough-steel bodies, with hard-steel cutting edges laminated to one face. However, in Japan, laminating steel developed into an art. Not only was a hardened steel added to a softer cutter body, but the entire body was often laminated by folding many layers of steel.

Where tools made in America and Great Britain around the turn of this century took new shapes as a result of highly industrialized metalworking processes, the more conservative, cottage-industry approach to toolmaking in Japan allowed traditional forms to remain. Today, most Japanese tools benefit from sophisticated industrial processes, while some individual toolmakers carry on the old skills.

Perhaps more so than Western hand tools, Japanese tools vary widely in price. For example, you can pay from \$17 to \$90 for a 1½-in. bench chisel. In many cases, a high price reflects a more traditional manufacturing process and, although the pricey tool may be beautiful to behold, it doesn't indicate superior performance.

Most woodworking catalogs offer a range of Japanese or Japanese inspired tools. A few sources are: The Japan Woodworker, 1731 Clement Ave., Alameda, CA 94501; Garrett Wade, 161 Avenue of the Americas, New York, NY 10013; and Woodcraft, 210 Wood County Industrial Park, P.O. Box 1686, Parkersburg, WV 26102.

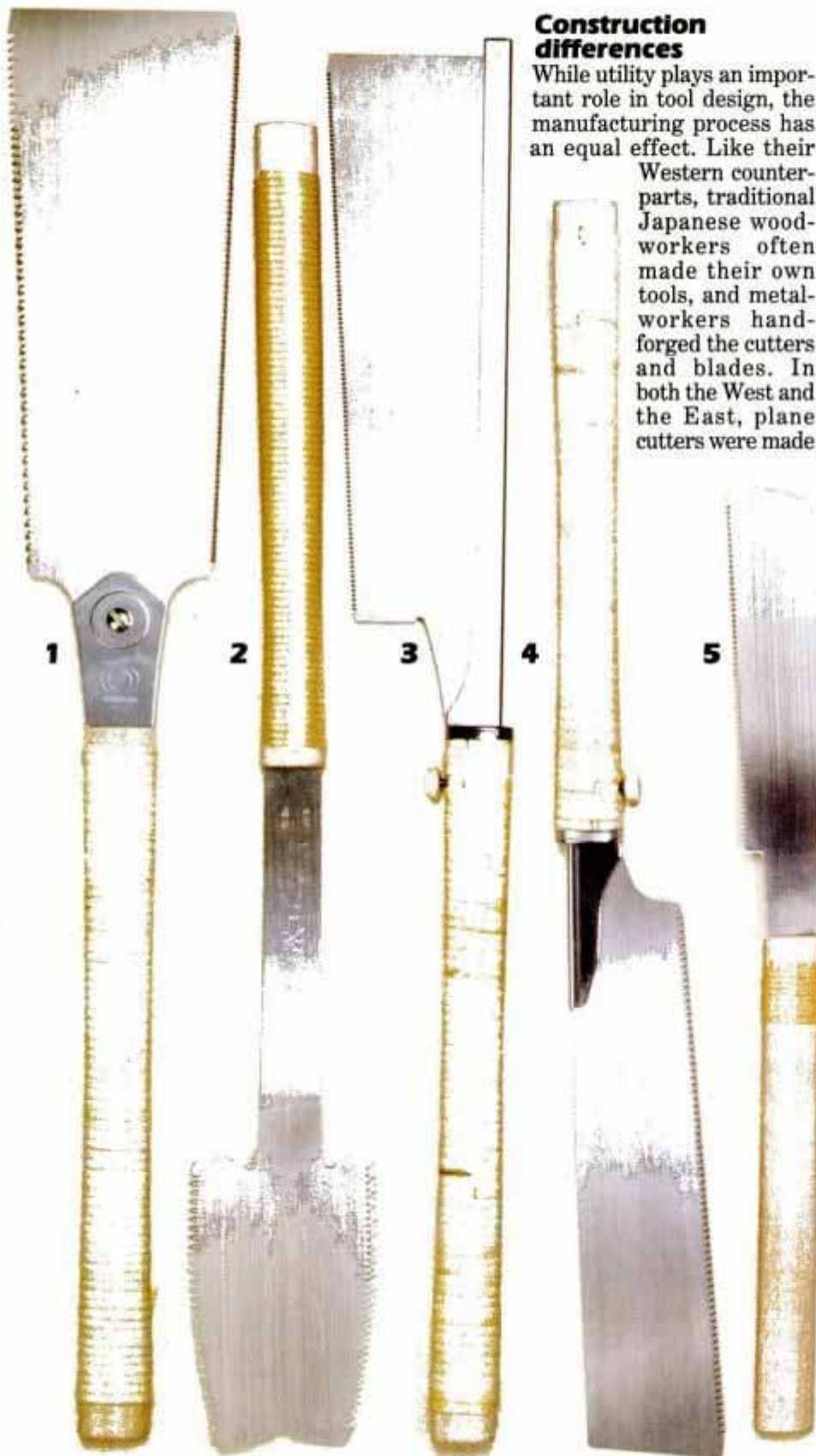
A sampling of saws

One of the most popular Japanese tools to enter the Western woodworking scene is the saw. Actually, there are many different types of Japanese saws, but they all have one thing in common: They cut on the pull stroke. This allows the blade to be very thin, because it's under tension when it's working.

The extra-thin blade cuts a thinner kerf so less force is needed, and the teeth are made harder to stay sharp longer. In fact, the teeth on Japanese saws are more prone to breakage if handled carelessly.

1. Ryoba saw—This double-edged saw (about \$40) is one of the most popular because it combines a ripping-tooth pattern on one side with a cross-cut-tooth pattern on the other. It is slightly taper ground toward the center to reduce binding. In contrast to Western saws, with one size saw available for either fine or coarse cutting, the number of teeth per inch on a ryoba saw varies with its length.

2. Azebiki saw—For sawing mortises or other blind cuts, this modified ryoba saw has curved edges so the



cut can be started in the center of the work. The wide blade, long handle and neck aid in making deep cuts (about \$24).

3. Dozuki saw—The dozuki (about \$30) is the counterpart of our Western backsaw. It features a stiff spine and is used for sawing tenons and making other fine cuts.

Dozuki saws come in a variety of tooth patterns for handling softwood and hardwood. Some modern versions are designed to handle plastic laminates and plywood, and others have unique raked teeth for faster cutting. Dozukis designed for dovetail work are shorter with a wider blade.

4. Kataha saw—With a short spine, this saw handles crosscuts across wide stock. It's available in a fine-tooth pattern for light work, or a coarser-tooth pattern for handling heavier stock (about \$20).

5. Flush-cutting saw—This saw has no stiffening spine and, in fact, is designed to be flexible (about \$20). The blade is placed against the surface and the handle is bent away so it doesn't interfere with the cut. The teeth have no set to prevent scratching the wood.



6

Chisel types

Japanese chisels have also been well received on our shores. The mass-produced varieties feature a hardened-steel cutting edge—slightly harder than the steel found on our comparable chisels—that's laminated onto a softer chisel body.

The underside of the chisel features one or more scalloped depressions instead of a flat surface. These depressions make it easier to lap this side of the chisel when sharpening. The chisels have a socket connection to a wooden handle, with a tang inside. Chisels meant to be struck have a metal hoop at the handle end.

6. Paring chisel—Viewed upside



down to show the scalloped bottom surface, this 1½-in.-wide chisel is designed for finish cuts and trimming without the use of a mallet or hammer. The paring chisel shown costs about \$75.

7. Post-and-beam chisel—Designed for deep mortising, this handmade chisel (about \$65) features an extra-long shank and a slightly curved profile to aid in working deep mortises.

8. Paring dovetail chisel—Triangular cross section enables this tool to reach into the corners of dovetails and other tight areas. Without the steel hoop at the handle top, it's meant for careful hand paring. The tool shown costs about \$48.

9. Bevel-edge firmer chisel—Like our Western bevel-edge chisels, this Japanese version handles routine trimming and paring, and may be struck with a hammer or mallet (about \$40).

10. Mortise chisel—Square-section mortise chisels are the choice for deep mortises in cabinetwork and carpentry. Like all Japanese chisels, it has a tang that extends into the handle and a steel socket to reinforce the wood around the tang. A steel hoop protects the handle end (about \$35).

11. Dovetail chisel—When dovetail work calls for a striking chisel, the triangular-section blade is mated with a hooped handle. This chisel is useful for chopping out tight corners in various joints (about \$45).

Striking tools

Like chisels, Japanese hammers look and function much like our Western varieties.

12. Hammer—The typical Japanese hammer has a barrel-shaped head with a cross section that's either round, slightly flattened or octagonal. The striking faces are made of hard steel that's laminated to a softer steel body. One face is often ground flat and the other slightly convex (about \$20).

13. Carpenter's hammer—Although this hammer resembles our typical Western claw hammer, it's balanced differently and it's claimed to be less fatiguing and better for toenailing (about \$30). This type of hammer is available with a smooth face, but the checkered face is preferred for construction.

Plane design and use

Less popular with American woodworkers is the Japanese plane. Like the saw, these planes are used on the pull stroke. Here, there's less argument for pulling over pushing, except that pulling, because of the reduced

12

13





force that can be applied, necessitates a finer, more controlled cut as well as a well-sharpened plane iron.

Japanese planes have a rectangular wooden body, with the iron placed well to the back end. To make them work properly, these tools must be adjusted and tuned properly—a factor in their limited popularity here in the United States. In fact, they are not ready for use as soon as you buy them. If you think you're ready to try one, be prepared to master the tune-up and adjustment skills before you take your first shaving.

14. Bench plane—The standard Japanese plane for smoothing and trimming is about 11½ in. long and has a plane iron that's about

2¼ in. wide. The planes are available with a blade angle of 40° for softwoods or 47½° for hardwoods (about \$100).

In addition to the smoothing plane shown, you'll find slightly longer jack planes for taking heavier cuts, and jointer planes for truing surfaces and edges. Japanese jointer planes are not as long as our Western versions, with typical models just over 18 in. in length.

15. Rabbet plane—This skew rabbet plane handles rabbets with and across the grain (about \$60). Because the blade is skewed, the tool produces very smooth surfaces, and it comes in both a lefthanded and righthanded model to handle cuts from either direction.

16. Scraper plane—Also called a sole-conditioning plane to indicate its use in shaping the bottoms of bench planes, this tool is handy for smoothing surfaces with varying grain patterns. Blade width is 1½ in., and the plane's length is 7½ in. (about \$50).

17. Spokeshave—Wooden-bodied Japanese spokeshaves are available with either flat or convex soles. The typical narrow-blade throat facilitates extremely fine cuts and smooth surfacing (about \$55).

Tools for sharpening

To keep chisels and plane irons razor sharp, the Japanese woodworker has developed fast-cutting stones. In contrast to traditional Western stones that use oil to carry away the small particles of steel cut from the tool, Japanese stones are lubricated with water.

18. Water stones—Water stones are softer than oil stones and wear more quickly, so they must be flattened periodically. Because the stone surface is continually being refreshed, the stones cut very quickly.

The darker 800-grit stone (right) handles routine honing, and is about 1¾ in. thick × 8 in. long (about \$30). It's also made in a very large size (about 3¼ × 4 × 9 in.) so that four faces are available for use. Coarser grits are available for even faster rough honing.

After initial honing on a 600- or 800-grit water stone, cutting edges are finished on a very fine pol-

ishing stone (about \$50) for a razor-sharp edge. Polishing stones are typically 6000 or 8000 grit (left).

Layout tools

Like Western woodworkers, the Japanese use knives for marking precise cutlines, and marking gauges and steel squares are used to handle layout chores. However, there are a few design differences.

19. Marking knives—Shown are single-bevel and double-bevel versions. The single-bevel marking knife is available in a righthanded and a lefthanded model. Each tool features laminated-steel construction and an extremely sharp, hardened cutting edge that's mounted to a softer steel body (about \$30).

20. Square—The Japanese carpenter square is much lighter than its Western counterpart, but has a few useful features (about \$25). In cross section, the blade is tapered to both marking edges.

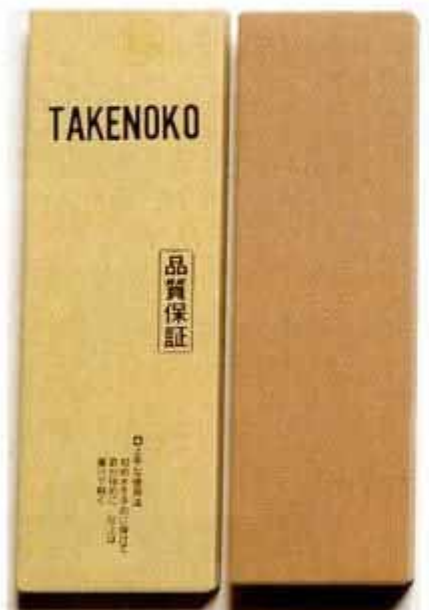
This allows the square to be tilted slightly when held against an edge to mark across a board. The taper also helps in marking a line that's precisely under the edge of the square.

21. Marking gauge—This wooden marking gauge has a single beam, with two irons for laying out tenons. The irons are beveled knives to cleanly score the wood (about \$20). Marking gauges for mortises have pins.

