

Popular Mechanics

OCTOBER 1995

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EDITOR'S NOTES

● I swear it was just a minute ago that I was sitting here writing about our special report on Detroit's 1995 new models. I blinked, and here it is—our special report for '96. As has been our practice in recent years, we'll be bringing you our new-car reports in two parts. In this issue, beginning on page 48, you'll find our first drives of the most significant new cars out of Motown, plus a run-down of all the tweaks and tech stuff. Part two, in our December issue, will highlight the newest of the new imports and pick up the late bloomers from Detroit. I have a feeling '96 is going to be a great year for car lovers. Some of the bestselling cars in America are being replaced with all-new models—Ford's Taurus/Sable and F-150, Honda Civic, Chrysler minivans, Saturn sedan and



The PM auto gang, almost at speed, at Pocono.

Mazda 626, among others, are all-new. Our auto editors have been traveling literally around the world in recent months, attending press conferences, new-model introductions and ride-and-drives to get the full poop on the '96s and to bring you the new cars as only PM can. . . . Around the world even included Pocono International Raceway in Long Pond, Pennsylvania, where the entire automotive editorial staff was hosted by the Porsche folks for a full day of legal speeding, driving the full line of '96 911 Porsches. Porsche bought the track for the day, brought in race driver Hurley Haywood to teach us what the pedals and buttons do, handed us the keys to the cars and turned us loose. Thanks



North (right) and mission commander Maj. Jim Smithers.

Porsche, and love that 911 Turbo! . . . I've said this before but it bears repeating. There is no finer-edited magazine in the world—with the possible exception of POPULAR MECHANICS—than *Aviation Week & Space Technology*. Here at PM, we depend on *Aviation Week* to keep us up-to-date on everything going on in that field. When I heard that David North, *Aviation Week's* managing editor, was going to have the opportunity to fly the Northrop/Air Force B-2 stealth bomber, I got very excited. North, who has contributed great articles to PM in the past, was to be the first civilian in the world to pilot the big flying wing. Hey, can we go along for the ride? I asked North. Sure, he said, and so you have this month's cover story beginning on page 66, which has to be one of the most revealing articles yet written on the awesome B-2—still one of the most highly classified weapons systems in the U.S. arsenal. . . . Hey, take pity on me. I'm a New York Jets fan. But even

the Jets can't turn me off to NFL football, or to some of the fascinating stories we've run on the science of sports. This time, we trace the history of the football helmet, from skimpy little leather hat to high-tech composite system that not only protects but also can strike a blow when the occasion calls for it. Check out the story on page 78. And, let's go Jets! Till next time.

Joe Oldham

Popular Mechanics

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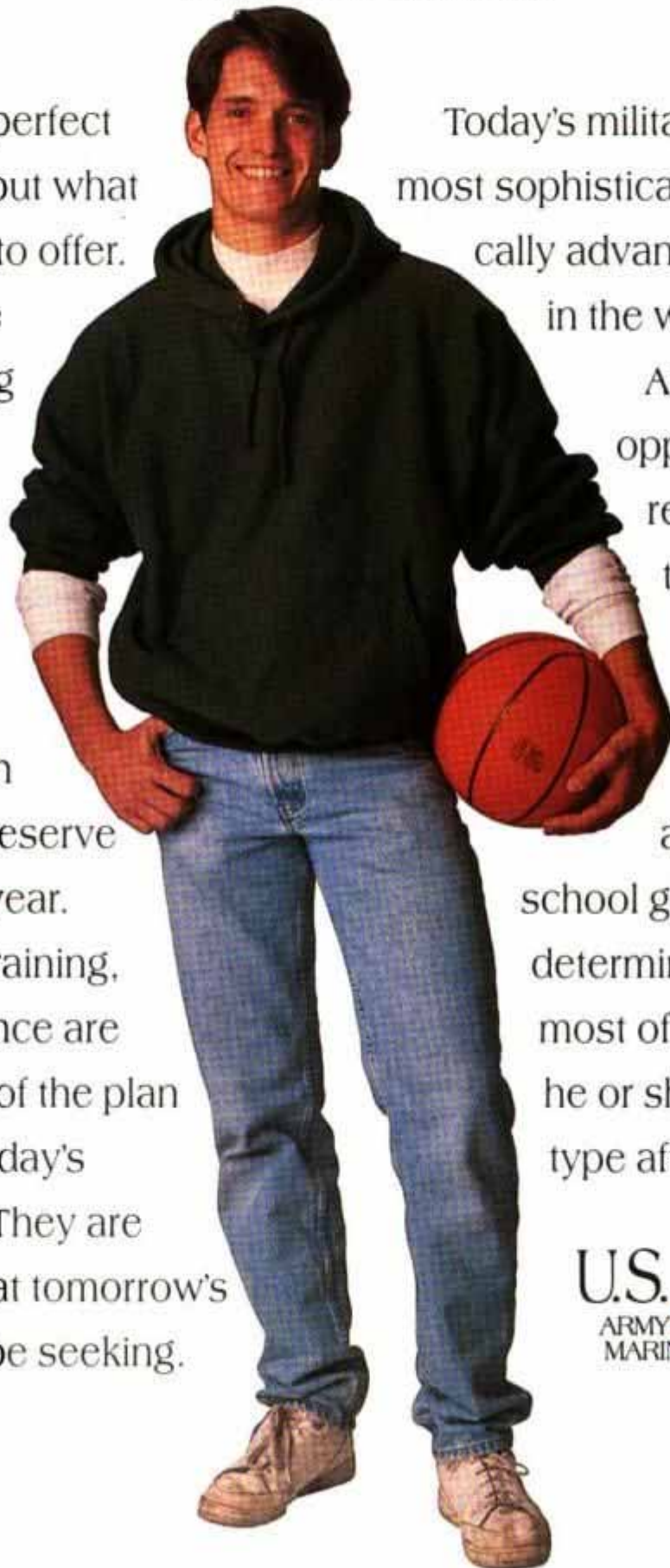
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IF YOU NEVER THOUGHT OF YOUR CHILD AS THE MILITARY TYPE, THINK AGAIN.

Now is the perfect time to think about what the military has to offer.

Although the military is getting smaller, the Armed Forces still need to recruit almost 400,000 young men and women for Active and Reserve positions each year.

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The Shame Of Enola Gay



Bravo, William Garvey. Finally, someone who understands history without distortion or present-day bias toward nuclear weapons. The crewmen of *Enola Gay*—along with the men and women who served their country during World War II—are heroes. Their stories and artifacts of that era should be displayed proudly. For years, the war had been depleting the country of its young men, while an entire nation longed for its end. Other than dropping the bomb, the only way to hasten its conclusion was by invading Japan, which would have cost thousands more American lives. When the bomb was dropped, my father was aboard a U.S. Navy ship poised to assist with the invasion of the Japanese mainland. Had the bombing mission not been carried out, he might not have survived.

LT. PAUL M. ESPOSITO, USN
JACKSONVILLE, FL

I'm afraid your cover illustration of *Enola Gay* is in error. The B-29 Superfortress had a nose, tail, belly and two side gun positions. Your illustrator, Attila Hejja, left off all the guns.

DENNIS HOLLAND
LAKE RONKONKOMA, NY

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

No, it wasn't Attila. It was Col. Tibbetts. As part of his mission strategy, Tibbetts ordered 25 specially built B-29s from Boeing for the nuclear role. They were stripped of unnecessary components, including all armament and guns except for the tail gun position. This allowed the planes to fly faster, higher and farther than would a normal B-29. And with 25 aircraft to choose from, he was ensured of plenty of backups should mechanical problems crop up. —Ed.

The people who scorn *Enola Gay* have no experience with the survival nature of a war environment. There is nothing remotely academic or objective when your buddies die and you have to take their bodies home and help their families bury them. Those who think themselves more moral and righteous than those in a war of survival 50 years ago—and write myopically with 50 years of hindsight—should understand that all decisions are made in the *now*. You can't make today's decisions until yesterday's give you a basis for judgment.

LT. COL. EDWARD D.
ROBERTSON SR.
USAF (RET.)
LAKE WINNEBAGO, MO

Joe Oldham, in his Editor's Notes, expressed it well when he stated: "The final blow was the Smithsonian insult." GEORGE L. ZEIS
TIFFIN, OH

The decision to drop the bomb was assuredly not an easy one to make. However, an invasion of Japan probably would have resulted in the deaths of nearly 1 million U.S. soldiers.

LOUIS J. GARDINO
F.E. WARREN AFB, WY

I was disappointed with your one-sided article. As the only country ever to drop an atomic bomb on civilians, America has long had an understandable guilt that many continue to deny. This guilt has been assuaged by the official story that the bomb was a wonderfully efficient new weapon that ended the war. Garvey swallows this argument uncritically and fails to present the mountains of evidence that bombing Hiroshima was totally unnecessary. The latest episodes in this charade were Congress's censoring the exhibit and forcing the direc-

tor of the Smithsonian Air and Space Museum to step down over the matter. Our government wants us to believe that atrocities are not atrocities if the other side provokes them.

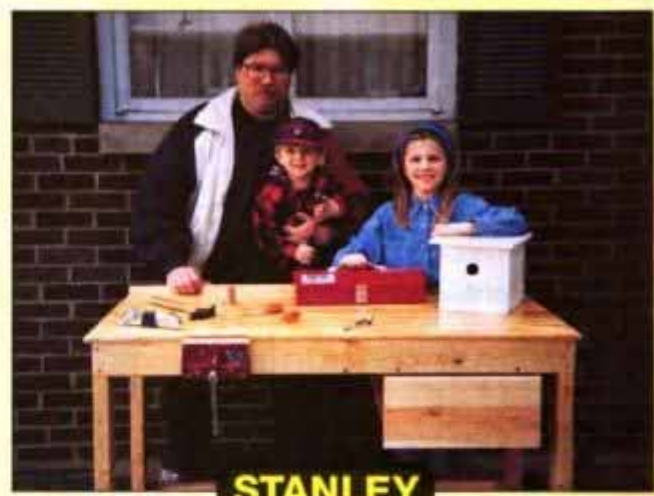
ROGER N. JOHNSON
MAHWAH, NJ

As a boomer son of a WWII vet, I extend my gratitude for your excellent article. It is appropriate that we honor those who fought so tirelessly to end a war thrust upon the American people.

Second-guessing and moralizing by people who were neither present nor

(Please turn to page 8)

Advertisement



Reader Project Of The Month

I built this workbench so my kids could have their own special place in my garage/workshop. The design is based on the utility workbench featured in your November 1991 Woodworking Guide. I used construction-grade 2 x 4s and plywood, scaled down the legs and added a drawer. The bench is sized for my 8-year-old daughter, who assisted in its construction. My 2½-year-old son, though too young to help, already enjoys construction equipment and tools.