21



20



18

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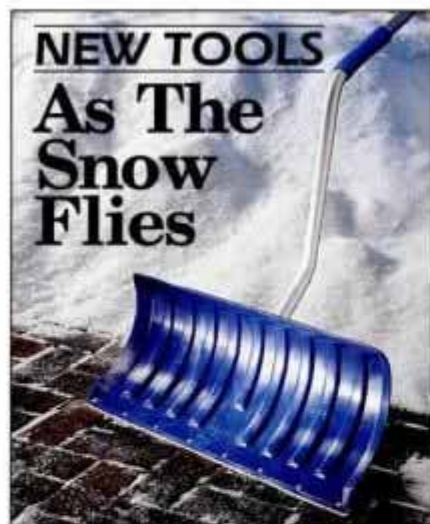
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HOME & SHOP JOURNAL



NEW TOOLS
As The Snow Flies



These two snow tools from Ames are designed to be lightweight and efficient.

Winter Wonderland

We think these two new snow tools are worth a mention. At left, the Snow Shovel/Pusher Model 16-241 (\$27) has a contoured aluminum handle and a D-grip that is large enough to accommodate gloves. Its ribbed plastic blade has a nylon wear strip, and it attaches to the handle with a webbed socket that reduces blade deflection.

The Snow Blazer (\$37) clears a walk in one pass with a 36-in.-wide blade. Its U-shaped steel tube handle is also attached with webbed sockets. Both are sold at hardware stores and home centers. Write Ames Lawn & Garden Tools, P.O. Box 1774, Parkersburg, WV 26102.

Roller Blade

Called the Snowmaster Snowscoop, this device is in a class by itself. Neither a shovel nor a pusher in the conventional sense, this device is a wheeled polyethylene snow blade. You push it into the snow and when it's loaded, you tip it back and wheel it away.

Although we didn't test it in snow, we did get our hands on a floor model at a recent trade show, and we thought the idea was interesting enough to include here. The device is 28 in. wide x 56 in. long, and though it weighs 17 pounds, it seemed easy to handle. It's equipped with molded-in handle slots and a replaceable steel scraper blade on the tool's leading edge. The Snowscoop is available from some home product catalogs or directly from the manufacturer (\$69.90, shipping included). For more information, contact Snowmaster, 230 Bunker Hill Rd., Houston, TX 77024, or call (800) 544-7669. **PM**



NEW PRODUCTS

Fall In Line

Outdoor power products make short work of leaves, snow, grass and brush.

BY ROY BERENDSOHN, Assistant Home Improvement Editor

See You Next Summer

This battery-powered riding mower might make you wish that the grass-cutting season was still ahead. It's equipped with a tri-blade 44-in. deck, near-zero turn capability and infinitely variable speed adjustment via a 5-speed transaxle. Each blade is powered by its own motor. Working on dry grass of average height, it can cut 2 acres before it needs recharging (based on a 2-hour run time). It comes with a recharger and recharges in 13 hours.



It has rack-and-pinion steering and disc brakes.

The machine runs on six 6-volt deep-cycle batteries, and you can buy it with or without batteries. With batteries and optional electric deck lift, it costs about \$6600. Without batteries and with nonadjustable floating deck, it costs about \$4950. Write Ardisam Inc., P.O. Box 666, Cumberland, WI 54829.

Be Quick About It

If your idea of fall lawnwork is to rid your yard of leaves and branches as quickly as possible, then consider the Yard Boss 800, an 8-hp chipper-vac that covers a 26-in.-wide swath of lawn with each pass. The machine adapts to ground conditions with single-lever height adjustment, six forward speeds and one reverse. To reduce the likelihood of a machine this size marking up your lawn, it's equipped with 10-in.-dia. pneumatic tires in back and rounded-shoulder tires up front. Its manufacturer says it chips branches up to 3 in. in diameter and shreds leaves and stalks using nine replaceable and reversible flail knives. It costs \$900 to \$1000 at White Outdoor Power dealers. Write White Outdoor Power, P.O. Box 361131, Cleveland, OH 44136.



Goodbye Rake

Toro and Lawn-Boy know that homeowners shred leaves with their lawnmowers, so if you use a mower on leaves, here are two products that should interest you. First, if you own a Lawn-Boy 21-in. staggered-wheel mower, consider the Leaf Shredder, a bolt-on steel screen that shreds the leaves as they fly around in the deck. The screen costs about \$25 at home centers and hardware stores. If you want a mulching mower that can do a number on leaves as well, consider the 5.5-hp Toro Super Recycler, a 21-in. mulching mower with a curved blade



(see drawing) that suspends and recuts leaves until they are tiny bits. The mower costs \$420 to \$600 at Toro dealers. It is available beginning March 1995. Write The Toro Co., 811 Lyndale Ave. S., Minneapolis, MN 55435.



Bring On The Brush

If you've wanted a chipper/shredder vac that handles like a lawnmower, take a look at Troy-Bilt's 5-hp model, designed for lots from 1/2 to 1 acre. It weighs only 90 pounds, and has three forward speeds, yet it chips 2-in.-dia. branches. Its manufacturer says it reduces leaves, pine cones and such to one-tenth their size, thanks to a 6-blade vacuum fan and a 360° screen in the shredding chamber. The machine costs about \$1000 at Troy-Bilt dealers and Sears. Write Garden Way Inc., 102nd St. and Ninth Ave., Troy, NY 12180.



Jungle Warfare

These retrofit trimmer heads are designed to make short work of jungle-like weeds and grass. One head has serrated plastic blades and a 12-edge trimmer line. The other head comes with 20 ft. of 12-edge line. Both cost about \$18, and they are equipped with an abrasive-resistant nylon line that sharpens itself. How? Good question.

Once the tip of conventional trimmer line dulls, you have to feed out more line to expose a fresh end, hence the need for self-advancing and bump-and-feed line heads. These heads are mechanically simpler. You simply cut a piece of line and insert it in the head. Once the



PM ILLUSTRATION BY ALBERT NOVAK



PHOTO BY ROSARIO CAPOTORTO

tip of this line is dull, a microscopically small piece of the line peels away, exposing a fresh edge. These heads fit all major brands of gas trimmers and some brands of electric trimmers. The line is also available by itself in spools. They're sold at hardware stores and home centers. Write The Source, 3400 Bradshaw Rd., Suite C-3, Sacramento, CA 95827.

Leaf Terror

Simplicity plunges into the walk-behind chipper/shredder market with three models: a 5-hp, an 8-hp and an 8-hp electric key start with recoil-start backup. Each is self-propelled and has a 25-in.-wide pickup nozzle with adjustable airflow. The machine's height is adjustable also, through a 4-in. range. The machine is quite adaptable, says the company: It can pick up matted wet or dry leaves and different sizes of leaves from a range of grass heights. It can also pick up seed pods and pine cones, and debris from a variety of hard surfaces. An accessory kit includes a 20-ft.-long suction hose with adjustable airflow and a broadcast tube, so the machine can be used as a blower. The machine chips limbs up to 3 in. in diameter and has a 4-bushel bag. The three models cost about \$1100, \$1300 and \$1500, respectively, at Simplicity dealers. Write Simplicity Manufacturing Inc., 500 N. Spring St., P.O. Box 997, Port Washington, WI 53074.



The Bigger, The Better

After last winter, you're probably considering getting the biggest snow thrower you can lay your hands on. Honda's HS828K1TAS is among the biggest on the market. Powered by an 8-hp engine, it was the first with hydrostatic drive. The trac-drive machine has an electric push-button start with recoil backup. It's also available with tires instead of trac-drive. It clears a 28-in. swath, can handle snow up to 20 in. deep and can throw it 49 ft. The machine costs about \$1900 at Honda dealers. Write American Honda Motor Co. Inc., 4475 River Green Pkwy., Duluth, GA 30136, or call (800) 426-7701.

The Party's Over

The T-300 is just the machine for tilling under those overgrown flower beds and vegetable gardens. It has an adjustable till path of 10 to 30 in., a worm gear transmission and an overload protection clutch to prevent gear slippage. Also note that it's a center tine model and the tines are below the engine for maximum tine penetration. The tiller costs about \$580 at Husqvarna dealers. Write Husqvarna Forest & Garden Co., 9006-J Perimeter Woods Dr., Charlotte, NC 28216, or call (800) 487-5962.



Keep Your Lights On

Ice storms may knock out your electricity, but the LR series generators are designed to keep the lights on. Homelite says the machines can run at full load for 7½ hours at a time. To provide this capability, the company has equipped them with low-oil cutoff switches, circuit breakers, vibration dampers and engines with cast-iron cylinder sleeves. All the generators have full roll-cage protection. They come in several sizes, ranging from 5 hp/2500 watts to 11 hp/5500 watts, and cost from \$600 to \$970 at outdoor power equipment dealers and home centers. Write Homelite, 14401 Carowinds Blvd., Charlotte, NC 28273.





Leaf Eater

Torque is a handy thing in outdoor power equipment. The more of it you can lay your hands on, the easier your work. The ES-2000 Shred 'N' Vac has 30% more torque than its predecessor, the ES-1000. To increase the durability of its 23.6cc engine, it has a commercial-quality air filter that is sealed at its perimeter and a mounting screw with rubber gaskets. According to the manufacturer, this makes it extremely tight, creating a clean airflow. And the filter's symmetrical shape makes it easy to replace and prevents it from being mounted incorrectly. The ES-2000 costs about \$270 at Echo dealers. Write Echo Inc., 400 Oakwood Rd., Lake Zurich, IL 60047.

Be Patriotic

Patriot says the commercial-like qualities in its electric chipper/shredder help it handle the rough and tumble use that homeowners dish out. For instance, the machine is powered by an unusual 15-amp dual capacitor (capacitor start, capacitor run) 1.5-hp industrial motor. The single-knife chipper/shredder rotor is supported with an outboard bearing, and internal rigidity is accomplished with a hefty 3/16-in.-thick center plate separating the chipping and shredding compartments. General stability is accomplished, interestingly, with a front leg designed to vibrate so it sends vibrations from the machine into the ground. The manufacturer says all these features result in a machine that grinds yard waste to 1/50th of its original size and handles 2 1/2-in.-dia. limbs. The machine costs about \$550 at outdoor power equipment dealers (the vacuum hose shown is optional). To locate a dealer, write The Patriot Co., 944 N. 45th St., Milwaukee, WI 53208, or call (800) 798-2447.



The Boss

The Mini Boss chain saw is designed for light commercial use or for the homeowner who cuts his own firewood and cuts wood around the yard. Available with a 12- or 14-in. bar, the 1.6-hp saw weighs only 9 pounds but it's equipped with an inertia chain brake, an electronic ignition with a lifetime warranty and an easy-access air filter. With a 14-in. bar, it costs about \$200 at Stihl dealers. For more information, write Stihl Inc., P.O. Box 2015, Virginia Beach, VA 23452, or call (800) 437-8445.



Clean It Up

After a summer of hard work, consider cleaning off your power equipment with a pressure washer before storing it. (While you're at it, put some gas stabilizer in the tank. McCulloch's Preserve costs about \$3 for 8 ounces. One container treats 32 gallons.) The F1000 pressure washer runs on 110 volts and connects to an outdoor faucet with a garden hose. Its 3-hp motor and adjustable spray tip produce 1000 psi (it also has a 150-psi setting). The company says it uses one-quarter of the water a



garden hose would use to wash an equivalent area. It costs about \$270 at home centers and hardware stores. For more information, write McCulloch, 6085 S. McCulloch Dr., Tucson, AZ 85706, or call (800) 423-6302. **FM**

**HOME
 IMPROVEMENT**

**Countertop
 Facelift**

You don't have to remove the old laminate, just cover it up.

BY NEAL BARRETT
 PM Illustrations by
 George Retseck

● Over the years, countless home surveys have shown that the kitchen is the most-used room in nearly everyone's house. Not only do we use a kitchen for food preparation, dining and cleanup, but also for a place to entertain guests, do homework and even to serve as a makeshift workshop. Because it's home to so many varied activities, your kitchen can take quite a bit of abuse, and as a result needs a periodic facelift.

It's common knowledge that a kitchen renovation can mean big expenses and big headaches. But there are some relatively inexpensive steps you can take that will give your kitchen some new life. Of course a new coat of paint on walls and cabinets (if appropriate) will go a long way toward brightening up a tired room. You can also replace your worn or outdated laminate countertops, which are some of the largest and most noticeable surfaces in any kitchen. While this job is much less expensive than a complete kitchen remodeling, it's still costly and very inconvenient. A better option, especially if you want to do the work yourself, is to resurface your countertops with new plastic laminate—without removing the old tops.

The techniques we show here will help you avoid much of the inconvenience of complete countertop replacement, but you can still count on having your kitchen out of commission for at least a day or two. If this is your first foray into the world of plastic laminate work, it is a good idea to purchase a piece of laminate and experiment with the application techniques before you tackle the counters.

Plan ahead

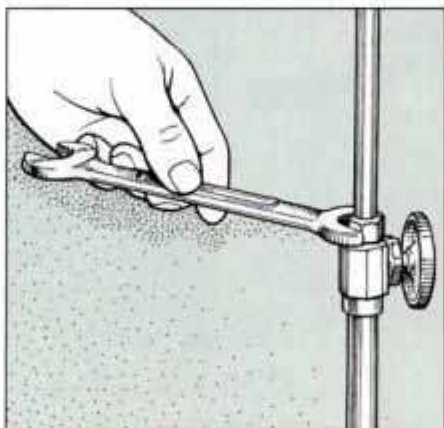
Before beginning this project, carefully inspect your countertop to make sure that it is a candidate for being



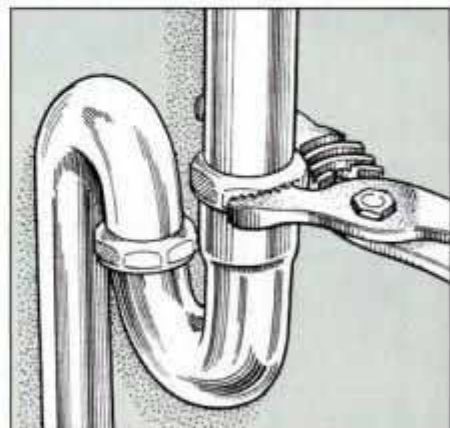
relaminated. The original laminate material must have a smooth finish, rather than the sculpted, uneven surface that some laminates offer. Next, check that the laminate is firmly bonded to the substrate over its entire surface. Any bubbles or loose edges

make the counter unsuitable for re-covering. If there are small cracks or pits in the counter surface, they can be filled with an auto-body filler (such as Bondo) and then sanded flush with the surface.

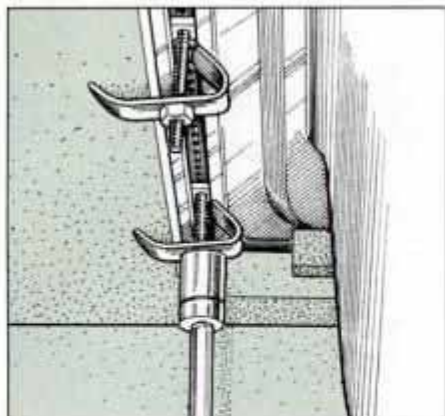
Bring a sketch of your countertop



1 Shut off the water to the sink, then loosen the compression fittings that hold the sink supply lines to the shutoffs.



2 Use slip-joint pliers or a pipe wrench to loosen the slip nut that holds the sink tailpiece to the waste line trap.



3 Remove the clips that hold the sink to the countertop, using either a screwdriver or nut driver, depending on fastener type.



4 Most sinks are set in a bead of caulk or putty. To loosen the bond, carefully work a putty knife around the rim of the sink.



5 Lift the sink from the countertop and store it in a safe place where the pipes and fittings will not be damaged.

layout, with dimensions, when you go to purchase the laminate. The material is usually available in a wide variety of sizes, and a sketch can help in planning the best sizes to purchase for minimizing waste.

When it comes to picking your adhesive, a user-friendly water-based contact adhesive is the best choice for home work. Check the adhesive container for approximate coverage and be sure to buy plenty of adhesive for the job.

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Getting started

The first step in preparing the countertop is to remove the sink. Use the local shutoffs to turn off the water to the sink, then loosen the nut on each shutoff that holds the sink supply lines (Fig. 1). Loosen the slip nut that holds the sink tailpiece to the trap (Fig. 2), and remove all the clips that fasten the sink to the countertop (Fig. 3). Most sinks are set in a bead of plumber's putty or caulk. To loosen the bond of this setting medium, carefully run a flat putty knife between the sink rim and the countertop surface (Fig. 4). When the sink is loose,

lift it from the counter and store it in a safe spot with all the applicable hardware (Fig. 5). Stuff a rag into the open end of the drain trap and cover the open ends of the sink supply lines to keep them clean while you work.

Next, check the entire counter surface for any holes, pits or cracks and fill them with auto-body filler. When dry, sand these patches flush with the surface, then lightly sand the entire counter surface with 120- or 150-grit sandpaper (Fig. 6). Thoroughly remove all sanding dust from the counter, then wipe the surface with denatured alcohol to remove any residual oils,

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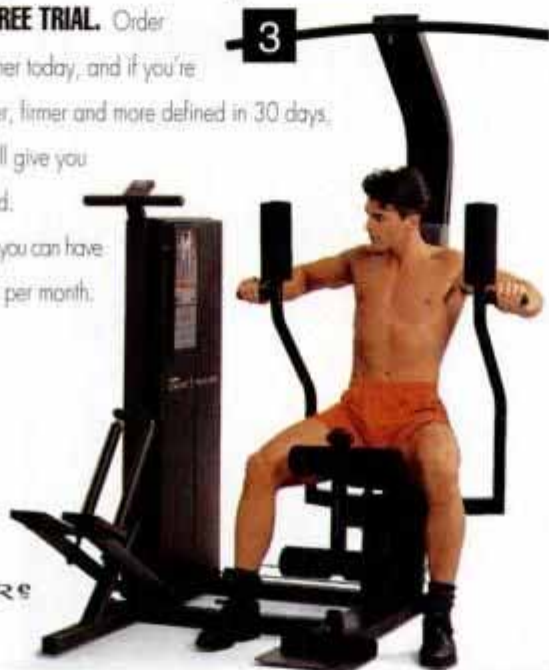


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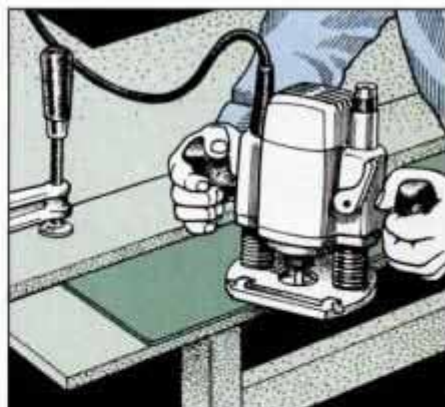
HOME & SHOP JOURNAL



6 Begin by sanding the entire countertop with 120-grit paper. This rough surface lets the contact adhesive hold better.



7 Brush away sanding dust, then wipe all surfaces with denatured alcohol to remove any grease or other contaminants.



8 Use a router and a flush trimming bit to make any seam cuts on the laminate. Be sure to clamp the stock to a straightedge.

line directly onto the old counter (Fig. 9). This line serves as a guide for the laminate after the adhesive is applied.

The next step is to spread the adhesive on both the laminate and the countertop. Most adhesives can be spread with either a brush or a roller. Generally speaking, a roller is the faster method, and the one that gives the most even coverage. There are special roller covers sold just for contact cement. They have a nubby, carpetlike appearance and are sold in

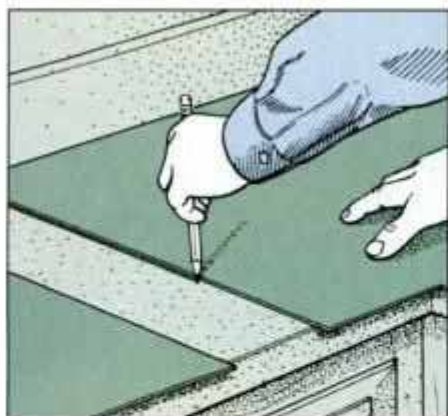
soaps or other contaminants (Fig. 7).

Lay out the sizes of your countertop pieces on the laminate material, allowing an overhang of 1/2 in. on all edges. There are several methods for cutting plastic laminate, but the most practical in this instance is to use a sabre saw fitted with a fine-tooth blade, like a metal-cutting blade. Support the laminate well on both sides of the cut and proceed slowly. A small amount of chipping near the blade is normal.

If your countertop requires a seam, the pieces must be cut perfectly straight. The preferred method of doing this is with a router and a ball-

bearing flush trimming bit. Securely clamp the laminate to a piece of plywood or flakeboard that has a straight edge. Make sure the laminate overhangs the edge by about 1/8 in. Then use the router to flush trim the laminate to the edge (Fig. 8). Trim the mating piece in the same manner to yield a nice, tight joint.

After cutting the joints, place the pieces together to check for fit. If there are any small gaps, you can use a mill file to gently remove material for the tightest possible fit. Then, lay the laminate on the countertop in its desired position and trace the joint



9 Before applying any adhesive, lay the laminate in place and mark any seam lines directly onto the countertop.



10 Pour out the contact cement on the counter and spread it evenly with a roller made especially for contact cement.



11 To perfectly position the laminate, support the piece on a series of 1-in.-dia. dowels spaced 12 to 16 in. apart.

paint stores and home centers.

Lay the laminate, bottom side up, on a large, flat surface that's been covered with old newspapers or plastic sheeting. Pour a small amount of contact cement onto the laminate and spread it with the roller. Continue in this way until all of the laminate is covered with adhesive. Next, move to the countertop and spread the adhesive there using the same technique (Fig. 10).

Contact adhesive must be allowed to dry until it no longer feels sticky



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when touched with your finger. Under most circumstances, this takes about 30 minutes. When the adhesive is dry, you can install the laminate.

Installing laminate

Since the adhesive bonds instantly when the laminate touches the counter, you must have a way of positioning the material without allowing the two surfaces to touch. To accomplish this, use a series of 1-in.-dia. dowels, spaced 12 to 16 in. apart along the length of the counter. Since the adhesive is dry, the dowels can be placed between the counter and lami-

nate without sticking—and they allow careful placement of the laminate over the counter without any contact between the two.

Carefully position the first piece of laminate using the seam mark as a guide. Then, beginning at one end, remove one dowel at a time to bring the laminate onto the counter (Fig. 11). Lightly smooth the laminate with your hand as you remove the dowels to avoid trapping any air and creating bubbles. Use a rubber roller (a rolling pin can substitute) to roll over the entire surface and ensure a good bond (Fig. 12). Move on to the next piece



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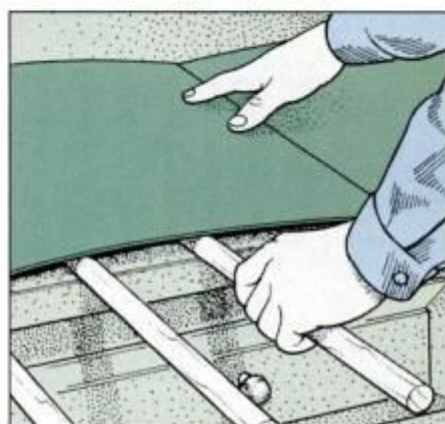


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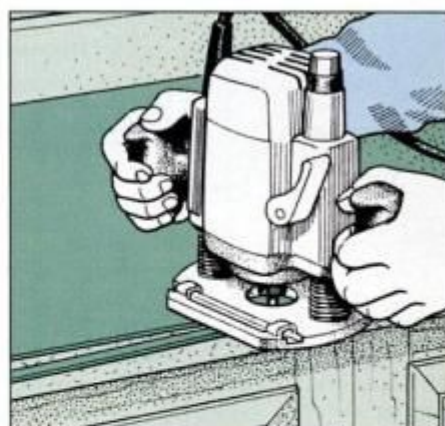
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12 Roll the entire surface, to ensure a good bond with the old counter, using a rubber J-roller or pastry rolling pin.



13 When installing the second piece of a laminate, always position the seam edge first. Then remove the closest dowel.



14 Use a router with flush trimming bit to carefully cut off the overhanging laminate on all the exposed edges of the countertop.

of laminate, again using the dowels to position the piece. Pay extra attention to the alignment of the pieces at the joint. Be sure to first remove the dowel closest to the joint, then work your way back from there (Fig. 13). Again, roll the piece to provide a complete bond.

Use the router with a flush trimming bit to trim the laminate flush with the countertop edge (Fig. 14). At those points where the countertop returns to the wall, and the router cannot reach all the way into the corner, use a mill file to trim it flush.

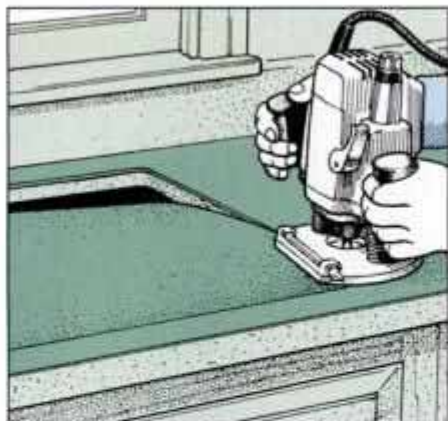
Drill an access hole of approxi-

mately 1 in. dia. in the sink cutout for entry of the router bit, then use the router to flush trim the laminate in the cutout area (Fig. 15). Use a mill file again to trim the laminate against the back side of the cutout if the router cannot reach all the way to the edge. Also use the file to trim inside corners where two pieces of laminate meet (Fig. 16).

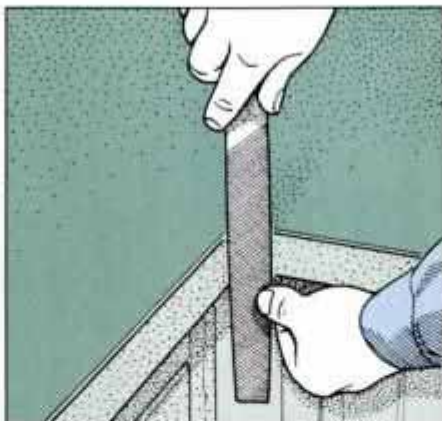
Cut strips of ¼-in.-thick hardboard to width for the backsplash. If you wish, you can leave these at rough length at this point, and trim them to finished length after lamination. Cut your strips of laminate to overhang

the hardboard by ½ in. on all sides. Apply the contact cement to all parts, then, when dry, position the laminate and roll it down (Fig. 17). Use the router to trim the laminate flush, then trim the strips to finished length using a miter box or table saw.