RICHARD J. ANDREWS
LORAIN, OH

If your project is chosen as Reader Project of the Month, you will receive a Stanley Home Improvement Kit, complete with hand and decorating tools, and an electric stapler/nailer, valued at more than \$200. For your project to be considered, please send a clear, color photo and brief description to: Reader Project of the Month, Popular Mechanics, 224 W. 57th Street, New York, NY 10019.



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required to make these monumental decisions insult those who agonized over the outcome of their actions. Those who sneer from the comfort of their office or study today, I suspect, would not have had the fortitude to be decisive

been the most horrible battle the world has ever seen—certainly more deadly than the devastation inflicted by two atomic bombs.

Yes, the Japanese people were victims of a terrible weapon, and I, like many Americans, feel sorry for

Your story validates why I subscribe to PM.

ROBERT MATERSON
BROOKLYN, NY

The Smithsonian, if left to its own devices, would have painted *Enola Gay* as a symbol of nuclear terror.

I am appalled by your callous attitude toward our targeting of 350,000 non-combatants. Contrary to your inferences, there was no military need to invade the Japanese mainland. The bombings of Hiroshima and Nagasaki were displays of military might probably used as much to intimidate the Russians as to end a war already won. *Enola Gay* represents the height of technological achievement and the depths of its application.

RICHARD T. LEE
SEATTLE, WA



if they were in the places of those they criticize.

The Japanese government and people suffered the consequences of their aggression. Regrettable as they were, those consequences serve as a warning to humanity. Let's celebrate victory, mourn the dead and vow to learn from it all so as to never repeat it.

REV. TERRENCE M. O'NEILL
ALBANY, NY

On behalf of the many loyal Americans who took part in WWII or lived through that period, I thank you. Your article gives a truthful account of the bombing of Hiroshima. The use of the atomic bomb was a blessing to mankind. Fortunately, it was in America's hands. Had there been a greater arsenal of these bombs, I would have advocated dispensing them over more of Japan—I believed it then and believe it now. No nation ever behaved in a more deplorable manner than Japan.

JAMES J. GOEBEL JR.
PRES., AIR FORCES ESCAPE
& EVASION SOCIETY
CONROE, TX

Instead of casting a cloud on the courageous actions of the men of *Enola Gay*, thanks must be given to all involved with hastening the war's end. After battling the Japanese across the Pacific one bloody step at a time, the U.S. was preparing for what would have

them. However, it was their government that started the war and forced such a tragic event. We must look at *Enola Gay* as a savior to our battle-weary GIs and, ironically, as a savior to the people of Japan, who could have suffered a more horrible fate at the hands of their own leaders.

GREG MASTRANGELO
WARWICK, RI

Garvey clearly and succinctly expresses the way we who were there in the Marianas felt about the dropping of the bomb and the current display of *Enola Gay* at the Smithsonian.

1ST LT. L. RAMER
USAF (RET.)
DELRAY BEACH, FL

You show an absolute lack of sensitivity with your headline "From Glory To Dishonor: Our Shameful Treatment Of The World's Most Famous Airplane." This is a plane that directly caused the deaths of hundreds of thousands of Japanese women and children. Where is the glory in attacking innocent civilians? The controversial argument that the atomic bombings ended the war aside, if *POPULAR MECHANICS* is ashamed of the treatment of the airplane and not of the death it caused, you can cancel my subscription.

GARY RAY ROGERS
SAN LUIS OBISPO, CA

Thankfully, it was not able to rewrite this important chapter of history. However, I am sorry to report that revisionists have succeeded in distorting history at the USS *Arizona* Memorial at Pearl Harbor. That exhibit contains film that has been carefully sanitized so as to not offend the Japanese, who figure prominently in tourism and business in Hawaii. The vicious nature of the attack is played down. Roosevelt's "infamy" speech is muted. And the film makes it look as though the Japanese were on an outing and accidentally dropped bombs and torpedoes. Forsaken are the 1177 officers and men of the *Arizona*, whose role in history has been reshaped in the name of investment and tourism. Why has there been no uproar over this?

FREDERICK J. LOPEZ
ISLIP TERRACE, NY

Yes, we should preserve *Enola Gay*, and, yes, we should have dropped the atomic bomb on Japan. However, we could have selected an outlying Japanese military base or another sparsely populated area for the first drop on Japanese soil. We Monday-morning quarterbacks aren't blaming *Enola's* crew or the bomb developers, but top Washington brass for selecting a major civilian area.

HERBERT B. MOSHER
ORCHARD PARK, NY

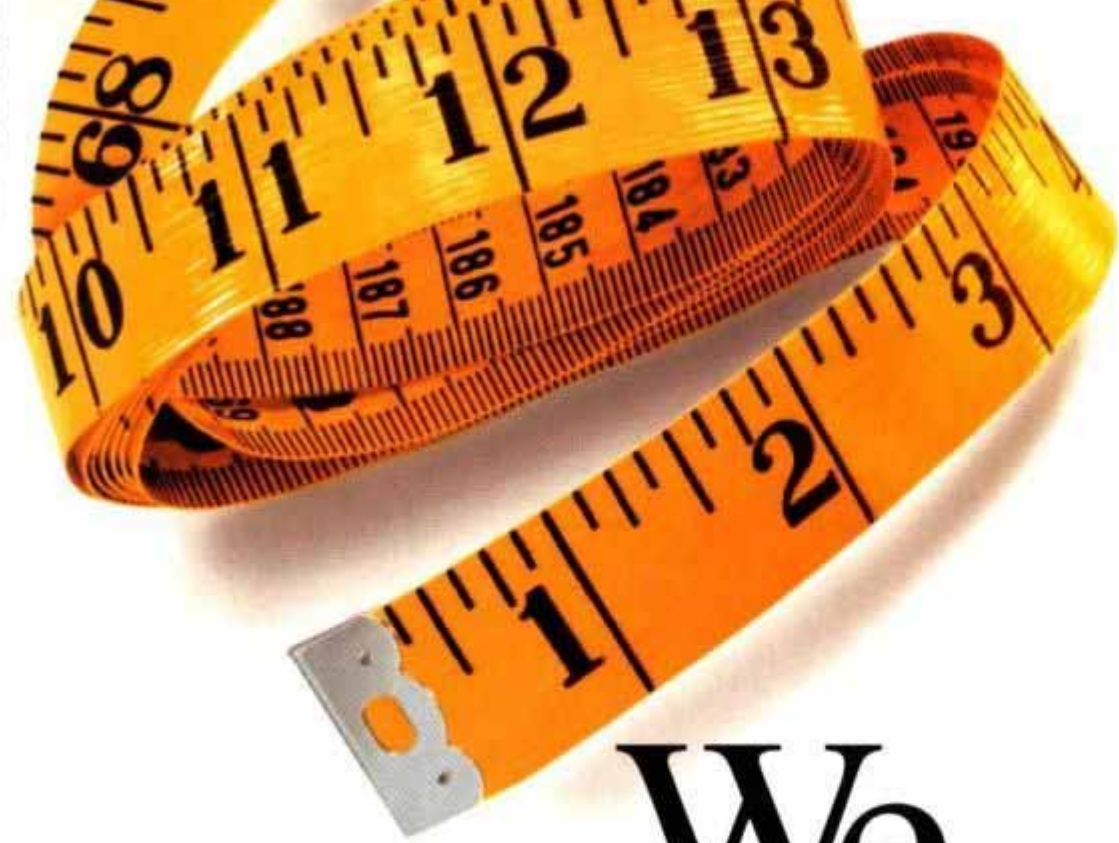
It irritates me to see protests about this important symbol of our freedom. The Axis powers were also developing a nuclear program. If we hadn't dropped the bomb first, they may have used one on an Allied city. Do not forget the people of Hiroshima and Nagasaki, but also remember the victims of Pearl Harbor, the London blitz and the Philippines, and all the young men who died as the result of Axis aggression. As a baby boomer who reaped the benefits of peace won by these men, I thank them for America's continued freedom.

VINCENT MENDOZA
SPOONER, WI

Enola Gay was neglected for so long because there was little interest on the part of the same veterans' groups that are now demanding its proper restoration and display. The Smithsonian should be commended, not condemned, for recognizing the historic importance of the aircraft and for bringing it to its present condition. The formidable project took up virtually all available space at the Paul Garver restoration facility, where technicians went so far as to allow, over many months, visitors to touch a fuselage panel to evaluate the effectiveness of preservative waxes and coatings.

ROBERT BENZON
SPRINGFIELD, VA

Having toured the Smithsonian's main storage and



We
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everything.

Chapter Three



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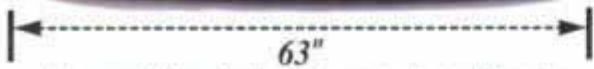
By changing the way Caravan looks,



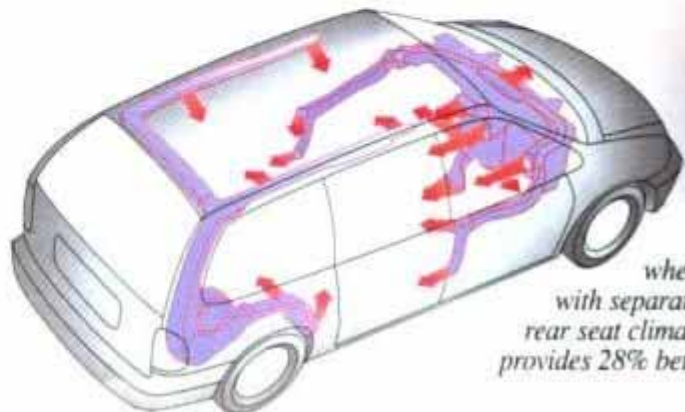
Our clever designers found a way to make the new Caravan's side-view mirrors both larger and less wind resistant.



We designed all the important controls to be easy to see and reach. After all, it's those little touches that matter most.