To apply the strips to the backsplash, we used clear silicone adhesive. The silicone can also be used



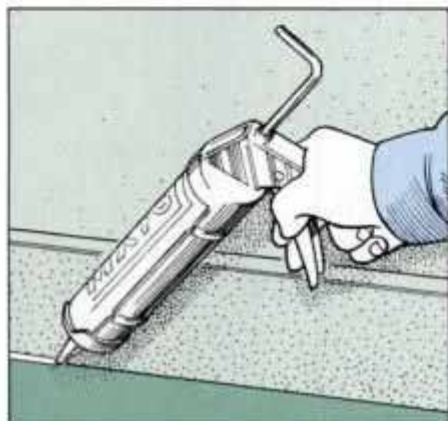
15 Drill an access hole inside the sink cutout area. Then use the router to trim the waste flush to the edge of the cutout.



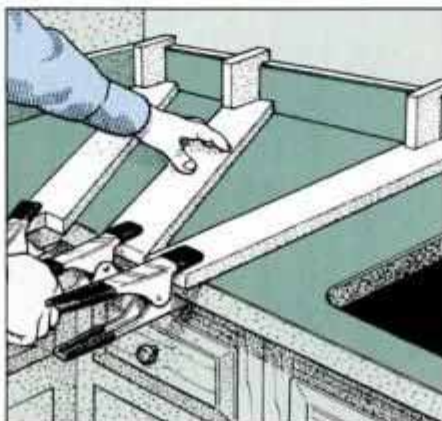
16 Use a mill file to square the inside corners of the countertop edges. Keep the file perpendicular to the counter surface.



17 Apply laminate to strips of 1/4-in.-thick hardboard to create the new backsplash. Trim the edges flush with a router.



18 Apply clear silicone caulk to the back of the new backsplash and to the counter where the new backsplash will be placed.



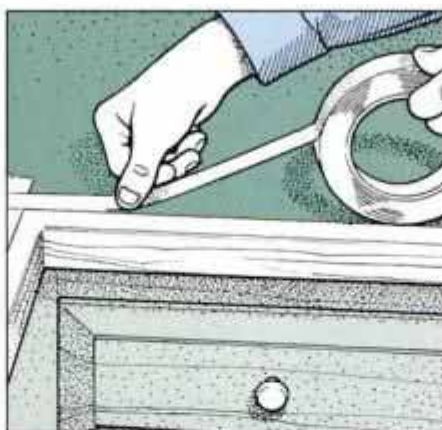
19 Push the new backsplash onto the old and hold it in place with clamps made from scrap plywood and spring clamps.



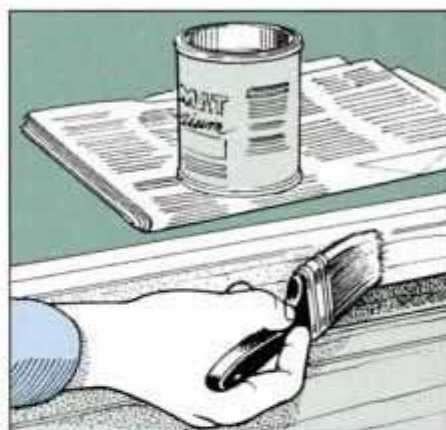
20 Cut strips of hardwood to size for use as backsplash caps. Then bore pilot holes and attach the caps with 8d finishing nails.



21 Attach hardwood edging to the front of all the countertops with finishing nails. Set nailheads and fill holes with wood filler.



22 Before applying a finish to the hardwood edging—or backsplash caps—protect the laminate with masking tape.



23 For the best protection, apply three to four coats of polyurethane to the edging and caps before using your new countertop.

to seal the joint between the backsplash and the countertop. Run a small bead of silicone along the back edge of the countertop, then apply a wavy bead along the backsplash (Fig. 18). Position the strip, then use some homemade clamping jigs to temporarily hold the strip in place until the silicone sets (Fig. 19). We made our jigs from some scrap ply-

wood that we screwed together and held in place with spring clamps.

Trimwork

Rip strips of 3/4-in.-thick hardwood (we used red oak) to width for the countertop edging and backsplash cap. Hold each strip in place, then drill pilot holes for No. 8d finishing nails (3/16 in. dia. is ideal) and nail the

strip to the edge (Fig. 20). Use a nailset to drive the nails below the wood surface and fill with matching wood filler (Fig. 21). Carefully sand the filler when dry. To finish these strips, first protect the adjacent laminate surfaces with masking tape (Fig. 22). Then brush on three coats of polyurethane, letting each dry before proceeding (Fig. 23). **PM**

Homeowners Clinic

BY NORMAN BECKER, P.E.,
Contributing Editor

Lead-Paint Removal

My old farmhouse is covered with clapboard that was painted with a lead-based paint. Can you tell me the most economical and efficient way to remove it? Also, what precautions should I take when doing this work?

VIOLA KLOPP
WOMELSDORF, PA

There is no economical or efficient way to remove lead-based paint. Repainting with an oil-based paint will not solve the problem because the lead will eventually leach through the topcoat.

There are currently three acceptable methods of abating lead paint:

1. Replacement.
2. Removal.
3. Encapsulating or covering.

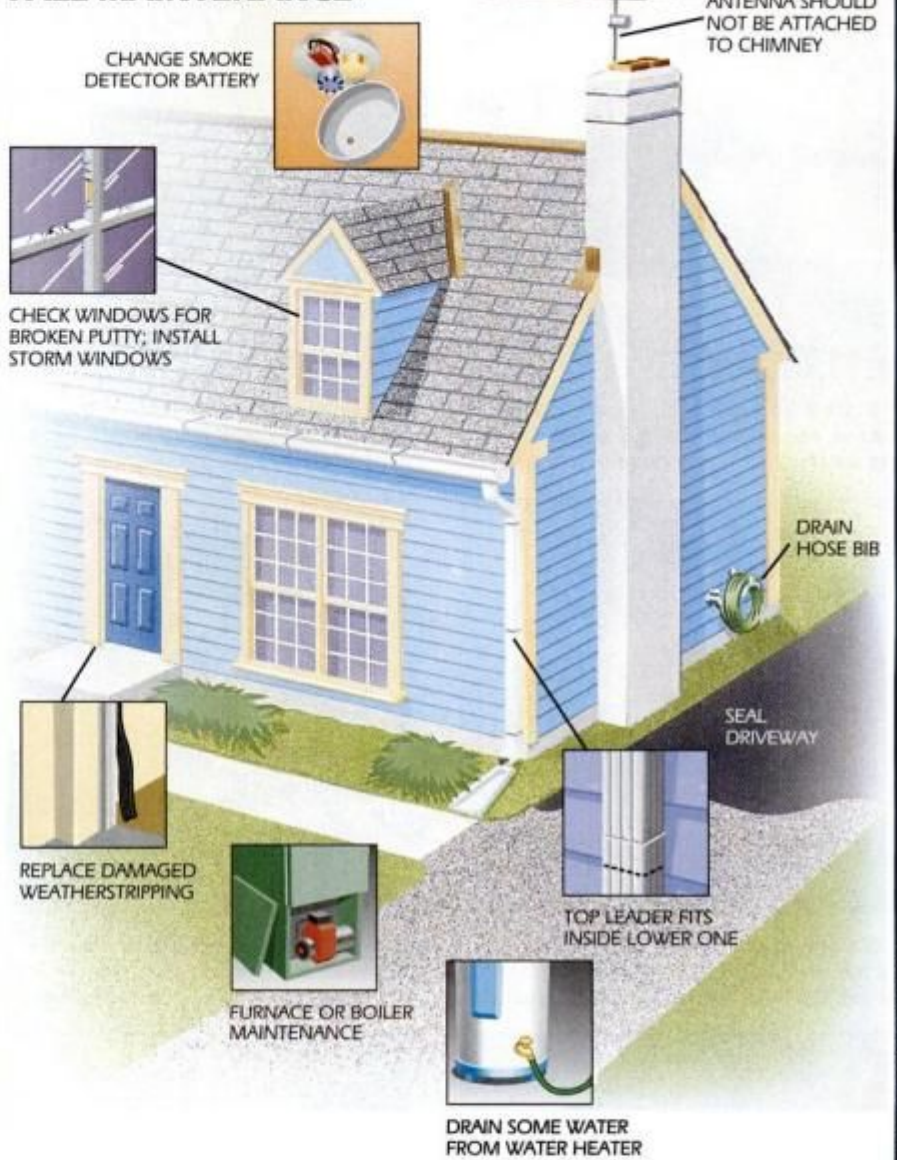
Replacement is most appropriate for windows, sills, woodwork and doors but not for exterior siding. Removal of the lead-based paint, which includes scraping the surfaces using hand scrapers, chemical solvents or heat guns, is the most costly because it is labor intensive and generates large amounts of lead dust, which must then be disposed of in special landfills.

The least costly approach is encapsulating and covering. The exterior walls may be covered with aluminum or vinyl siding. However, the walls should first be treated with an encapsulant to prevent lead-based paint contamination during the siding installation. The encapsulant is sprayed or rolled on. It bonds chemically with the lead in the paint below to prevent it from leaching.

Since you refer to the building as an old farmhouse, I assume that some of the paint is peeling and flaking. If this has been the case, the ground around the building is contaminated from lead dust and flakes. If the soil is contaminated, it should be covered with sod or gravel. It's likely that the walls and trim inside the house have been covered with lead-based paint, too.

Before any work is undertaken, you should engage the services of a trained lead-paint inspector to determine the extent of the problem.

FALL MAINTENANCE



● A house is not only a person's home, it's also in most cases a major financial investment. And in order to keep its value, a house must be maintained. If you've been putting off maintenance projects because of the heat and humidity of summer, the cool, dry days of fall are a good time to catch up.

This list is a generalized one in that it does not contain every maintenance item, and you may find that some of the items don't apply to your house. Still, it's a good place to start, and you should expand it to meet your needs.

Grounds:

- Check and repair concrete walkways. Look for areas that are susceptible to damage from de-icing salts.
- Seal driveway. A black surface helps melt ice and snow.
- Do fall pruning and lawn care. Spread mulch on flower beds.

House, exterior:

- Clean gutters. Refasten loose gutter brackets. Check for missing strainers.
- Downspout sections should be properly installed, with upper section fitting into lower section.
- Check TV antenna for sturdiness. Antenna should not be attached to chimney.
- Trim tree limbs away from roof.

- Check visually for loose shingles, flashing.
- Install storm windows. Remove debris from windowsills. Repair damaged putty.
- Drain external hose bibs and leave hose bibs open.

Interior:

- Replace smoke detector batteries. Check detector for operation.
- Replace damaged weatherstripping.
- Drain a couple of quarts of water from water heater to remove sediment.
- Have routine maintenance done on boiler or furnace.
- Replace furnace filter and put several filters aside for winter months.

Water Heater Venting

I just replaced my gas hot water tank. The instructions for the new tank recommend that at least once a year I inspect the venting system to look for obstructions, damage and rust. I checked the visible portions of the vent, but most of it runs through interior walls. Is there an alternate way to check the venting system other than visual inspection? R. WISNIEWSKI
STRONGSVILLE, OH

The vent system for a water heater should discharge exhaust gas harmlessly outside and not "spill" it back into the utility room. In addition to a visual inspection, you should check the area by the draft diverter (at the base of the vent pipe) for escaping exhaust gas. Put your hand close to the opening at the top of the water heater. If exhaust gas spills out of the diverter, you will feel hot gases blowing across your hand. This is a condition that must be corrected because the gas contains carbon monoxide. This colorless, odorless gas is poisonous and can cause asphyxiation.

Another check for faulty venting is to hold a lit match at the draft diverter opening. If the exhaust gases escape into the room, they will blow out the flame. If the vent system is functioning properly, the flame will be sucked into the draft diverter hood.

As a safety precaution, I recommend that homes with fuel-burning appliances be equipped with one or more UL-listed carbon monoxide detectors such as the one manufactured by First Alert. These cost from \$40 to \$60 at home centers and hardware stores.

Grab Bar

I had a company out to install a bathtub grab bar, but they could not successfully locate the wall studs. They

A list of companies that sell and service antique gas, coal and wood stoves, ranges and boilers. —Steve Toth

Barnstable Stove Shop
P.O. Box 472, Route 149
W. Barnstable, MA 02668
(508) 362-9913

Shop specializes in restoration of pre-1930 gas Glenwood ranges. Shop also restores all types of wood and coal stoves.

Brunelle Enterprises Inc.
203 Union Rd.
Wales, MA 01081
(413) 245-7396

Specializes in Glenwood and Crawford ranges and the restoration of wood and coal stoves.

Bryant Stove Works
RFD 2, P.O. Box 2048
Thorndike, ME 04986
(207) 568-3665

Restores all models of wood, coal and combination stoves.

Erickson's Antique Stove Inc.
2 Taylor St.
P.O. Box 2275
Littleton, MA 01460
(508) 486-3589

Shop sells and restores all models of wood, coal, gas, and wood/gas combination stoves. Shop specializes in 1920-30 gas ranges.

Heckler Bros.
4105 Steubenville Pike
Pittsburgh, PA 15205
(412) 922-6811

Company furnishes castings and firebrick for coal furnaces, boilers, and cooking and heating stoves. Please include pattern numbers from parts you need to replace.

**Hickenbottom
Antique Stove Works**
8515 Prunedale Rd. N.
Prunedale, CA 93907
(408) 663-4413

Shop specializes in wood and gas heating and cooking stoves from 1840 through 1949.

Mark's Supply Co.
230 S. Main St.
Shenandoah, PA 17976
(717) 462-0748

Shop sells and restores wood and coal stoves, and sells parts for wood and coal stoves.

**Stanley Iron
Works Inc.**
64 Taylor St.
Nashua, NH 03060
(603) 881-8335

Shop sells and restores all model wood, gas and electric ranges. Company also converts old cooking ranges to modern gas and electric appliances.

**Wedgewood,
Western/Holly**
1309 E. Las Tunas Dr.
San Gabriel, CA 91776
(818) 448-7668

Shop specializes in restoration and parts for gas and electric ranges, 1920 to present.

recommended some other methods of installing a grab bar instead of attaching it to studs. What method do you recommend?

MARY LOU PARLATO
DETROIT, MI

The only method that I recommend for securing a grab bar is to fasten it to the studs. A person can exert considerable force on a grab bar, and if the bar is not adequately fastened, it will probably pull out of the wall, rather than being loosened.

Many people mistake the washcloth rail on a ceramic soap dish as a grab bar. It is not designed for this. The only grab bar suitable for a bathtub is a stainless-steel model secured to the studs. There are instruments that locate studs. If the company that you called cannot locate the studs, perhaps you should call another company.

To Stain Or Not To Stain

I have a question that needs an unbiased answer. I have a contemporary home that I built seven years ago. The exterior is rough sawn cedar. It was

BUZZWORD

● Ever step into a room and the first thing you notice is all the joints in the drywall showing through the paint? This condition is known as joint banding, and to find out its causes and cures, we called United States Gypsum, a drywall and plaster products manufacturer. USG says joint banding results from too thin a layer of joint compound over the tape, sloppy installation and wavy framing lumber behind the drywall. The cure? Use three coats of compound above

Joint Banding

the tape. When in doubt, skim coat the entire surface with compound after the third coat of compound has dried and has been sanded. And use good-quality framing materials behind the drywall. If you have a new room professionally painted, request that the paint be rolled, not sprayed. Rolled paint hides imperfections. Finally, glare from lighting or sunlight emphasizes drywall flaws while diffuse light hides them.

—Roy Berendsohn

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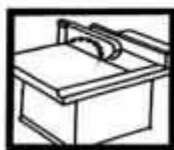


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stained with a Cabot wood-preserving transparent stain because I wanted an "instant" weathered look. This is a one-story house with a hip roof and a 3½-ft. overhang all the way around. With the foundation shrubbery, not much weather gets to the siding.

My question: Does it need restaining? Painters and paint store owners tell me it needs restaining. I don't think it needs it, but I want to do what's best for my home. Your unbiased professional opinion would be greatly appreciated.

D.D. RACKLEY JR.
TALLAHASSEE, FL

The answer depends on the extent to which the siding is exposed to the weather. All species of wood that are exposed to the weather swell and shrink, depending on moisture gain or loss. This, in turn, causes the surface to crack and check. When wood is exposed to the Sun's rays over a period of time, the cellular structure is affected to the extent that naturally weathered cedar wears away at a rate of ¼ to ½ in. of surface per 100 years. You can retard natural weathering by coating the cedar with a good-quality stain containing a water-repellent preservative. However, if your siding is indeed protected from the weather as you describe, then coating it should not be necessary unless you want to do it for aesthetic reasons.

The main cause of problems with all types of wood siding is constant moisture. As long as the wood is kept dry, it can last indefinitely. However, when the moisture content exceeds 20%, the wood will rot. The

area of concern with wood siding is the portion near the ground. Although it is not good construction practice, I quite often find siding is either very close to the ground or in direct contact with it. This usually results in rotting sections. Although cedar has a natural resistance to rot, it is not immune to it.

In order to retard the growth of the fungi that cause rot, wood that is exposed to constant moisture should be coated with a good paraffin-based water-repellent preservative.

Sump Pump Care

Can you tell me how to care for my sump pump? Every winter I have to call a repairman after the first rain to get it started. What is the standard procedure to keep these things in good running condition?

MARY L. MEARNS
SANTA CRUZ, CA

Normally, a sump pump does not require any maintenance. Certainly not yearly maintenance. In all probability, the pump's intake port is sucking in dirt from the sump pit, and this is clogging the pump. The pit should have a liner, which prevents the earthen walls of the pit from eroding and depositing silt and tiny pebbles at the base. The pump should also be positioned so that the intake port is not at the base of the pit. Some sump pump manufacturers also make screens or filter boxes that can be installed in front of the pump's intake. Check with the manufacturer of your pump to see if such optional equipment is available. You can also make one yourself

Free Painting Guides

• Homeowners looking for help with their next painting project can find it in these nine Answer Guides. Each is de-

are well prepared and thorough given their compact size. They're available at Sherwin-Williams paint dealers. —R.B.

voted to a basic painting issue that homeowners deal with. For instance, Answer Guide No. 4 is titled *Mildew Control*, while No. 3 is titled *House Paint Problems*. Not all the guides are dedicated to problem solving, some just tell you how to do the job. Guide No. 2, for instance, is dedicated to special paint effects, and No. 7 tells you how to do exterior staining. All the guides



using a window screen. However, you should periodically check the screen to make sure it is not clogged.

Condensation On The Foundation

I have a home in the mountains of Arizona, and I find condensation collects on the beams bolted to the foundation. Vents have to be closed in winter to keep the pipes under the house from freezing. There is 2 in. of foam insulation on the inside of the foundation wall.

What can I do to keep the water from accumulating on the 2 x 8 bolted to the foundation?

F.R. KUFFER
PINETOP, AZ

Moisture buildup in a crawlspace—assuming it is not the result of water seepage—is normally caused by subsurface water. Even when the ground in the crawlspace seems dry and dusty, moisture can accumulate in the area as a result of capillary action. Capillary rise occurs in nearly all crawlspaces built in areas where the soil is clay or silt. According to the University of Illinois Small Homes Council, as much as 18 gallons of water per day can evaporate into a crawlspace under a 1000-sq.-ft. house.

If this is the source of moisture, then it can be controlled by covering the ground with a vapor barrier (4-mil polyethylene). The interior joints should be overlapped by a minimum of 6 in., and the perimeter edges should be turned up onto the walls of the crawlspace.

Another possible source of moisture into a cold crawlspace is from the warm house above. Excessive moisture inside the house (high water vapor pressure) can travel downward through the floor into the cold crawlspace (low water vapor pressure) and condense on the cold surface. To prevent the downward flow of moisture vapor, you can install a vapor barrier between the overhead floor joists in the crawlspace.

Septic System Chemicals

Is it really necessary to add yeast or chemicals to a septic tank to maintain balance and trouble-free operation? Thank you in advance for answering this common question.

JOHN T. FLACK
SPRING HILL, FL

The most important maintenance item for a septic system is periodic

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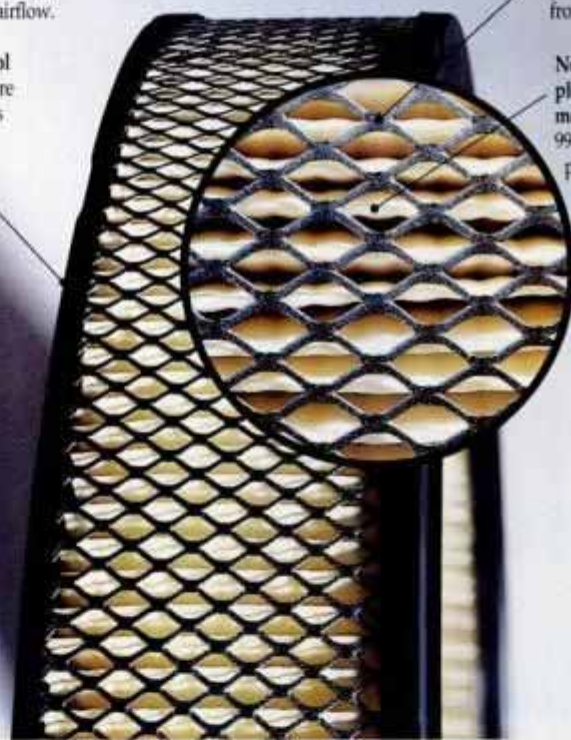
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pumping. Most health departments recommend that septic tanks be pumped every two to three years or when the total depth of sludge and scum exceeds one-third of the liquid depth of the tank.

Health officials in the federal government and many state governments have found that the operation of septic tanks is not improved by the addition of chemical compounds, enzymes or septic tank cleaners. In general, the addition of chemicals to septic tanks is not recommended. Some products that claim to "clean" septic tanks contain compounds that may damage the

disposal field and actually result in clogging.

In the Manual Of Septic Tank Practice by the U.S. Department of Health, Education and Welfare, it states that although hundreds of these products have been placed on the market (some of which have been marketed using extravagant claims), none have proven to be an advantage in properly controlled tests. **PM**

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

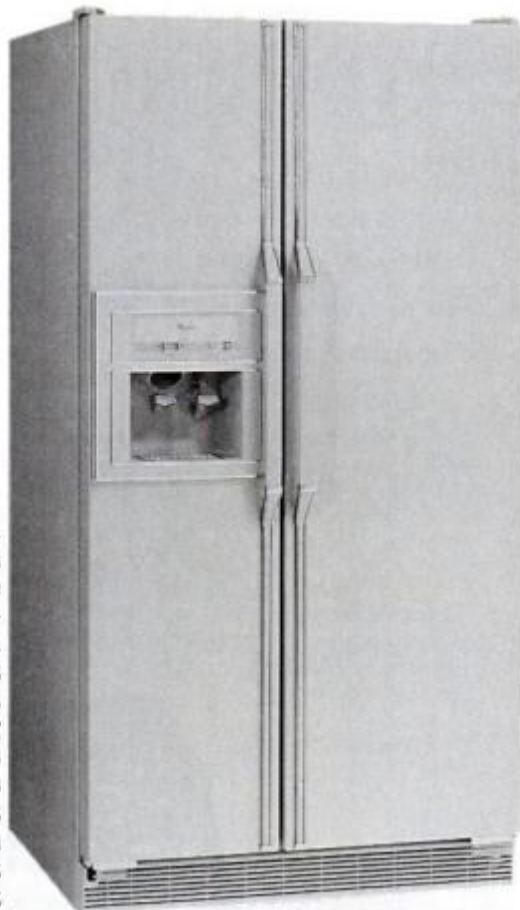
Just ask Norman about it. Send your question to Homeowners Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

NEW PRODUCT
High-Tech Fridge

Whirlpool's award-winning refrigerator hits the marketplace.

BY ROY BERENDSOHN,
 Assistant Home Improvement Editor

● Whirlpool has seen the future, and it looks a lot like a refrigerator. In fact, it is a refrigerator, the same one that recently netted the company \$30 million in prize money from a consortium of electric utilities. It also received the 1994 POPULAR MECHANICS Design & Engineering Award. When the refrigerator was introduced, some of its refinements were still confidential, but now that the production units are finally in the marketplace, it's clear that Whirlpool not only developed a great



product but also may well have ushered into the appliance marketplace a whole new way of developing products.

PM reader buys a fridge

"I hate the idea of buying into old technology on something you're going to have for 20 years," said PM reader Tom Rose, a technical manager in Los Gatos, California, who bought one of the Whirlpool SERP (Super Efficient Refrigerator Program) refrigerators.

Rose felt compelled to buy the refrigerator because it would cut his utility bill. While conceding that it was good to get an appliance that was designed to be environmentally responsible, Rose maintained the financial considerations were foremost in his thinking. And, he said, "Let's face it, refrigerant doesn't leak out very often." Whirlpool estimates that this appliance can save a homeowner nearly \$400 in electricity over the course of 17 years.

Of course, there are other homeowners who simply want to use less energy, said Dennis Moir of Western Appliance in San Jose, the deal-

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er who sold Rose his appliance. Owning energy-conserving appliances gives these people "a sense of contribution" that they are really helping the environment, he said. Still, Moir admitted that even in a "highly enlightened" marketplace like Silicon Valley, where homeowners are hip to technology and aware of environmental matters, manufacturers have to make it easy and affordable to own environmentally benign products.

Incremental improvements

The technology that you buy into with this appliance is at once impressive and basic, demonstrating how a product can be improved with incremental advances. For instance, engineers improved energy efficiency by putting a bend in the drain tube that leads from the evaporator to the drip pan in the condenser compartment. When the condenser fan was blowing, the air movement across the tube created a siphon effect allowing warm air to enter the bottom of the appliance. Putting a bend in the tube prevented the air siphoning.

Along similar lines, the company increased the door thickness to fit more

insulation. Tom Rose said opening the appliance is a little like "opening a bank vault" because of the door thickness, but he said it doesn't interfere with using the appliance.

Along more complex lines, the company replaced the condenser fan motor, switching it from a shaded pole type to one with an internal capacitor, improving cooling and motor efficiency in the process. The real challenge, however, was to make the compressor work with the new non-ozone-depleting refrigerant (HFC134a). The new refrigerant was chemically incompatible with the lubricant and materials used in the existing compressor, according to Whirlpool engineer Vince Anderson, director of environmental and regulatory programs for Whirlpool.