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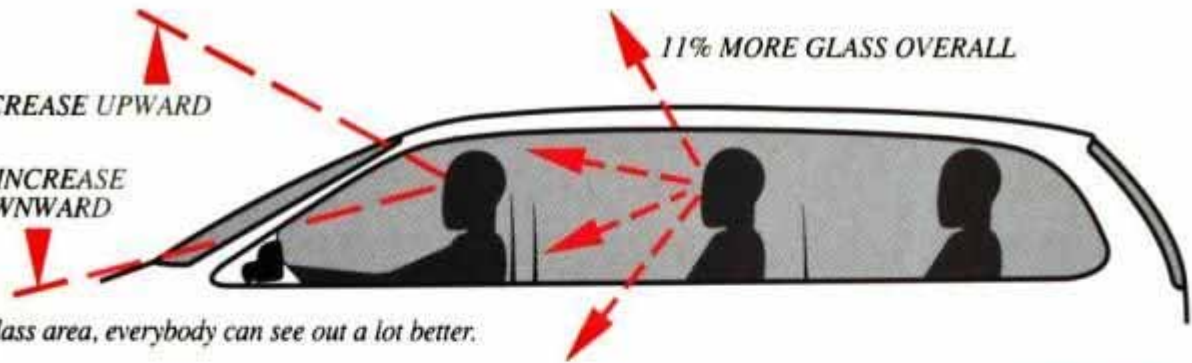


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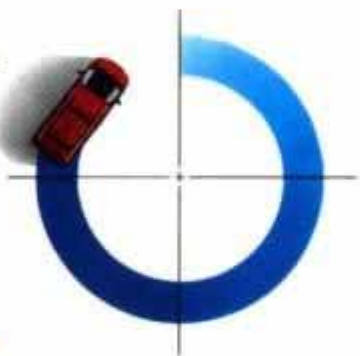
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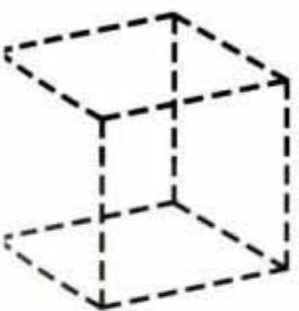


We rounded the corners
for a more aerodynamic
shape, and still found a
way to get more room inside.



we've improved the way it works.

There's 34 cubic feet
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restoration facility and seen the meticulous work being done on *Enola Gay*, I was disgusted by your vicious attack on these good people.

THOMAS B. STELINGER
PALO ALTO, CA

The Smithsonian has neither the proper space nor, due to its liberal leanings, the real desire to display military aircraft. The proper place for *Enola Gay* is at the Air Force Museum at Wright Field—alongside *Bock's Car*.

G.L. GROSS
USAF (RET.)
GROVEPORT, OH

Shame on the Smithsonian!

CHIP HEWLETT
KAYSVILLE, UT

Enola Gay should be displayed without script—no photos, no comment. Observers who cannot comprehend the historical, life-saving impact of the represented technology should return to the textbooks.

ERNIE LAMAR SANDIDGE
MCCAMEY, TX

Many thanks for your courageous positions on the Second Amendment and *Enola Gay*.

JAMES H. BLEECKER
SACRAMENTO, CA

My mother's five brothers were in WWII. Three of them lost their lives. Four uncles on my father's side also served. As the daughter of a B-29 pilot, I believe that *Enola Gay* should be displayed in its entirety somewhere other than the Smithsonian. It has been treated like an embarrassment instead of the historical artifact that it is.

JOY NEAL KIDNEY
WEST DES MOINES, IA

Enola Gay is not the world's most "famous" airplane, as your cover asserts. That distinction belongs to the Wright Flier, now and forever. However, *Enola Gay*, no doubt, has secured its reputation as the world's most "infamous" airplane.

A.C. HALL
DALLAS, TX

Your article states that the B-29 Superfortress housed

two pressurized compartments. Actually, it had three. The front one housed the bombardier, airplane commander, pilot, flight engineer, navigator and radio operator. The middle compartment housed the central fire-control gunner, left and right blister gunner and radar operator. The third compartment housed the tail gunner, who spent most long-travel time—over water to the initial point—in the middle compartment. I flew 35 missions from Guam to Japan in 1945 in the B-29 Superfortress, *The Natural*.

LT. COL. ROBERT E. LEMON
USAF (RET.)
MISHAWAKA, IN

Thanks for your aggressive defense of the *Enola Gay* restoration. Even though I was born 10 years after the war, I understand its significance and wholeheartedly support the effort to return the plane to its original condition. We should not allow *Enola Gay* to pass from view, for to do so would put an end to any healthy debate—pro or con—about our use of the atomic bomb.

NORMAN NASON
WINNETKA, CA

Although I certainly disagree with the Smithsonian's reading of history, I believe it is vitally important that we periodically re-examine our history and its meaning. Otherwise, it becomes stale and shallow or, worse, government propaganda. If the Smithsonian's experts truly saw the Pacific conflict as "Western Imperialism," their duty was to say so. Backing down is an example of cowardice.

COLIN MACKENZIE
MISSION HILLS, CA

If only *Enola Gay* was in flying condition so it could drop one more bomb—on the Smithsonian.

CLAUDE B. HART
ELKIN, NC

William Garvey said it all in so few words.

JERRY KEENE, TOMAH, WI
(AND 9 OTHER WWII AND
KOREAN WAR VETERANS)

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- a) provides 28% better airflow b) helps eliminate family arguments
c) keeps hot things hot and cold things cold d) both a and b.

2. With the new Dodge Caravan's optional driver-side sliding door —

- a) you can spend less time running around
b) what goes in one side goes out the other
c) grand entrances are a whole lot easier
d) some of the above.

3. The new Dodge Caravan can run —

- a) a 100-yard dash in well under ten seconds b) forever
c) 100,000 miles before a scheduled tune-up
d) rings around other minivans.

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(1) No purchase necessary. One entry per licensed driver, 18 years or older. Void where prohibited. (2) To enter, completely fill out the entry blank or print your name, address, quiz answers and "Caravan I.Q. Sweepstakes" on a 3"x5" card and send it to Caravan I.Q. Sweepstakes, c/o Popular Mechanics, Promotion Dept., 224 W. 57th St., New York, NY 10019, to be received no later than Nov. 30, 1995. (3) Drawing to be held on Dec. 15, 1995. Illegible, late, lost, postage due, damaged and facsimile entries will not be considered. Winner will be notified by mail within 5 days after the drawing date. (4) Winner will be awarded a Deluxe Home Improvement Tool Kit. Value \$750. Federal, state and local taxes are the sole responsibility of the winner. No substitution or transfer of prizes. (5) Employees (and their immediate families) of Popular Mechanics, Chrysler Corporation, Chrysler Corporation product dealers, and their advertising, public relations, and merchandising agencies are not eligible. (6) Odds of winning depend on number of eligible entries received. The decision of Popular Mechanics in all matters relating to the rules and administration of the sweepstakes shall be final. The winner will be required to execute an affidavit of eligibility/prize acceptance and release and consent to use of his/her name and/or likeness in advertising without further compensation, unless prohibited by law. Noncompliance will result in disqualification and the selection of an alternate winner. Sponsors are not responsible for damage, losses or injury resulting from the use and acceptance of prizes. (7) Winner's name can be obtained by sending a self-addressed, stamped envelope to: Caravan I. Q. Sweepstakes, c/o Popular Mechanics, Promotion Dept., 224 W. 57th St., New York, NY 10019.



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TIME MACHINE

90 YEARS AGO: OCTOBER 1905



Robo-Fiddle

In the century's early years, the piano wasn't the only musical instrument harnessed into automation. A Chicago engineer mechanized the violin. Keys to the invention: spinning discs that pressed against the strings, replacing the bow. Meanwhile, 58 electric fingers played along the instrument's neck. The electromagnets that controlled these devices were themselves controlled by the musical score, a scrolling strip of perforated paper.

Easy Riders

While internal combustion was putting horses out to pasture, it wasn't yet ready to retire the steam locomotive engine. But a gas-powered vehicle was already doing away with one familiar railroad sight—the hand-car. Instead of propelling themselves by pumping away at a lever, track-repair crews could

now rest and smoke their pipes en route. Delivering 8 hp, a 2-cylinder engine drove the new platform at a merry clip of 15 mph.



60 YEARS AGO: OCTOBER 1935



Pond Hopping

Louis Bleriot had made history by flying across the English Channel in 1909. Now, the father of ocean aviation set his sights on the North Atlantic. To cross the ocean in a single hop could never pay, he reasoned, because planes would have to tote 10 times as much fuel as payload. Instead, Bleriot proposed man-made floating islands, called seadromes. Plying these rest stops, his "avion-marin" could carry 20 passengers at 170 mph.

Clean Air

With very high frequency, broadcasters pushed into the radio spectrum's rarefied end. Stations in Boston, Philadelphia and Pittsburgh were already experimenting with shorter wavelengths. At a frequency of 55.5 MHz, broadcasts dodged the interference from weather and electric appliances that rasped through regular radios. Although transmitters had limited range, they were cheap to construct and could operate in neighbor-

ing cities without conflicting. A stepping stone to TV, VHF radio was thought to be the ultimate urban medium.



30 YEARS AGO: OCTOBER 1965



Power Brokers

A Lincoln Continental with a 462-cu.-in. V8—that really says it all about Detroit's offerings for 1966. Performance was everyone's destination. And the way to get there was with gargantuan racing engines, only slightly domesticated for street use. Styling changes were subtler: less chrome, more fast-back roofs. As if to distract government regulators, carmakers also pointed up safety features such as shoulder harnesses and padded dashboards.



Foot Fad

Remember Rollkas? No? What Rollerblades are in 1995, Rollkas were in 1965—at least in Austria. Introduced to the United States that summer, Rollkas were steel-nylon Caterpillar treads that attached to boots. You strapped them on and rolled downhill, wielding poles for balance and turning. Rollkas proved more like ice skates than skis, although one PM editor likened the sport to riding an escalator that was running amok. **PM**

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TECH UPDATE

News Of Tomorrow's Technology Today



Rockets Could Ride The Maglev Express

WASHINGTON, DC—Think of it as the bullet train to space. The track: a 2½-mile magnetic-levitation (maglev) guideway that climbs through a tunnel carved up a mountainside. Suspended above this guideway, a flatbed sled carries a single-stage rocket spacecraft. Along the track, superconducting electromagnets fire in sequence, accelerating the sled to 600 mph. Then, at the mountain's peak, the spacecraft ignites its engines and leaps from the sled to continue its journey all the way into orbit.

That's the vision behind MagLifter, a future launch system being kicked around in Code XZ—NASA's advanced-concepts think tank. The technology could make the jump from blueprint to reality with a few billion dollars' investment. In return, say proponents, MagLifter could cut the high cost of space launch by serving as a reusable first stage.

Electromagnetic launchers have been proposed before (see Tech Update, page 16, April '88). But MagLifter has an edge. Unlike high-velocity coilguns, the system would subject payloads to no more than three times the pull of gravity. By limiting the stress of acceleration, MagLifter could accommodate such sensitive packages as commercial satellites.

Given a boost by the maglev accelerator track, the winged rocket could carry twice as much cargo as a ground-launched equivalent. Alternatively, it could haul the same payload

Electromagnetically accelerated rocket blasts off as it separates from carrier sled at mouth of MagLifter tunnel.

but be built far more robustly to enhance its reusability.