Anderson, who helped engineer the appliance, said that, unlike a car, in which you can change the oil after several thousand miles, a refrigerator's lubricant system is completely sealed for the projected life of the appliance—at least 17 years. Periodically removing the compressor to fix this is out of the question.

Whirlpool engineers debugged the process using elevated temperature

cycles to approximate the wear on the compressor. Also, they field-tested the system by making a deal with Whirlpool employees: They could buy test models at a substantial discount.

Finally, the unit features microchip technology that even real technophiles can appreciate. The appliance does not defrost at preset intervals, as conventional refrigerators do. Instead, a microchip in the defrost control "reads" the information sent to it by a variety of sensors, which interpret temperature and humidity. The microchip turns the compressor and defrost circuit switch on and off. Current is sent to the defrost heater only when it's appropriate, saving energy that would be wasted on an unnecessary defrost cycle.

Not content to leave a good thing alone, the company says it plans to introduce improvements next year, one of which is vacuum-panel doors. This should reduce the bank-vault effect that Tom Rose spoke about.

The refrigerator is sold under the Whirlpool, Frigidaire, KitchenAid and Kenmore brands. For a SERP brochure, write: SERP, Whirlpool Corp., P.O. Box 405, St. Joseph, MI 49085. **FM**

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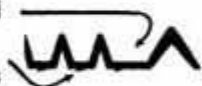
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HOME & SHOP JOURNAL

VIDEO REVIEW

Mastering Your Table Saw

● The Taunton Press has the uncanny ability to find knowledgeable craftsmen with a relaxed air on camera. This has resulted in a stream of top-notch instructional videos on woodworking and carpentry. This video continues the tradition.

Kelly Mehler, a skilled cabinet-maker with a gift for instruction, leads the viewer through every step in table-saw use. He takes a saw out of its box, sets it up and goes to work.

Appropriately, Mehler's approach is from the bottom up. He tips the saw over and the viewer gets an excellent view of the machine's insides. He explains the saw's parts, and how to check them for flatness, fit and square. You see how to tighten, tweak and otherwise adjust the parts so the saw performs reliably and safely.

Nothing is overlooked or viewed as being too basic. For example, Mehler shows how to install a blade, set the fence and how to stand when using the saw. After watching the video, we had a new appreciation for basic table-saw skills and how they can be improved. The video costs about \$35, and it has an excellent companion book that costs about \$26. Shipping is extra for both. Write The Taunton Press, P.O. Box 5506, Newtown, CT 06470.

—Roy Berendsohn

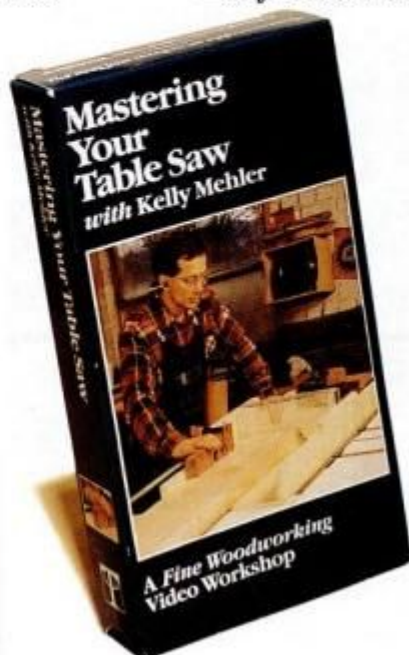


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The Alternate Fuel Report: Hydrogen-Powered Miata

BY JIM DUNNE, Detroit Editor

● At a glance, it looks like any other Mazda Miata. An appealing 2-seater with peppy performance and agile handling. However, once behind the wheel and on the road, you realize that this is far from your standard-issue Miata. In fact, it's far different from just about every other automobile on the road.

For one thing, you instantly notice that this Miata does not have the smart acceleration you expect from Mazda's small sports car. For another, this car's handling is slightly less nimble than the norm.

Well, truth is, beneath this Miata's hood there's a 2-rotor rotary engine—just like the company's RX-7 sports car. Except that this rotary engine runs on hydrogen fuel.

And that hydrogen is stored in a special all-metal tank that adds about 500 pounds to the diminutive car's weight.

Beyond electric power

While most future-automotive research is centered around electric vehicles, Mazda is seriously looking into the viability of hydrogen gas as an alternate fuel. The appeal is great: The fuel works easily with today's en-

gines—particularly rotary engines—and there's a never-ending supply of the stuff. If you have water and electricity, you can produce hydrogen. Furthermore, the exhaust emissions from hydrogen-fueled engines are squeaky clean, and the fuel itself can be recreated to power an engine again and again.

Mazda's hydrogen Miata performs much like a gasoline-powered car you drive every day. Yes, the small car's performance is down thanks to the added weight of the fuel tank. But in reality, during my test drive with the most-rare Miata, I found that the car performs and handles on a level with some current midsize sedans. Acceleration is slower than you would

expect in a rotary-powered Miata, because of the 120-hp rating and the hundreds of pounds of fuel in the trunk. And weaving through a small slalom course betrays the extra weight of the car, revealing a slower response to handling maneuvers.

One key problem with hydrogen fuel is the 500-pound weight of the fuel tank. In cars, hydrogen is stored by combining it with metal. That forms metal hydride, the heavy material that makes up the fuel "tank." As the metal is warmed, it gives up the gas, and this is fed into the engine.

An added drawback is the loss of trunk room. The hydrogen tank takes up about as much space as a large suitcase. However, Mazda engineers believe that metal-hydride pieces can actually be built into the vehicle, serving as both structure and fuel tank.

Slow on the uptake

Finally, there is one other irksome drawback to hydrogen fuel. There is some delay in refueling the tank. Hydrogen gas is fed into the tank more slowly than today's gasoline pump—a lot more slowly, in fact. A typical refill for 60 miles worth of fuel takes about 10 minutes using today's methods. A major part of the research into hydrogen fuel targets this refueling delay.

Mazda officials say that hydrogen-fueled cars should be ready for production sometime before the year 2020. That's an eternity in car development terms—way beyond any real likelihood. But you have to start somewhere. Today, the company has a total of 11 hydrogen-fueled cars in test stages. One is operated by a steel company in Japan, where the by-product of steelmaking—hydrogen—is abundantly available as a fuel for the vehicle.

PM



Metal-hydride fuel is stored in a suitcase-size tank (inset) that consumes the Miata's trunk. The refueling process is a slow one, and requires special equipment.

Later this year there will be a luxurious LT 4-door with all-wheel drive.

Regardless of configuration, the Blazer is powered by a stronger 4.3-liter V6. For '95 this engine produces 195 hp and 260 ft.-lb. of torque. While a 5-speed manual will be available later this year in 2-door models, a 4-speed automatic is standard.

Other important standard equipment includes 4-wheel ABS, a driver's airbag and air conditioning.

GM's full-size sport/utility vehicles used to be called the Blazer and Jimmy. Last year GMC renamed its version the Yukon. This year Chevrolet follows suit, renaming its big Blazer the Tahoe. Right now, both are available only with two doors, 4wd and a choice of V8s—a 5.7-liter gasoline engine or a 6.5-liter turbodiesel. Coming later this year—possibly as early as this spring—the 2-door versions will be joined by 4-door models. These will offer a choice of 2wd or 4wd. Larger than the 2-door models, these 4-door full-size sport/utilities will still be smaller than the Suburban.

The seemingly perennial EPA fuel-economy champ, the '95 Geo Metro, is an all-new design. Longer, wider and taller than before, the Metro sits on a wheelbase that is nearly 4 in. longer than it used to be. Ride and handling are also improved by the 13-in. wheels

and tires, rather than the 12-in. ones of before. Inside there's more room, as well, with 1 in. more front headroom and 3 in. more rear legroom.

The standard engine for the 4-door model (there's no more 5-door hatchback) is a new sohc 1.3-liter Four with 70 hp and 74 ft.-lb. of torque. The hatchback coupe is still powered by an sohc 1.0-liter Three with 55 hp and 58 ft.-lb. A 5-speed manual is standard equipment and a 3-speed automatic optional on all except the base coupe.

Oldsmobile

As big news as the Riviera is from Buick this fall, perhaps even bigger news is its 4-door sibling, the Aurora from Oldsmobile. We've written about this car before—a year ago, in fact, when we first drove the Aurora. But now, finally, it's here. As you read this, you should be able to stroll into your local Olds dealership to kick some tires and see about a test drive.

In case you've forgotten, that test drive should be a dandy. The Aurora, like the Riviera, starts with an amazingly stiff chassis. Unlike the Riv, however, the Aurora boasts four doors and, since it is from Oldsmobile, a V8 engine.

The 250-hp 4.0-liter dohc V8 is derived from the Cadillac Northstar V8 and puts out 260 ft.-lb. of torque. The 4.0-liter is the only engine and a 4-

speed automatic is the only transmission. The sculpted, curvaceous body is more than contemporary, it should help drag all of Oldsmobile into the next century. The 5-passenger interior is equally modern with form-fitting seats and a curving dashboard.

The list of standard equipment is as mind-boggling as it should be with the short list of options reserved for items like traction control and higher-speed-rated tires.

Pontiac

As Chevrolet has the all-new Cavalier, Pontiac has its new small car, the Sunfire. Sharing essentially the same engineering beneath the skin, the startling difference is that skin. As has been Pontiac's wont through the years, the Sunfire has strikingly good looks. Swoopy, sexy and zoomy looking, Pontiac's designers have done the job of differentiating the Sunfire from the pack of other front-drive small cars.

GMC

This is such a prolific year for GM that there's big news from the truck division as well. The GMC Jimmy is as all-new as its sibling, the Chevrolet Blazer. Under the skin, the Jimmy and Blazer are essentially the same. And, like Chevrolet, GMC gets a full-size 4-door sport/utility later on. **PM**

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New Tone For Tunes

BY REBECCA DAY



one way people are incorporating music invisibly into their homes. At the opposite end of the spectrum are speakers that demand to be seen.

One look at any of the new B&W designer speakers and you realize there's been a decided lack of creativity among loudspeaker designers since the birth of hi-fi.

The B&W Emphasis speaker (\$9000 a pair) is in the shape of an inverted saxophone, the \$35,000-a-pair Nautilus mimics a snail shell, and the more conventional Blue Room Pod speakers (\$1900 to \$2500 a pair) bear a striking resemblance to George Jetson's robot maid, Rosie. Futuristic chic or iconoclastic, the B&W designer line is a far cry from the rectangular wooden boxes that define loudspeakers for most people. Chris Browder, executive vice president of B&W, maintains that traditional rectangular boxes have been the cheapest, most practical way to make speakers—but not necessarily the most sound. Despite the fact that the design-conscious, upscale buyer who's the target for this designer line is looking for unique shapes and sizes, Browder maintains that form follows function.

The saxophone-like Emphasis and the snail-like Nautilus use a gradually tapered transmission-line design, for example, which functions well from an acoustical as well as a design standpoint. None of the designs use parallel surfaces, minimizing the occurrence of unwanted sound wave reflections, which are a bane of rectangular speakers. The acoustical advantage of the circular shape used in the fiberglass enclosures of B&W's Blue Room House Pod and Techno Pod speakers is to keep diffraction and resonance to a minimum, Browder says.

The marriage of form and function doesn't always come easily. Because of the impracticality of the design of the 4-driver Nautilus speaker, B&W designers couldn't use a conventional crossover to achieve a flat response

for the speaker. The electronic crossover it uses requires four separate stereo amplifiers to drive it. B&W lavishly modeled the Nautilus with a quartet of Krell Audio Standard amplifiers at the high-end Stereophile show last spring in Miami to the tune of just over \$100,000.

Eliminating diffraction and resonance are two of the goals of Spheric Audio's more real-world K Series and Krystol Series cylindrical loudspeakers (\$400 to \$700 per system). The 3-piece Krystol System II (\$699) features a rectangular subwoofer and a pair of 37-in.-tall satellite columns. The 1-in. dome tweeters mount to the front of the cabinet and the 4-in. air-cooled midrange is inside the grille, firing upward. Mid and high frequencies are dispersed 360° through the thin glass dome at the top of the enclosure, theoretically for an open, spacious sound.

"If used right," says marketing manager Michael Robbins, "glass is a great reflector for high frequencies." The uniform dispersion is said to result in middle and high frequencies reaching the ear



Both sides of the Bose 501's woofer (left and above) are used to generate more bass from a smaller space. The B&W Nautilus (top left) minimizes standing sound wave problems.

● In the loudspeaker world, all roads lead toward the same goal: to recreate the experience of a live concert or studio recording. The destination might be the same for every manufacturer, but the vehicles and routes for getting there are as diverse and numerous as the recorded interpretations of Beethoven's *Fifth*.

Traditionally, manufacturers have stuck by the monolithic tower loudspeaker as the general shape into which they'd mold their various drivers and crossover systems. Today, however, with music and home theater systems becoming more of a lifestyle statement, aesthetics have become a priority in overall speaker design. Speakers have to look good, sound good and take up a minimal amount of space. In-wall speakers are

HAVE IT YOUR WAY

(Continued from page 79)

the rear chain stay and is adjusted after connecting the derailleur cable. The front derailleur bolts into the seat tube and must be angled so that it's parallel to the curve of the largest chainring about 1 to 3mm away.

To determine the correct chain length, run the chain through the front and rear derailleurs and around the smallest front chainring and rear cog. Use a chain-rivet extractor to open the end link of the chain, and close it around a link that provides the chain with a little tension in this position.

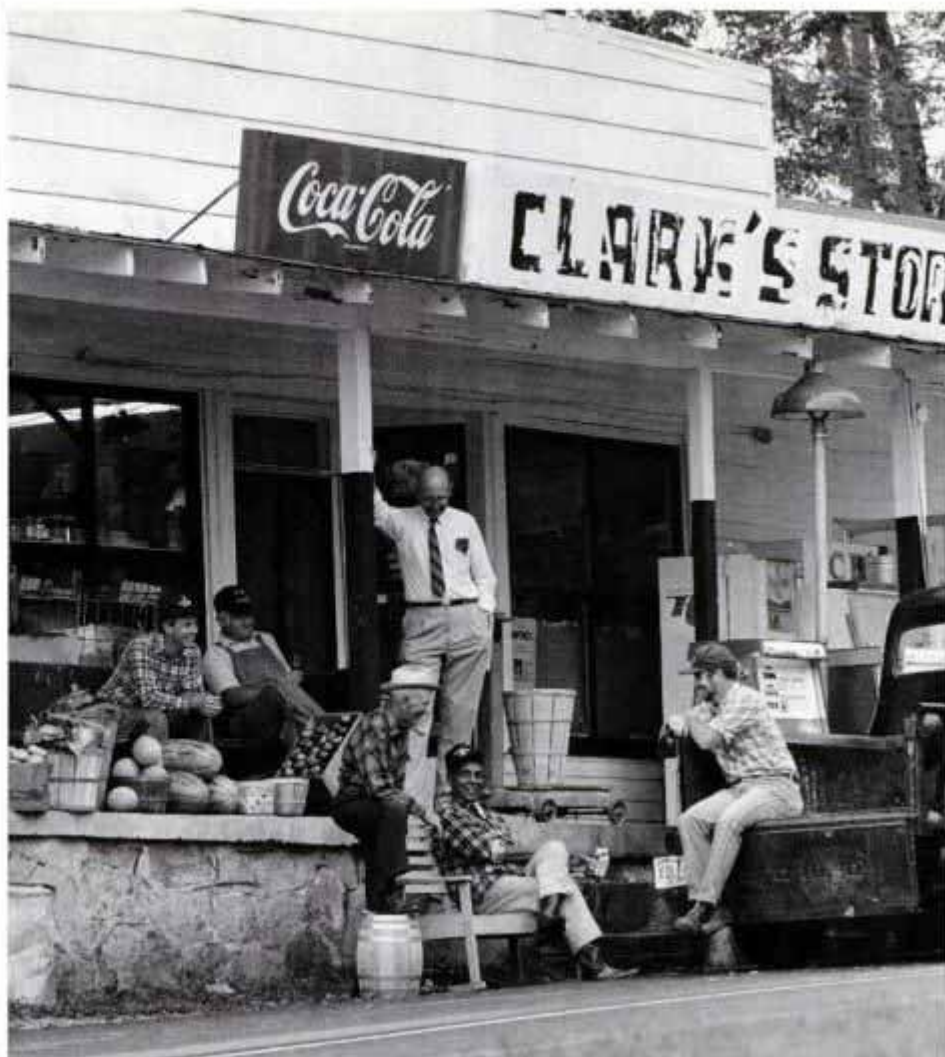
Since the derailleur cable doesn't come under great stress, it can be snipped off with only an inch or so of extra cable at the derailleurs. However, before snipping, make sure the handlebars move freely and there's a nice, round curve connecting to the derailleurs. Now, remove slack from all cables, and adjust tensioning points for smooth operation.

The acid test for this bike came the day after assembly, when it was scheduled to star in a photo session. Since it was newly assembled, I brought along tools to adjust loosened nuts and stretched cables, which are normal for a new bike.

Right off the rack, the bike handled like a sports car. It was light (several ounces less than 27 pounds), tight and nimble. However, there was a problem. It was obvious that I needed a little time to get used to the Shimano SPD Dual Cleat-Lock pedals (no clips or straps). Locking your shoes into these cutting-edge pedals can be a little intimidating. Since some hard riding was called for, I decided to replace the clipless pedals with a pair of Shimano Deore LX clip-and-strap pedals from an old bike. It will take time to get comfortable with the clipless pedals, but I anticipate a performance boost when I do.

Unlike earlier dual-suspension bikes, the Specialized S-Works FSR frame keeps the wheels on the ground on the bumpiest terrain and refuses to bounce with power-robbing oscillations. The Ritchey Bite 2.1 tires grab rock and dirt with a solid grip. The Shimano Deore XT drivetrain and brake systems offer smooth and easy shifting plus brute stopping power.

Now, the fact that I picked out all the parts and spent a long day putting them together may have influenced my glowing review. After all, I can only blame myself if the bike is a dog. On the other hand, since it rides exceptionally well, I guess I can take most of the credit. Or at least as much as the bike companies did when all they did was order and assemble parts. **PM**



What do you enjoy doing on Saturdays? Whatever it is, we hope it includes a sip of Tennessee Whiskey.

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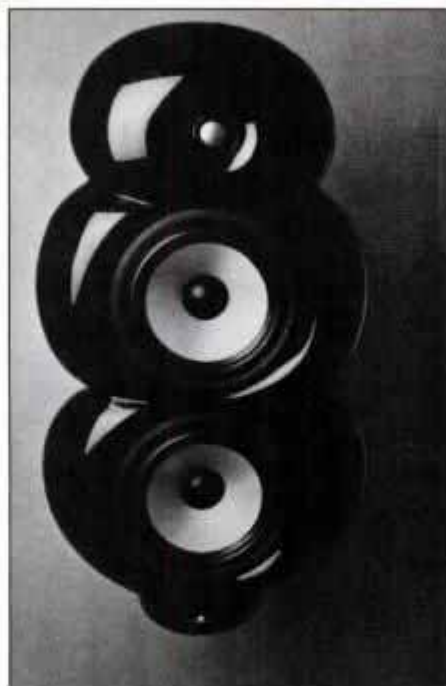
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AUDIO (Continued from page 114)



For the Jetsons: Blue Room Pod speakers.

simultaneously, eliminating listening fatigue that can be caused by a time delay and harsh high frequencies.

Each speaker also has an L-Pad on the rear to enable listeners to adjust middle- and high-frequency output according to the size of the room and the listener's taste.

The 2-piece K Series from Spheric Audio is also cylindrical. Inside the column, the midrange and tweeter are mounted above the driver with the voice coils of the midrange and tweeter drivers aligned to reduce listening fatigue. The vented, floor-loaded woofer design is said to cancel standing waves and reduce distortion by using the floor to reflect the lower frequencies.

Despite the attention to acoustical refinement, Spheric maintains a strong visual sense regarding speaker design. "Music is art," is a company philosophy, which translates to "appearance is equally important as musical reproduction." The Spheric speakers come in a variety of finishes including walnut, rosewood, silver burl, red oak and unfinished oak.

At Bose, new designs incorporate traditional theories but with a smaller footprint. The new 501 speaker incorporates the company's Direct/Reflecting technology in a cabinet that consumes a minimal

amount of floor space, totaling just 7 $\frac{5}{8}$ sq. in. The goal of the Direct/Reflecting design is to send out several paths of direct and reflected sound to recreate the same paths that exist during a live performance.

To achieve this design goal, Bose engineers sliced off one corner strip of the 501 (the upscale 701 boasts a similar, but more symmetrical, design) to accommodate a pair of 2 $\frac{1}{2}$ -in. Stereo Targeting tweeters. The tweeters, located on the angled portion of the cabinet and on the adjacent front side, were designed to broaden the sound stage. While typical speakers have a "sweet spot" that creates a central image between the two stereo speakers, Bose's goal is to broaden the sound stage so that even people sitting off-axis from the sweet spot can realize the stereo image. The front tweeter provides direct sound to the listening position, and the driver on the angled baffle is targeted toward the wall (and toward off-axis listeners) to reproduce the reflected sound that's typical of a live performance.

Bose also uses an unorthodox approach to bass reproduction. If you measure a speaker's capabilities by the size of the woofer behind the grille, you'll have to adjust your thinking when auditioning the 501. The 5 $\frac{1}{4}$ -in. woofer is inside of the speaker pointing down. The movement of the woofer generates two masses of air on either side of the woofer cone. Unlike a traditional woofer in a cabinet that uses one side of a cone to generate a sound wave, the 501 utilizes the back



B&W's Emphasis is sax-like.

and front, which allows more bass production from a smaller space. Another benefit of this design, Bose says, is that if you happen to overdrive the woofer, the distortion produced by the cone stays within the cabinet and is filtered out by the air mass itself. The air mass both launches the bass waves into the room and serves as a natural acoustic filter as well.

Speakers are not just for the family room anymore. People are choosing to place speakers in bedrooms, bathrooms and dining areas. Whether you want your speakers to be attractive pieces of furniture or simply to take up less living space, there's a speaker in every shape, size and color to fit your needs.

FM

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By Dane Spotts



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GOING ONLINE (Continued from page 75)

your wishes into Unix—invisibly to you. You'll get road maps, too, to find your way to that medical library at the University of Bongo-Bongo.

Currently, some of the commercial online services offer varying degrees of access to the Internet. Your options might be limited to electronic mail and joining discussion groups, but the advantage here is that the Internet front-end provided by your regular service should be as familiar and easy to use as any other interface.

Here's a quick summary of how to connect to an online service, how much it costs and some highlights of each service. The toll-free numbers will get you a service representative who'll help you from there.

• **America Online** (800) 827-6364. Monthly membership fee is \$9.95, which includes 5 hours of use, \$3.50/hour afterward. The flat fee covers all AOL services—there are no extra charges or premium-priced features. The hourly rate applies round-the-clock (no prime-time surcharge). Besides access to the Internet, features include *The New York Times*, CNN, *Chicago Tribune*, *Time* and dozens of other publications. One old but defunct favorite, *Saturday Review*, has been resurrected as an online magazine.

• **CompuServe** (800) 848-8990. Offers a variety of pricing options. Standard plan is \$8.95/month for unlimited use of basic services. So-called Extended Services cost \$6 to \$8 (at 300 or 1200/2400 baud). Premium Services add a surcharge to this, which is detailed before you buy. There's no prime-time surcharge if you connect through the CompuServe network's phone lines. The features are voluminous but one that's unique was a recent experimental download of the Aerosmith song *Head First*—not even available on the group's *Get A Grip* CD. At no charge, subscribers were able to record the entire 3-minute 14-second song on their hard disks. (Make that a 4.3-megabyte audio file!) Thousands did so, though it took an hour even at 14.4 baud. While the master recording was digital, sound quality of the download was similar to FM stereo.

• **Delphi** (800) 695-4005. \$10 monthly for 4 hours, then \$4/hour; or \$20/month for 20 hours, then \$1.80/hour. Internet access is \$3/month. There's a \$9/hour surcharge for out-of-network connections during business-weekday hours. Delphi offers features similar to the other services, but its trump card is complete access to the Internet, through an easy-to-use interface.

• **eWorld** (408) 996-1010. \$8.95/month for 2 hours of evening/weekend

use, \$4.95/hour afterward. Its highly graphic interface is designed for Apple Macintosh computers and Newton PDAs. It offers nearly 100 features, including news from Reuters. Like a Mac, eWorld is very much a point-and-click planet with a variety of forums, information providers and Internet access. One nice feature is the use of shortcuts—basically one-word addresses—that make getting around easier. eWorld promises to be a hangout for Mac users.

● **Genie** (800) 638-8369. For \$8.95 a month, you get 4 hours of standard service. It's \$3/hour afterward, and with a \$9.50/hour surcharge weekdays from 8 am to 6 pm. Premium features have extra surcharges. After CompuServe (1979), the General Electric Information Network is the longest-running act online. It's a quiet but cool service, with a mature orientation in its special-interest groups. For example, hobbyist forums include homebrewing, autos, do-it-yourself projects and plans, and ham radio—including practice tests for licensing. Other user groups include law enforcement, military, medical, education, even writing. For now, Internet access is E-mail only.

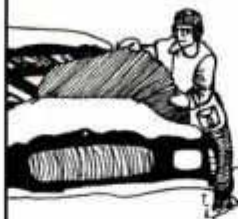
● **Prodigy** (800) PRODIGY. This gets you the \$29.95 membership kit (a one-time fee). Monthly price packages vary. The basic is \$14.95/month for untimed use of hundreds of features. Some premium services have surcharges. Prodigy's family orientation is strong on the entertainment and education angle—ESPN sports features, PBS kids' stuff. Pictures and sound are top-notch. Internet access is E-mail for now.

As you can see, there's a lot to explore via online services. Our advice is try 'em all. Every service offers some kind of free trial membership. Many new PCs come with one or more of the services preloaded in the computer. As for eating up your free time while you're getting your bearings, don't sweat. Most of the services give you practice sessions at no charge. All it will cost you is a local phone call.