Right now, MagLifter advocates are looking at mountains in the Southwest as potential staging areas. Another option is to locate the system in Ecuador, where a 20,000-ft. peak would suit payloads destined for equatorial orbits. Meanwhile, designers hope to draw from the current X-33 and X-34 reusable-rocket programs to shape the rocket vehicle.

Highlights This Month

- **Construction Zone**—Latest on the space station.
- **Far Sighted**—Long-distance drone for spy missions.
- **Deep Heating**—Geothermal energy gets hot again.
- **Role Player**—F-22 fighter may serve double duty.
- **Net Profit**—Fish farming to ply deepest water yet.
- **Tire Walls**—Old rubber becomes new sound barrier.
- **Power Lines**—Railroads to carry solar electricity.

Writer/Editor: Gregory T. Pope
Reporters: John Boatman, Philip Chien,
Mike Fillon, Scott Gourley, Francis Hamit,
Rick Schrader

Countdown To Space-Station Age

HUNTSVILLE, AL—The recent space-shuttle visits to *Mir* set the clock ticking toward the launch of the International Space Station. NASA and its global partners are about 25 months from lofting the first components. But the world's biggest high-tech project is beginning to take shape.

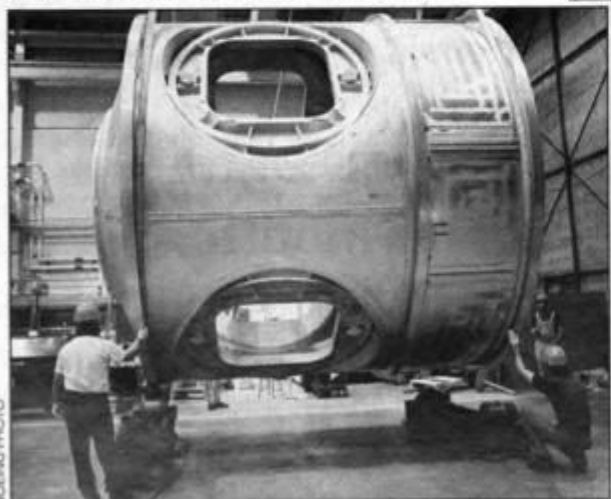
Boeing welders and machinists have just finished their work on the first U.S.-built flight article—Node 1, which will connect the pressurized lab and habitation modules. The second node, linking the lab with European and Japanese facilities, is already complete and will soon begin pressure testing.

Meanwhile, in Russia, the Khrunichev enterprise has done the basic structural work on the Functional Energy Block—the first component slated for launch (in November 1997). Initialed the FGB from its Russian name, this space tug will provide propulsion during the station's early years. Node 1 will mate with this segment in December 1997.

Other Russian components will go up later. One of the most important, the Service Module, will reboost the space station every day to counter atmospheric drag. The solar arrays on this module have been recently redesigned to augment the station's power supply during its construction period.

Japan is driving ahead aggressively with its contributions to the station. The free-flying prototype for the Japanese Exposed Facility is now in space, launched last March aboard an H-2 rocket.

But the outlook for the European elements remains murky. Member nations of the European Space Agency (ESA) are debating whether to continue funding the Columbus Orbiting Facility (COF), the lab originally planned for the canceled space station *Freedom*. Although Germany favors COF, France is now pushing to spend the money on a reusable space ferry. The other space-station partners have made it clear that if the ESA doesn't cough up the lab, it will be denied access to the station.



Node 1's aluminum exterior structure, weighing 5000 pounds, is now complete.

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7. LAB MODULE
8. NODE 1
9. HAB MODULE

RUSSIA

10. RESEARCH MODULES
11. FGB TUG
12. DOCKING & STOWAGE MODULE

13. SOYUZ ACRV

14. UNIVERSAL DOCKING MODULE
15. SERVICE MODULE
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SOLAR ARRAYS

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ILLUSTRATION BY JOHN PRASSANITO & ASSOCIATES

Sky Spy To Trot The Globe



connaissance aircraft anywhere. With a range of 14,000 miles, it can fly more than halfway around the world—or spend two days loitering in the stratosphere over a battlefield.

The lanky air vehicle is currently under

to engine performance by compressing intake air. Critical to the success of Tier II-plus will be its Allison AE 3007 turbofan, tweaked to fly at 65,000 ft.

Behind the hump, electrooptic and infrared cameras will work with high-resolution synthetic-aperture radar. Tier II-plus will be able to see features as small as 1 ft. across.

Although the wide-winged airframe will lack the stealth of the

Operating much like an unmanned U-2 spy plane, long-distance Tier II-plus will soar on skinny wings.

SAN DIEGO, CA—Weighing 12 tons, with a wingspan of 116 ft., this is hardly a portable drone. But no one need carry the Tier II-plus unmanned re-

construction at Teledyne Ryan Aeronautical. A distinctive nose hump will house a 48-in. satellite-communications antenna—and should contribute

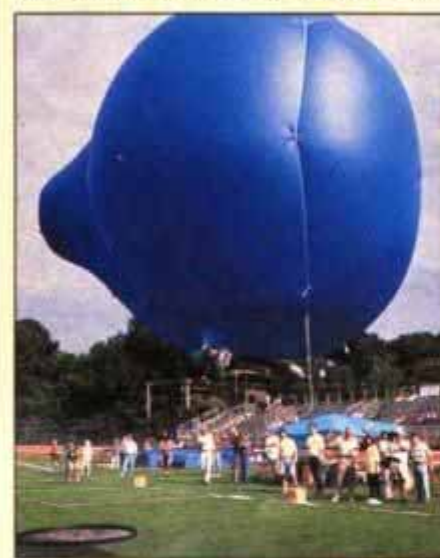
Tier III-minus DarkStar (see Tech Update, page 18, Sept. '95), it will tow decoys and carry radar-jamming equipment to foil surface-to-air missiles. Designed for different missions, the two spy drones will nevertheless share ground-control equipment.

Flying Robots Make Progress

ATLANTA, GA—What a difference a year makes. After a dismal showing last summer (see Tech Update, page 26, Aug. '94), contestants returned to the annual Aerial Robotics Competition at Georgia Tech with smarter, better machines—and this time made a game of it.

As before, the flying vehicles had to pluck discs from a bin, fly them across a barrier and deposit them in another bin, all autonomously. True, no machine has done that yet. But first-time participant Stanford University came close enough to garner an unprecedented \$7000 prize. Second place went to Technische Universität Berlin's blimp.

The Stanford robot, a miniature helicopter, did everything except give up the disc at the end (it had no mechanism to do so). It also stayed airborne for a contest-record 3 minutes. Key to its performance: differential carrier-phase GPS readings, in a navigation system that kept the aircraft aware of its position to within inches.



Stanford's minichopper snags two discs during contest. Berlin blimp (above left) bagged second place.

GEORGIA TECH PHOTOS

Heat Miners Tap Earth's Basement

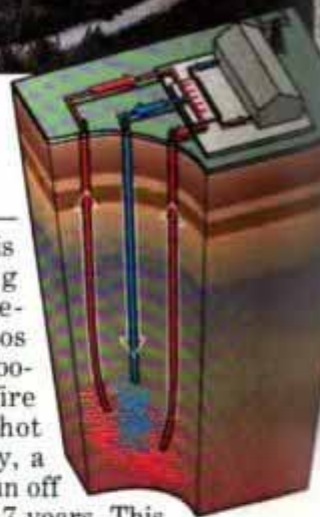


Geothermal plant would circulate water through hot crystalline rock to extract heat.

LOS ALAMOS, NM—Geothermal energy is once again warming the cockles of researchers' hearts. Los Alamos National Laboratory is ready to fire up its Fenton Hill hot dry rock test facility, a heat mine that has run off and on for the past 17 years. This time, engineers want to prove that hot dry rock—which underlies most of the planet—can supply power on a commercially viable basis.

The rock itself bakes 12,000 ft. below the surface. The facility pumps high-pressure water through the subterranean hot spot, opening cracks through which the water can pass and absorb warmth. Three years ago, tests showed that the returning superheated fluid delivers consistent 360° F temperatures. After running through a heat exchanger, the water plunges back down to the heat reservoir.

Los Alamos wants to team with industry to install a powerplant at Fenton Hill. Researchers believe it could generate 30 megawatts.





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Fighter's Many Faces

MARIETTA, GA—Gone the way of the 600-ship Navy and other Cold War concepts is the dedicated single-mission aircraft. Instead, the Pentagon wants maximum bang for its buck.

Take the F-22. Conceived as an air-to-air fighter when there was still a USSR, the Lockheed Martin/Boeing stealth machine could end up serving double duty as a ground attacker or even a spy plane. Another role under consideration is suppression of enemy air defenses, either with the HARM radar-killing missile or via nonlethal jamming.

The Air Force now has Lockheed Martin working on a 2-year F-22 derivatives study. Already, engineers have modified the basic airframe to launch two 1000-pound Joint Direct Attack Munitions (JDAMs), which are gravity bombs with movable fins and GPS units for guidance. During a conflict—once U.S. forces rule the skies and have destroyed air defenses—the F-22 could abandon stealth to carry more smart weapons on hardpoints below each wing.



Air-superiority F-22 may become strike fighter, launching JDAM bombs.

Runway Stops For Runaways

ATLANTIC CITY, NJ—Airliners still run off runways. The consequences have been disastrous, especially at older airports that are bordered by bodies of water or local development.

of this material would collapse under the airliner's wheels, and the crushing action would decelerate the plane.

Recent tests show promise. In one, an FAA 727 plowed into a 196-ft.



FAA engineers examine ruts in cellular concrete ground-arrest system after test.



To reduce the danger, the Federal Aviation Administration has joined with ESCO of Aston, Pennsylvania, to concoct low-density cellular concrete, one-third the weight of water. Installed at the end of a runway, a bed

bed at 42 mph and was slowed to 17 mph. (An initial speed that low isn't unusual for an overrun.)

The first system will be installed at New York's Kennedy International Airport later this year.

SOHO's Staring At The Sun



SOHO will get up close and personal with the nearest star—the Sun.

GREENBELT, MD—Due for launch this fall is the first satellite in a decade that's dedicated to local astronomy—watching our own Sun. Built by the European Space Agency, the Solar and Heliospheric Observatory (SOHO) will ride a NASA-bought Atlas IIAS.

SOHO will patrol a unique orbit, circling the L1 Lagrange point, where Earthly and solar gravity balance out. On-board, 12 instruments will operate for up to four years. They'll probe the Sun's atmosphere, gauge the solar wind and measure how the Sun oscillates.

Scientific goal: to better understand how the Sun governs Earth's climate.

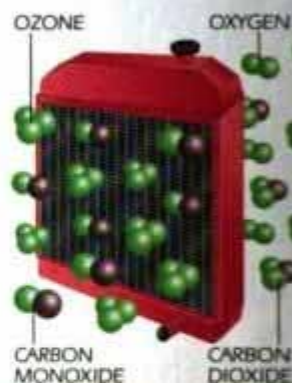
Smog Lifters

ISELIN, NJ—Ozone and carbon monoxide—two vicious factors in urban air pollution—may soon find themselves blown out of town. The Englehard Corp. and Ford are teaming up to launch a fleet of cars that eat smog.

The secret? Englehard's new catalytic material, known as PremAir, that coats the cars' radiators and air-conditioning condensers. The catalyst converts carbon monoxide into carbon dioxide, and ozone into oxygen.

Englehard cites independent studies to assert that the catalyst will be more effective in fighting pollution than electric cars or reformulated fuel. If all cars in Los Angeles sported the coating, they'd completely process the L.A. basin's air up to 15 ft. in altitude.

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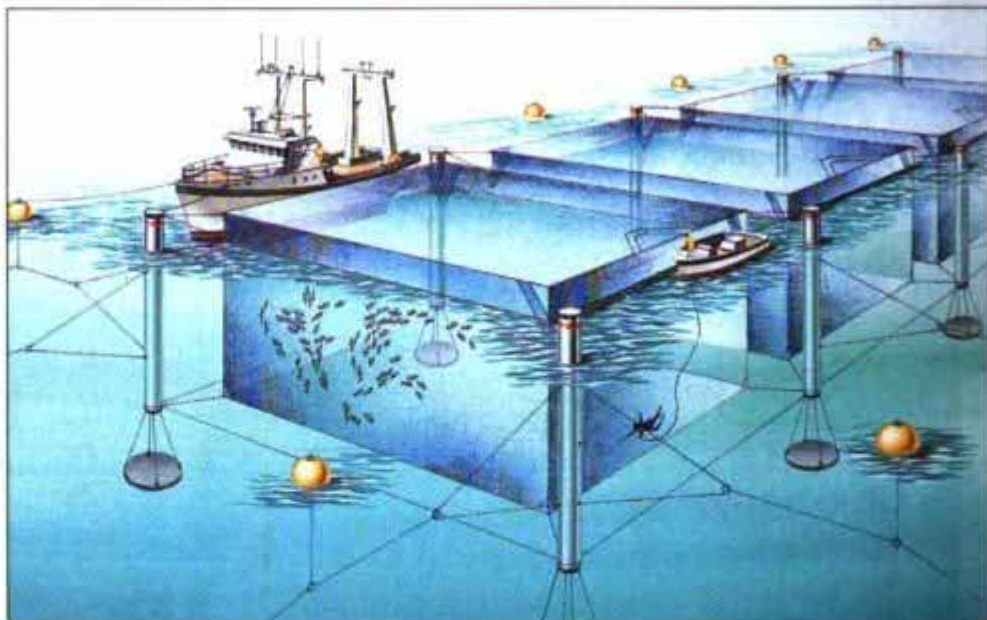


Fish Farms On The High Seas

SEQUIM, WA—If a recent World Bank prediction holds up, 40% of our seafood will have to come from ocean ranches by the year 2020 (see *Tech Update*, page 20, March '95). Thinking ahead, aquaculturalists hope to pioneer the open sea, because space and high-quality water are dwindling along the coastline. Accordingly, the Pacific Northwest Laboratory's Marine Science Lab has embarked on a program to take fish farming deeper than it has ever gone before.

The research focuses on containment systems that can withstand the forces of nature in the open ocean. One promising rig, developed by Net Systems, is now undergoing sea trials off the Washington coast. It's called the Ocean Spar Net Pen System.

The structure consists of buoys,



Resilient open-ocean aquaculture system could solve national seafood deficit.

moored vertical spars and connecting cables. These surround floating containment pens made of flexible net-

ting. The cables transfer forces from wind and waves to the buoys, which distribute the loads over a broad area.

From Missile To Mountain Bike



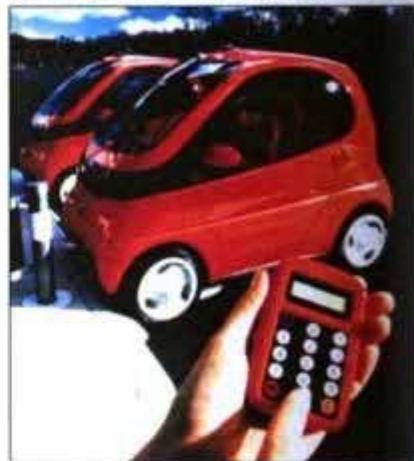
Russian-built bike exploits beryllium's inherent vibration-dampening property.

SAN JOSE, CA—Keep an eye out for beryllium. Element 4 on the periodic table is the latest (and possibly the last) exotic structural material to hop from military to commercial applications. Much lighter and stronger than titanium, beryllium combines resiliency and stiffness—two traits usually considered mutually exclusive.

One entrepreneur has harnessed a Russian beryllium alloy formerly used for missile components. Beyond Fabrications has converted a factory outside Moscow to crank out high-end mountain bikes that weigh less than 24 pounds. The frames contain a composite of recycled weapons material and newly processed alloy.

Self-Service Rent-A-Car

PARIS, FRANCE—Notoriously impatient, Parisian drivers may suffer through fewer traffic jams if Peugeot-Citroën pulls off its



Just 7 ft. long, TULIP electric rent-a-cars would thin Parisian traffic.

TULIP proposal. The idea is to scatter a fleet of electric 2-seaters throughout the city.

Subscribers to the TULIP service would reserve their vehicles through remote-control handsets. At stations where TULIPs are picked up and dropped off, the vehicles' nickel-cadmium batteries would be automatically recharged between rides. What's more, a "smart street" guidance system would put navigation beacons at every intersection.

Planners believe that 50,000 to 100,000 TULIPs will lure Parisians from their cars and taxis.

Tires Turn Into Highway Walls



VIENNA, AUSTRIA—How to solve two environmental problems at once? Convert old tires into highway noise-abatement barriers. That's the idea behind Ecowall, from the Austrian firm Econtract.

The tires are first cut to conform to a flat vertical

surface, such as a framework of recycled plastic. The cavities are filled with earth, and the tires are perforated and planted with creeping vines or other local flora.

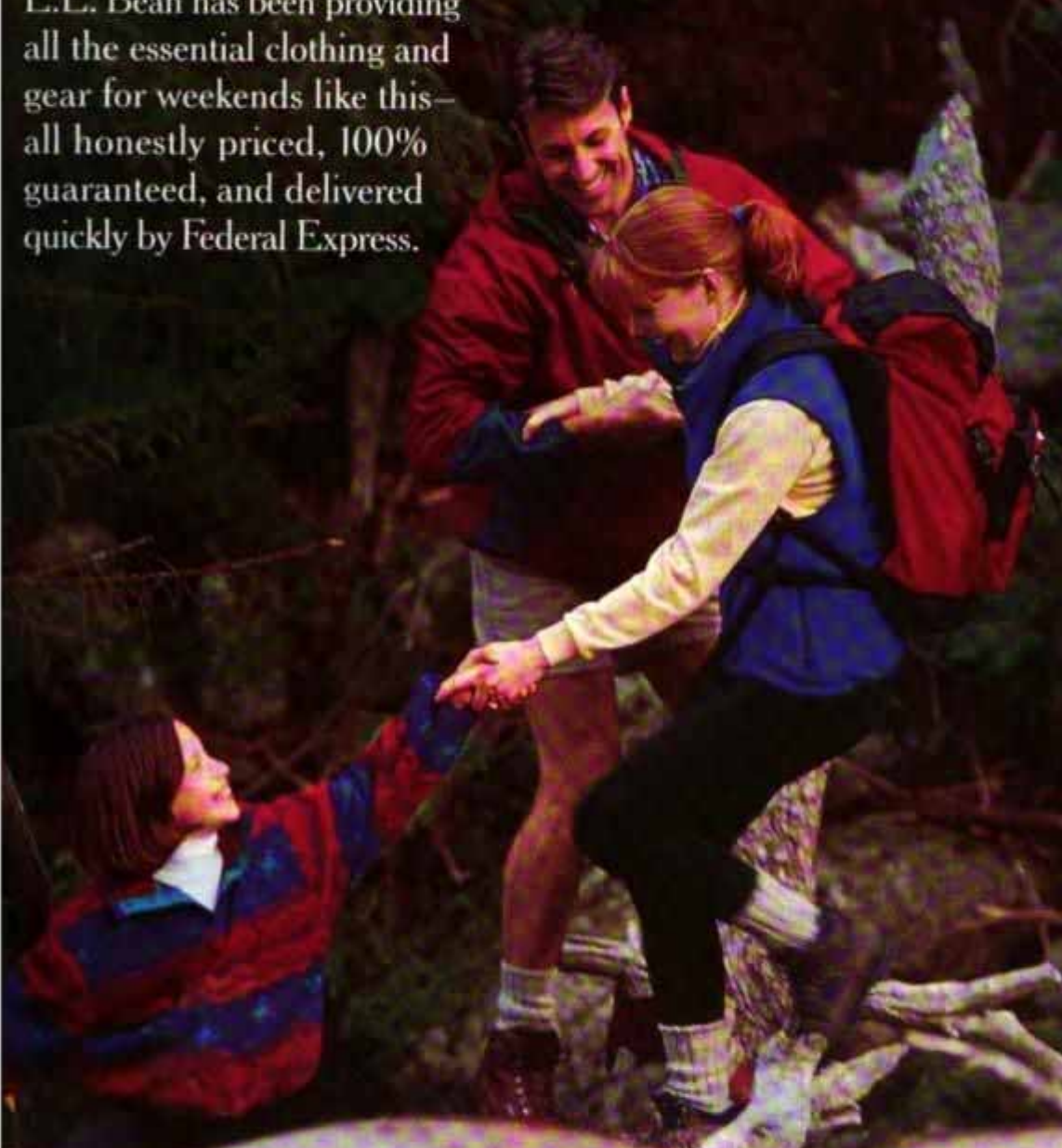
Advantages? Low maintenance, for one—tires don't rot, and plants just need an occasional pruning. The walls defy graffiti and absorb, rather than reflect, traffic noise. Intrigued, California will test the concept along a northern highway.



Ecowall masks old tires with vines to create noise barrier.