Just keep in mind that while you're online, your phone line will be occupied. That means you can't get incoming calls, or phone out for pizza. Telephone services such as call waiting won't help. You have to turn these off when you're online, as they'll disrupt modem operations. Also, if you've got one of the new computers with a built-in phone answering machine, don't expect it to take messages while you're in cyberspace. Remember, your phone is off the hook while you're hooked online. Unless you really want to disappear, you might consider a second phone line. **FM**

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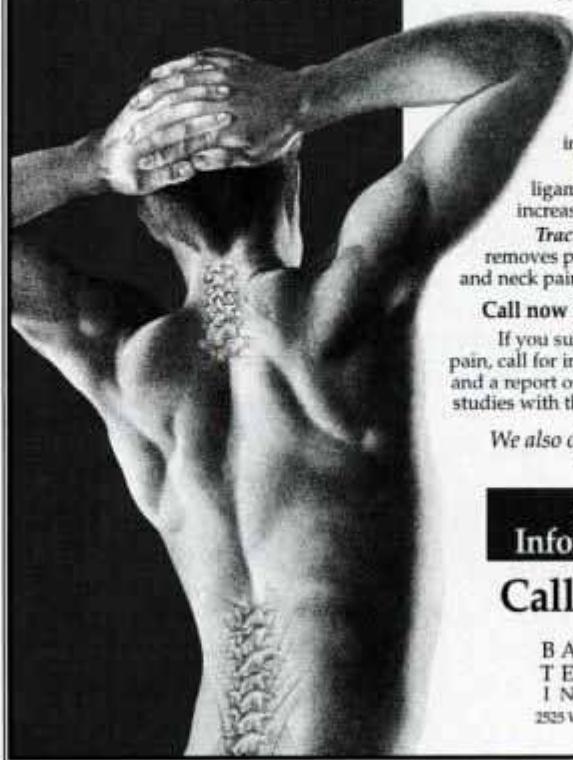
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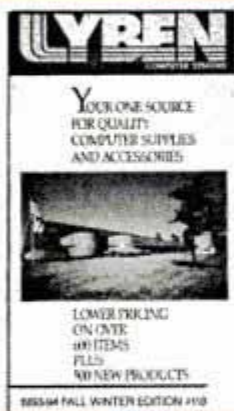
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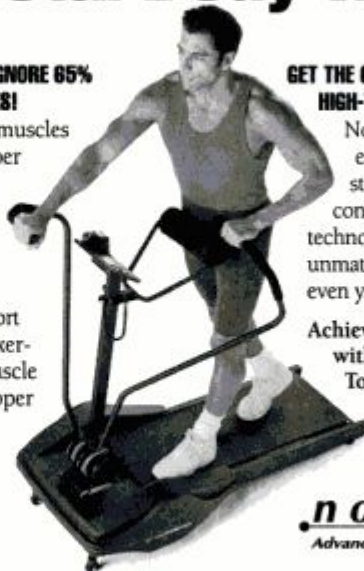
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ENGINEERING THE '95s

(Continued from page 59)

and locations of the grid lines to provide most of the heat in the center, the least at the perimeter of the grid.

• Teflon-encased ball joints replace rubber bushings at the front pivots for the lower control arms of the top-of-the-line Cavalier and Sunfire models. The ball joint can flex in response to roughness in the road and isolate it from the chassis a lot better than a simple bushing, and still provide handling control. At the rear is a rubber bushing, but it's a conical vertical design that is designed to absorb road impacts well for a good ride. This conical rubber bushing was introduced last year on GM N-cars (Pontiac Grand Am, Olds Achieva, Buick Skylark), but the Teflon-lined spherical bushing complements it perfectly.

• A "poor man's" theft-resistant ignition key design is being introduced on the deluxe models of the new Cavalier and Sunfire, GM's entry-level cars. The PASSKey with the resistor pellet works well, but you can't duplicate it at the local hardware store. The new setup uses a conventional key, but it goes into a special lock cylinder that contains a resistor. An on-board computer must read the correct resistance of whatever's in the lock. If the resistance is incorrect, the

engine will not start. If the lock is jimmied, the engine starts but shuts down immediately and won't restart for 10 minutes. The new setup is called "PASSlock." Because there's a conventional key, the Cavalier/Sunfire joins the rest of the automotive world, with a single key for doors, deck and ignition. Look for GM to phase in this design throughout the corporation.

• Corvette has adopted a multipivot wiper blade with higher pressure and a different pivot angle to improve high-speed performance.

• Have you heard about the pingpong ball in the '95 Chevy Lumina gas tank filler tube? Well, it's not really a pingpong ball. When the tank is filling, the floating ball can seal off the fill neck, so there's no fuel spitback. It may not be high tech, but you don't need electronics for everything.

FORD

It's easy to get excited about gee-whiz technology, but the '95 Ford lineup has a lot of solid engineering and you don't have to be a hardcore technophile to appreciate it.

Explorer

Just look at the new Explorer with its rack-and-pinion steering and double-wishbone/torsion bar front suspension

—even with 4wd. This is a first, because Ford had to be careful not to compromise the off-road ruggedness of its top-selling model when it dropped its venerable Twin I-beams and recirculating-ball steering.

The new suspension and steering have obvious carlike ride/handling advantages in a vehicle already known for these qualities. But you can't just stuff a passenger-car rack in there—it wouldn't last. The Explorer unit is 31mm (1¼ in.) in diameter, which is 25% bigger than the one in a Taurus.

Centerpiece of the design is a U-shaped front crossmember with rectangular slots that allow the rack to pass through to the wheels. A double-Cardan universal joint between the pinion and steering shaft permits the sharp angle necessary to clear the front axle with 4wd, and still operate smoothly. Clearance between the 4wd axle cover and the rack housing is a scant ¼ in., so Ford also had to put in strict dimensional controls for manufacturing.

The logical attachments for torsion bars are at the rear of the lower wishbone. But the length of bar necessary for the suspension would put the rear mount well to the rear of the transmission crossmember, so an additional crossmember would be necessary. To avoid extra weight and

expense, Ford attaches the torsion bars to the transmission cross-member. To get the bar length, it put slots in the rears of the wishbones, and routes the torsion bars through them to mounts in the front. Neat, indeed.

Contour/Mystique

Because the Contour and Mystique originally were expected to be out last spring, PM reviewed the cars and their new 2.5-liter V6 last year. The cars are just hitting the market now, however, so we'll provide some additional detail.

The 2.0-liter 4-cylinder develops only 125 horsepower at 5500 rpm and 130 ft.-lb. of torque at 4000 rpm, but with its 4-speed automatic, it should be competitive. Want more? The V6 has 170 horses and a healthy 163 ft.-lb. of torque.

The optional traction-control system is basically an adaptation of one used in the Corvette. In addition to pulsing the antilock brakes to stop wheelspin (at low speeds), a computer-controlled motor can unwind the throttle-cable pulley to back off the throttle at speeds above 30 mph.

Allergy sufferers will appreciate another bit of trickle-down technology. The Contour/Mystique is the first installation of a high-efficiency interior air filter in a low-priced car, which can keep the compartment free of pollen and other allergy triggers. Previous applications were in foreign luxury cars, such as BMWs, Mercedes-Benzes and Saabs.

Taurus/Sable

Keeping an old pushrod engine competitive—particularly in its last few years on the top-selling model—is just as critical for Ford as it has been for GM. The 3.0-liter V6 was given a moderate (but thorough) rework to quiet it down, smooth it out and improve oil and coolant sealing.

The crank is new and fully counterweighted (seven instead of four weights), which not only smooths engine operation but makes the shaft more rigid. And with an aluminum damper, it weighs about the same. The bottom end of the engine block was "massaged," to move metal from overly thick areas into the bulkhead and sides, for greater rigidity (and quietness) without adding weight.

The previously solid valve stems are being drilled to hollow them out. This reduction in weight is primarily intended to cut impact noises when the valves close. Ford actually measures an overall 4% improvement in speech intelligibility (how well you can understand what someone else is saying) in the passenger compartment from this seemingly minor change.

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The temperature knobs or slidebars on heater-a/c panels are traditionally attached either to cables (which are prone to bind), which, in turn, connect to the flap doors, or to butter-smooth electric-motor setups. Unfortunately, there is not always enough room for an electric motor, so Ford developed a pull-pull cable that resembles a clothesline with its pulley at each end. Introduced first on the new Mustang late last year (after PM's new-car issue), it's now coming on the '95 F-Series trucks.

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perature knob, you operate a bevel gear that turns a gear on a cable pulley. The wraparound cable performs the same action at a pulley on the heater/air-conditioning case at the other end, pulling in either direction to open or close the temperature-controlling blend-air door. It's absolutely smooth and effortless, and there are no fancy electronics, wiring, connectors or motor to fail. The cable housing is a rugged design that should be forever kink-free, and there's no adjustment to go out. Earthshaking? No, but it's definitely one of Ford's better ideas. **PM**

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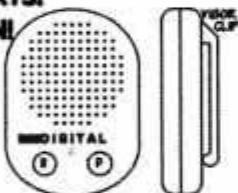
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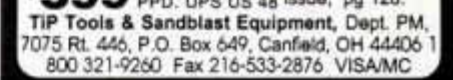
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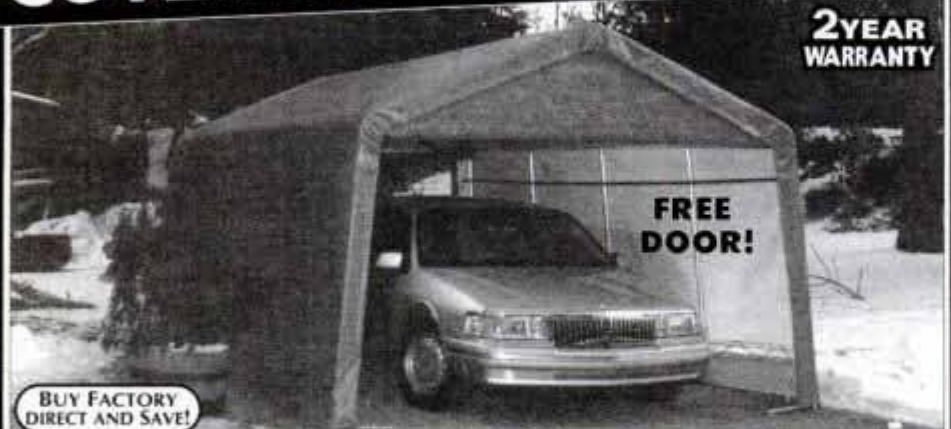
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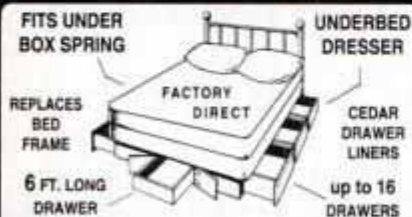


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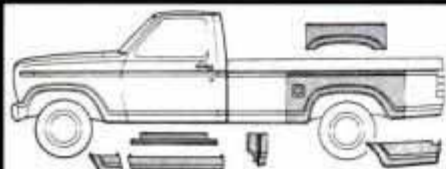


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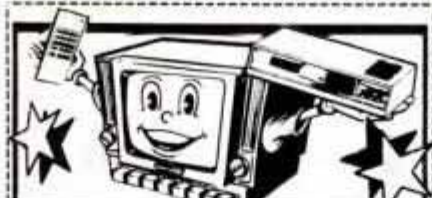
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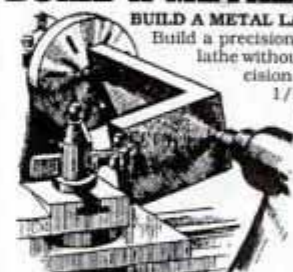
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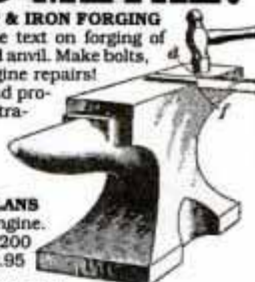
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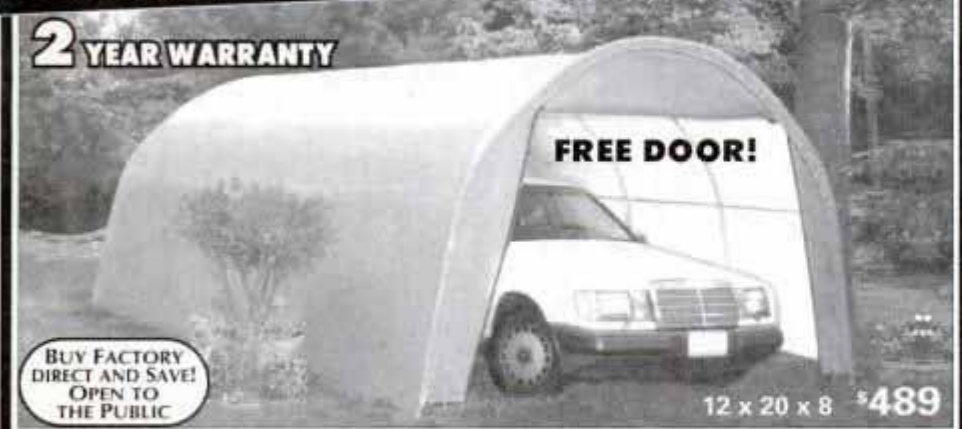


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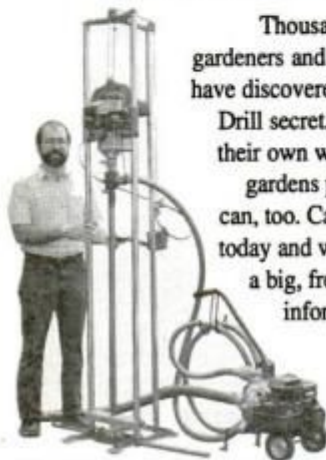
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