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Shutterbug Spacecraft

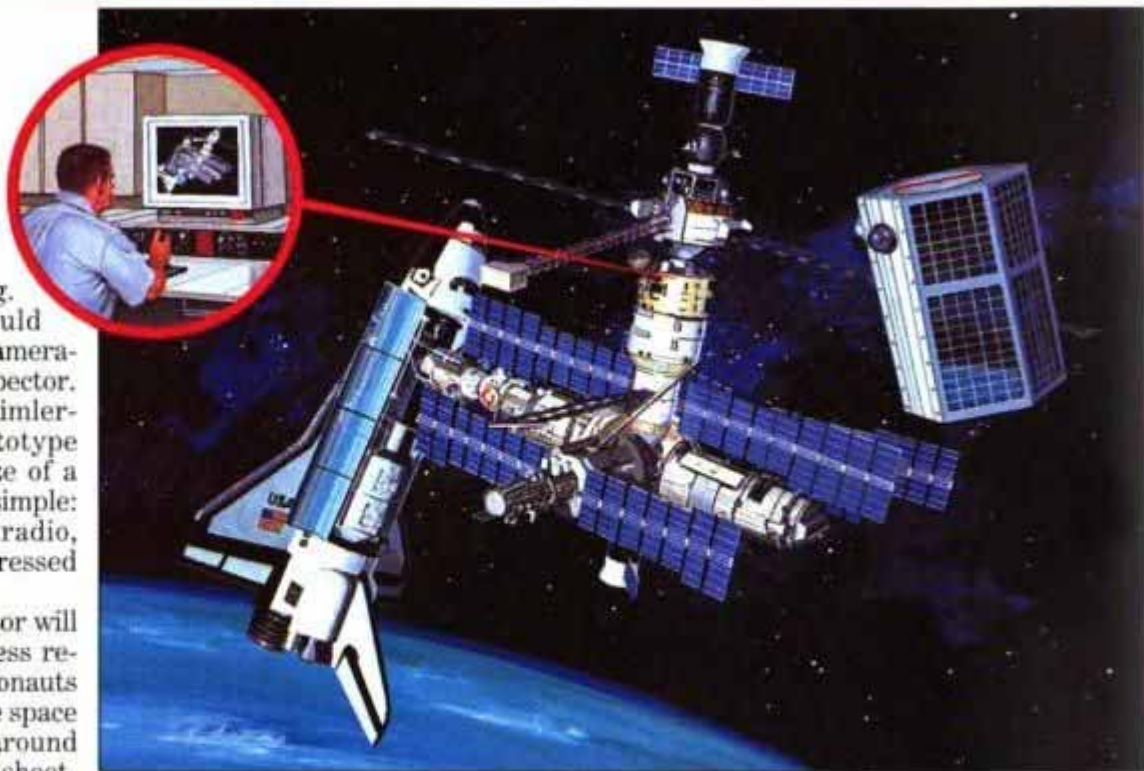
BAIKONUR, KAZAKHSTAN—NASA and the Russians went through all kinds of orbital contortions to get photos of the recent shuttle-Mir docking.

Far more convenient would have been a free-floating, camera-toting spacecraft—like Inspector.

Built by Germany's Daimler-Benz Aerospace, the prototype Inspector is about the size of a wastebasket. Its design is simple: video camera, batteries, radio, gyros and a tank of compressed nitrogen for propulsion.

Early next year, Inspector will fly to Mir aboard a Progress resupply vehicle. Once cosmonauts have finished unloading the space ferry, Inspector will flit around the Russian space station, shooting Mir and the Progress as they separate. Inside Mir, a cosmonaut will fly Inspector by remote control.

After the Progress departs, Inspec-



Remote-control Inspector may transmit real-time video of future shuttle-Mir docking.

tor will continue to circle and film Mir. Then, Inspector is supposed to blast itself into an unused orbit. But NASA

is considering a proposal to keep Inspector in Mir's vicinity until the next shuttle docking mission.

People-Power Products



PASADENA, CA—Supply your own torque, and an electric motor responds to match your input with supplemental power. It's a nifty idea that Yamaha Motor Corp. has incorporated



into a hybrid electric bicycle called the Yamaha PAS. Now, students at the Art Center College of Design have crafted their own machines around the Yamaha gadget, known as the Power Assist System.

In a power-assisted sewing machine, designed by Hanshin J. Kim, the Yamaha device adds to the action generated by foot pedals. Meanwhile, Danny Pestonji's jogging stroller features removable power-assist motors in the handlebars. A diver tow dubbed the SeaWasp, designed by Scott Winslow, combines the system with an integrated oxygen tank.

For active paraplegics, Gregory Hathaway has put the motors and a battery into pods built into a wheelchair.

Not only does the device supplement the user's arm power when the chair is in motion, but it



Power-assisted products include (clockwise from top left) jogging stroller, sewing machine, diver tow and wheelchair.

Training Wings

WICHITA, KS—The Beech Mk. 2, Raytheon Aircraft's version of the Pilatus PC-9, will loft a future generation of Air Force and Navy student pilots. The 33 x 33-ft. trainer won the hotly contested Joint Primary Aircraft Training System competition (see Tech Update, page 22, Jan. '95).



Beech Mk. 2 beat out six competitors to win the role as the future Air Force/Navy trainer.

Germany, Australia and other countries already use the existing PC-9 as a trainer. The new Beech aircraft is a beefed-up evolution of the Swiss-made turboprop, with a more powerful engine, strengthened fuselage and added fuel capacity. It will replace the Air Force's T-37B and the Navy's T-34C.

The first operational aircraft will be delivered to the Air Force in 1999. The Pentagon has elected to stretch out production of the 711 planes to the year 2017.



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New Tanks For The Desert Rats



NEWCASTLE UPON TYNE, ENGLAND—Although they no longer face the threat of mass armored invasion, the Europeans aren't sitting by idly. France, Germany and Great Britain all have new main battle tanks in the pipeline. Undergoing field trials right now is Britain's Challenger 2—a sub-

stantially different tank from the Challenger that fought in Desert Storm.

Built by Vickers Defense Systems, the Challenger 2 retains the 120mm rifled gun of its predecessor, but mounts it in a completely new turret. Inside, the fire-control system features separate gunner's and commander's

Vickers-built powerhouse Challenger 2 fires 120mm rifled gun six times in 24 seconds—faster than an autoloader.

sights. The vehicle can hit road speeds of 47 mph on a Perkins V12 diesel.

Instead of upgrading its existing Challengers, the British Army is stocking up on newly built Challenger 2s.

Blackbird's Backpack

PALMDALE, CA—It's no secret that Lockheed Martin Skunk Works is sky-high on its design for the X-33 reusable rocket demonstrator (see "Return Of The Lifting Body," page 38, May '95). But the proposed vehicle must leap into space on a radical rocket engine—known as a linear aerospike—that has yet to fly. So, Skunk Works will harness its original thoroughbred—the SR-71 Blackbird—to conduct the first-ever flight tests of the engine.



Developed in the 1960s by Rocketdyne, the linear aerospike looks nothing like a conventional bell-shaped

Blackbird will carry operational linear aerospike to test rocket engine at Mach 3.

rocket engine. Instead, it features two lines of small thrusters that shoot their exhaust gases onto a wedge-shaped surface. The exhaust impinges against both upper and lower faces of this surface to provide thrust. Key advantage: The engine operates with consistent efficiency at any altitude.

In April 1996, a NASA SR-71 will piggyback a cutaway scale model of the Skunk Works X-33 concept, complete with its own functioning linear aerospike.

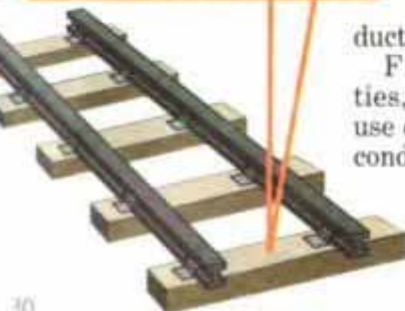
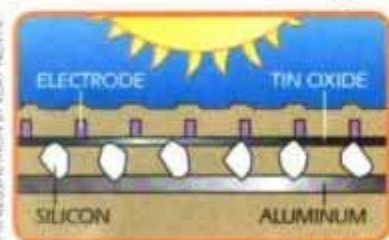
Solar Power On Track

CORVALLIS, OR—Concrete and old railroad tracks may not spring to mind when you think of solar power. But a group of electrical engineers at Oregon State University want to change that. They're designing a rugged, cheap photovoltaic cell that's coupled to America's rail network.

Instead of glass or plastic, cement will encase the solar cell. The photovoltaic hardware will lie just below the surface where enough sunlight can filter in to trigger a voltage. Electrodes would then conduct the current off the cell.

Fashioned into railroad ties, the cement cells would use existing railroad tracks to conduct power over distances.

Cement photovoltaic cell forms railroad tie that generates low-voltage power.



Frisking From Afar



DEERFIELD, MA—Between microwave and infrared lies the millimeter wave band. This little-heralded portion of the electromagnetic spectrum turns out to be perfect for "remote frisking." Millitech Corp. has designed a camera to accomplish just that. The idea calls for measuring the time delay and intensity of millimeter wave energy that radiates naturally. At millimeter wavelengths, people are good emitters, while metals are very poor. Dielectric objects, such as plastics, ceramics and powdered drugs, are somewhere in between. Clothing and building materials, such as wallboard, are virtually transparent.



Millimeter-wave camera picks up both metallic and plastic concealed handguns.



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You can't catch what you can't see. With the new Spirit II, you are as invisible to cop radar as a donut hole. And yes, it's completely legal nearly everywhere. Spirit is a "passive" jammer - not transmitter. It bounces back a scrambled message to detectors. When the Spirit receives a radar signal, it mixes the signal with a modulating FM chirp, streaking it back, and totally confusing the radar gun's computer brain. The 2 to 3 mile range gives you plenty of time to correct your speed. No tickets, no hassles, and your car

insurance might get cheaper, too. So effective is the Spirit II that if you get a ticket in the first year you use one, the manufacturer will completely refund your fine!

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- **New Spirit II Radar Jammer**, with micro-circuitry. #SPR-2 \$119.95

Jams all three bands: X, K, and KA, too. Fits in your shirt pocket.

Check with your local and state authorities before ordering. Not available in Washington D.C., VT, NH, or OK residents.



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Can also be used reversed as low power microscope. Includes Russian documentation. Hurry, comrade, supplies limited.

Sorry, Mr. Jones is not in. This is Lucille, his secretary, may I help you?

New micro-size voice disguiser even works with pay phones!

Here's just some of the things you can do with our new palm-sized voice changer: fool your friends, confuse your enemies, be your own secretary, make anonymous calls for business or security reasons, or protect women and children home alone.

Unlike sophisticated desk-top voice-changers, the Micro-Disguiser has no modular hook-ups! Slip it from your pocket and place it over any pay phone's mouthpiece! Miniature electronics alter your voice in a choice of eight different levels. Extreme settings sound hilarious, and mid-ranges will even fool your own mother.

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Get one for a woman friend, and let harassing callers think a man is at home.



Take back control of your telephone.

Tele-Screen™ Phone Protector eliminates unwanted calls. Harassing calls, sales calls, any call you wish. Incoming calls are greeted by a voice prompt: "Thank you for calling. Please enter the four-digit pass-code." Your phone rings only if the caller enters the correct code. Voice prompt repeats and if no code is entered, the caller is automatically disconnected! Use the keypad to change the code, or de-activate the unit. It's like having an unlisted phone number when you want it unlisted. Like during study, meal-time, romantic evenings, or when you only want calls from those you gave your password to. Also secures fax and modem lines!

- **Tele-Screen™** #TS-300 \$44.95

Installs easier than an answering machine, with its own AC power pack. Rings once to let you know it's working. Un-Telescreened extensions will regular ring.





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switch on the Infrared Illuminator - and see in pitch black *total darkness*.

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■ T3C-2 Night Vision Scope, with Illuminator #T3C-2 ~~\$499.00~~ Now \$299.00!

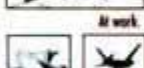
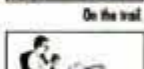


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The amazing Gyroscopic Razor whirls its hidden blades at over 20,000 rpm - twice that of other shavers. The result is a skin-tingling super-smooth shave, anywhere. Neil Armstrong even took one to the moon. One pull of the gyro-throttle spins four orbiting micro-blades - long enough to buzz even a week's worth of whiskers. Concealed powerplant is a precision ballistic gyroscope, just like those in guidance systems. No more hunting around for batteries! Steel and ABS casing is tough enough to take a NASA blast-off. Try one in the woods, at the airport, or cruising to work. And enjoy one smooth shave for man, and one shaving leap for mankind.

■ Apollo 13 Gyroscopic Razor #BRN-72 \$49.95

It's even been to the moon.



Even both & planes.



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Did you know that every time you make a call, you are giving out your name and phone number? The revolutionary new Automatic Caller I.D. Blocker gives you back your privacy. Simply click it into your phone jack, and all phones on the line are secured, including extensions. Let caller I.D.'s draw a blank - especially important for transacting business, or for women or children home alone. State-of-the-art circuitry works on local and long distance calls. Best of all, it's completely automatic. No need to dial special codes or services. Once installed, it does the rest. And at a price far lower than the cost of your privacy. Get two - one for your home or office, and one for a special friend's house.

■ The Automatic Caller-I.D. Blocker #PVCY-100 \$39.95

New photo-electric Cyclops speaks your words for you! Leave messages your visitors are sure to hear.

Why wonder if the next person home will find your scrawled note? Instead, push a button and record your message - up to a full 20 seconds - in the digital memory of the new Cyclops. Then just set it by the door and go about your business. Cyclops's scanning infrared eye will automatically detect the next visitor - and speak for you! If it's an intruder, they're long gone. If it's friend or family, Cyclops will speak your message and even accept their return recording to you! No missed messages, meetings, or connections. Best of all, it's completely wireless and self-contained. And only 3" x 3" to take anywhere. Here's just a few ways you might use it:

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- In the car:** "Don't forget Sally's medicine."
- Your room:** "Touch my stuff and you're dead meat."
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■ Cyclops Photo-Electronic Voice Robot #CL300 \$49.95

Requires 4 AAA batteries, not included. Comes with lifetime warranty, and optional wall mount hardware.

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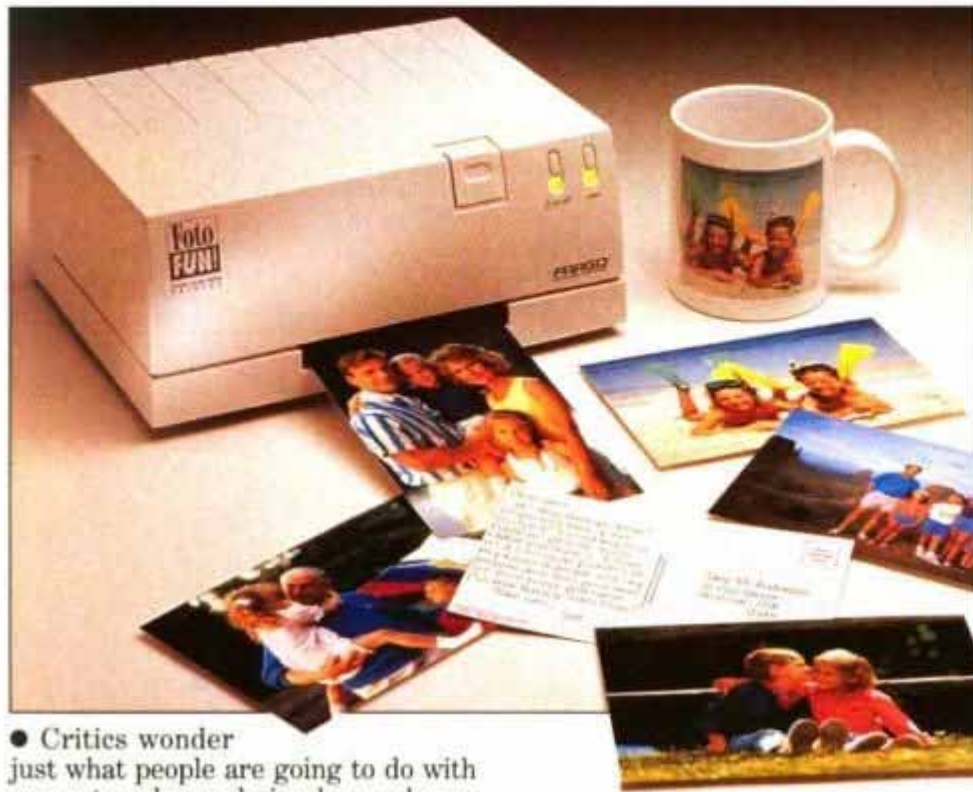
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Printing PC Pictures

BY FRANK VIZARD, Electronics Editor



● Critics wonder

just what people are going to do with computers beyond simple word processing, but the truth is that once people get a new tool, they start using it in ways the makers never imagined. One unintended byproduct of the computer revolution is the resurgence of photography as a hobby.

Not that people ever stopped taking pictures. But what they aren't doing is developing their own pic-

tures. All this may change as the means to process and print your own photos becomes affordable.

The new darkroom is your computer. Excellent software programs such as Picture Window (\$99), from Digital Light & Color (800-577-7090), let you manipulate images to correct mistakes and create new composite images from separate pictures.

How do you get images into your computer? Accessories like color scanners let you input images directly. You can even import video images with an add-on image converter, such as Snappy. But the least expensive way is to simply have your photos put on a floppy disk. Outlets such as Thrifty-Payless, with 645 locations, will do the job for as little as \$3.99 for a 24-print roll. There are also millions of other images available for downloading on the World Wide Web.

Completing the loop in terms of your own darkroom means having a way to print the photos. One new method comes courtesy of Fargo Electronics, a Minnesota-based company, better known for business printers. Fargo's new FotoFun! digital color printer lets you develop prints as big as 4 x 6 in. Printers are available for both Windows and Macintosh appli-

cations. Installation is similar to that of a standard printer, but our initial experience indicated that the machine may get a little cranky in hot weather.

Indeed, the experience was reminiscent of the early days of VCRs—if you're not careful, the paper will jam, and the ribbon tears easily. There's also an installation program that will make you more conversant with the printer setup controls than you might be normally. This is a machine for the dedicated and patient amateur photographer.

FotoFun!, listing for \$399, uses thermal dye sublimation technology to print on specially coated paper. A 36-sheet paper and ribbon kit lists for \$39. There's also a kit for printing on mugs for \$30.

Another alternative that's been available for some time is to use a color printer, machines that have been noticeably improving in quality as they come down in price. These machines are also becoming more versatile as well.

Good examples are two new printers from Canon, the BJC-4100 and BJC-610, listing for \$269 and \$369, respectively. With the right paper, both printers can turn out very good color prints. What makes them special, though, is a CD-ROM software program that gives them added versatility.

The CD-ROM contains five applications aimed at getting more out of a printer than just letters. These include the following:

- A Hallmark collection of 50 designs that can be used to create 150 different greeting cards.
- A Crayola coloring book that lets kids print their finished work.
- A stationery store of 250 templates for creating your own customized letterheads.
- 100 templates and 500 designs for creating stickers and labels.
- A "Pattern Maker" cross-stitch program, which prints colored stitching patterns directly onto fabric. This software lets you import photos and artwork and translate them into cross-stitch patterns. Templates are included, but original patterns can also be developed.

Canon also will market a variety of
(Please turn to page 36)



Canon's newest printers let you transfer images onto more than just paper.

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In clinical studies with Cardizem CD, the most common side effects, seen in less than 5.5% of patients, have been headache, dizziness, slow heart rate, heartbeat irregularities, and swelling of the ankles. Cardizem CD is not appropriate for all people, especially those with certain serious heart rhythm conditions. Make sure your health care professional knows about your medical history, including heart, liver, and kidney problems. Tell your health care professional about other medications you are taking because of possible drug interactions which could result in other potentially serious side effects.

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Talk to your doctor or health care professional about Cardizem CD. Only a health care professional authorized to prescribe Cardizem CD can evaluate the potential risks and benefits of Cardizem CD for you.

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CONTRAINDICATIONS

CARDIZEM is contraindicated in (1) patients with sick sinus syndrome except in the presence of a functioning ventricular pacemaker, (2) patients with second- or third-degree AV block except in the presence of a functioning ventricular pacemaker, (3) patients with hypotension (less than 90 mm Hg systolic), (4) patients who have demonstrated hypersensitivity to the drug, and (5) patients with acute myocardial infarction and pulmonary congestion documented by x-ray on admission.

WARNINGS

- Cardiac Conduction.** CARDIZEM prolongs AV node refractory periods without significantly prolonging sinus node recovery time, except in patients with sick sinus syndrome. This effect may rarely result in abnormally slow heart rates (particularly in patients with sick sinus syndrome) or second- or third-degree AV block (13 of 3290 patients or 0.40%). Concomitant use of diltiazem with beta-blockers or digitalis may result in additive effects on cardiac conduction. A patient with Prinzmetal's angina developed periods of asystole (2 to 5 seconds) after a single dose of 60 mg of diltiazem.
- Congestive Heart Failure.** Although diltiazem has a negative inotropic effect in isolated animal tissue preparations, hemodynamic studies in humans with normal ventricular function have not shown a reduction in cardiac index nor consistent negative effects on contractility (dp/dt). An acute study of oral diltiazem in patients with impaired ventricular function (ejection fraction 24% ± 6%) showed improvement in indices of ventricular function without significant decrease in contractile function (dp/dt). Worsening of congestive heart failure has been reported in patients with preexisting impairment of ventricular function. Experience with the use of CARDIZEM (diltiazem hydrochloride) in combination with beta-blockers in patients with impaired ventricular function is limited. Caution should be exercised when using this combination.
- Hypotension.** Decreases in blood pressure associated with CARDIZEM therapy may occasionally result in symptomatic hypotension.
- Acute Hepatic Injury.** Mild elevations of transaminases with and without concomitant elevation in alkaline phosphatase and bilirubin have been observed in clinical studies. Such elevations were usually transient and frequently resolved even with continued diltiazem treatment. In rare instances, significant elevations in enzymes such as alkaline phosphatase, LDH, SGOT, SGPT, and other phenomena consistent with acute hepatic injury have been noted. These reactions tended to occur early after therapy initiation (1 to 8 weeks) and have been reversible upon discontinuation of drug therapy. The relationship to CARDIZEM is uncertain in some cases, but probable in some. (See PRECAUTIONS.)

PRECAUTIONS

General. CARDIZEM (diltiazem hydrochloride) is extensively metabolized by the liver and excreted by the kidneys and in bile. As with any drug given over prolonged periods, laboratory parameters of renal and hepatic function should be monitored at regular intervals. The drug should be used with caution in patients with impaired renal or hepatic function. In subacute and chronic dog and rat studies designed to produce toxicity, high doses of diltiazem were associated with hepatic damage. In special subacute hepatic studies, oral doses of 125 mg/kg and higher in rats were associated with histological changes in the liver which were reversible when the drug was discontinued. In dogs, doses of 20 mg/kg were also associated with hepatic changes, however, these changes were reversible with continued dosing. Dermatological events (see ADVERSE REACTIONS section) may be transient and may disappear despite continued use of CARDIZEM. However, skin eruptions progressing to erythema multiforme and/or exfoliative dermatitis have also been infrequently reported. Should a dermatologic reaction persist, the drug should be discontinued.

Drug Interactions

Due to the potential for additive effects, caution and careful titration are warranted in patients receiving CARDIZEM concomitantly with other agents known to affect cardiac contractility and/or conduction. (See WARNINGS.) Pharmacologic studies indicate that there may be additive effects in prolonging AV conduction when using beta-blockers or digitalis concomitantly with CARDIZEM. (See WARNINGS.) As with all drugs, care should be exercised when treating patients with multiple medications. CARDIZEM undergoes biotransformation by cytochrome P-450 mixed function oxidase. Coadministration of CARDIZEM with other agents which follow the same route of biotransformation may result in the competitive inhibition of metabolism. Especially in patients with renal and/or hepatic impairment, dosages of similarly metabolized drugs, particularly those of low therapeutic ratio, may require adjustment when starting or stopping concomitantly administered diltiazem to maintain optimum therapeutic blood levels.

Beta-blockers. Controlled and uncontrolled domestic studies suggest that concomitant use of CARDIZEM and beta-blockers is usually well tolerated, but available data are not sufficient to predict the effects of concomitant treatment in patients with left ventricular dysfunction or cardiac conduction abnormalities. Administration of CARDIZEM (diltiazem hydrochloride) concomitantly with propranolol in five normal volunteers resulted in increased propranolol levels in all subjects and bioavailability of propranolol was increased approximately 50%. In vitro, propranolol appears to be displaced from its binding sites by diltiazem. If combination therapy is initiated or withdrawn in conjunction with propranolol, an adjustment in the propranolol dose may be warranted. (See WARNINGS.)

Cimetidine. A study in six healthy volunteers has shown a significant increase in peak diltiazem plasma levels (58%) and area-under-the-curve (53%) after a 1-week course of cimetidine at 1200 mg per day and a single dose of diltiazem 60 mg. Ranitidine produced smaller, nonsignificant increases. The effect may be mediated by cimetidine's known inhibition of hepatic cytochrome P-450, the enzyme system responsible for the first-pass metabolism of diltiazem. Patients currently receiving diltiazem therapy should be carefully monitored for a change in pharmacological effect when initiating and discontinuing therapy with cimetidine. An adjustment in the diltiazem dose may be warranted.

Digitalis. Administration of CARDIZEM with digoxin in 24 healthy male subjects increased plasma digoxin concentrations approximately 20%. Another investigator found no increase in digoxin levels in 12 patients with coronary artery disease. Since there have been conflicting results regarding the effect of digoxin levels, it is recommended that digoxin levels be monitored when initiating, adjusting, and discontinuing CARDIZEM therapy to avoid possible over- or under-digitalization. (See WARNINGS.)

Anesthetics. The depression of cardiac contractility, conductivity, and automaticity as well as the vascular dilation associated with anesthetics may be potentiated by calcium channel blockers. When used concomitantly, anesthetics and calcium blockers should be titrated carefully.

Cyclosporine. A pharmacokinetic interaction between diltiazem and cyclosporine has been observed during studies involving renal and cardiac transplant patients. In renal and cardiac transplant recipients, a reduction of cyclosporine dose ranging from 15% to 48% was necessary to maintain cyclosporine trough concentrations similar to those seen prior to the addition of diltiazem. If these agents are to be administered concurrently, cyclosporine concentrations should be monitored especially when diltiazem therapy is initiated, adjusted, or discontinued. The effect of cyclosporine on diltiazem plasma concentrations has not been evaluated.

Carbamazepine. Concomitant administration of diltiazem with carbamazepine has been reported to result in elevated serum levels of carbamazepine (40% to 72% increase), resulting in toxicity in some cases. Patients receiving these drugs concurrently should be monitored for a potential drug interaction.

Carcinogenesis, Mutagenesis, Impairment of Fertility

A 24-month study in rats at oral dosage levels of up to 100 mg/kg/day and a 21-month study in mice at oral dosage levels of up to 30 mg/kg/day showed no evidence of carcinogenicity. There was also no mutagenic response in vitro or in vivo in mammalian cell assays or in vitro in bacteria. No evidence of impaired fertility was observed in a study performed in male and female rats at oral dosages of up to 100 mg/kg/day.

Pregnancy

Category C. Reproduction studies have been conducted in mice, rats, and rabbits. Administration of doses ranging from five to ten times greater (on a mg/kg basis) than the daily recommended therapeutic dose has resulted in embryo and fetal lethality. These doses, in some studies, have been reported to cause skeletal abnormalities. In the perinatal/postnatal studies, there was an increased incidence of stillbirths at doses of 20 times the human dose or greater. There are no well-controlled studies in pregnant women; therefore, use CARDIZEM in pregnant women only if the potential benefit justifies the potential risk to the fetus.

Nursing Mothers

Diltiazem is excreted in human milk. One report suggests that concentrations in breast milk may approximate serum levels. If use of CARDIZEM is deemed essential, an alternative method of infant feeding should be instituted.

Pediatric Use

Safety and effectiveness in children have not been established.

ADVERSE REACTIONS

Serious adverse reactions have been rare in studies carried out to date, but it should be recognized that patients with impaired ventricular function and cardiac conduction abnormalities have usually been excluded from these studies. The following table presents the most common adverse reactions reported in placebo-controlled angina and hypertension trials in patients receiving CARDIZEM CD up to 360 mg with rates in placebo patients shown for comparison.

CARDIZEM CD Capsule Placebo-Controlled Angina and Hypertension Trials Combined	Cardizem CD (n=607)	Placebo (n=301)
Adverse Reactions		
Headache	5.4%	5.0%
Dizziness	3.0%	3.0%
Bradycardia	3.3%	1.3%
AV Block First Degree	3.3%	0.9%
Edema	2.6%	1.3%
ECG Abnormality	1.6%	2.3%
Asthma	1.8%	1.7%

In clinical trials of CARDIZEM CD capsules, CARDIZEM tablets, and CARDIZEM SR capsules involving over 3200 patients, the most common events (i.e., greater than 1%) were edema (4.6%), headache (4.6%), dizziness (3.5%), asthma (2.6%), first-degree AV block (2.4%), bradycardia (1.7%), flushing (1.4%), nausea (1.4%), and rash (1.2%).

In addition, the following events were reported infrequently (less than 1%) in angina or hypertension trials.

Cardiovascular: Angina, arrhythmia, AV block (second- or third-degree), bundle branch block, congestive heart failure, ECG abnormalities, hypotension, palpitations, syncope, tachycardia, ventricular extrasystoles.

Nervous System: Abnormal dreams, amnesia, depression, gait abnormality, hallucinations, insomnia, nervousness, paresthesia, personality change, somnolence, tinnitus, tremor.

Gastrointestinal: Anorexia, constipation, diarrhea, dry mouth, dysgeusia, dyspepsia, mild elevations of SGOT, SGPT, LDH, and alkaline phosphatase (see hepatic warnings), thirst, vomiting, weight increase.

Dermatological: Patechiae, photosensitivity pruritus, urticaria.
Other: Amblyopia, CPK increase, dyspnea, epistaxis, eye irritation, hyperglycemia, hyperuricemia, impotence, muscle cramps, nasal congestion, nocturia, osteoarthralgia, pain, polyuria, sexual difficulties.

The following postmarketing events have been reported infrequently in patients receiving CARDIZEM: alopecia, erythema multiforme, exfoliative dermatitis, extrapyramidal symptoms, gingival hyperplasia, hemolytic anemia, increased bleeding time, leukopenia, purpura, retinopathy, and thrombocytopenia. In addition, events such as myocardial infarction have been observed which are not readily distinguishable from the natural history of the disease in these patients. A number of well-documented cases of generalized rash, characterized as leukocytoclastic vasculitis, have been reported. However, a definitive cause and effect relationship between these events and CARDIZEM therapy is yet to be established.

Prescribing Information as of April 1993

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cc06493b

special papers for each application. These will include 100%-cotton fabric, T-shirt transfer paper, back-print film, high-gloss film and water-resistant paper. Call Canon at (800) 848-4123 for more information.

Prints from video

Another way to build your photograph collection is to develop prints directly from a VCR, camcorder or other video source. To do this job, you need a video printer.

Although video printers have been around for a few years, it's only recently that you might begin to call the printed images photographic in quality. A good example of this new breed of video printers is the Panasonic PV-MP10. Its superior performance is in large part due to the use of a 10-bit processing system, a step forward from older 8-bit systems.

The PV-MP10 can capture an image in two different ways. A FIELD MEMORY mode freezes a single video field, and is useful for capturing fast-moving action. For more static video shots, FRAME MEMORY combines two successive video frames to reproduce an image with the maximum lines of resolution and greatest amount of picture detail.

Choosing the appropriate mode is all the brainwork that's required with this product. What it does illustrate, though, are any flaws in your earlier thinking concerning sufficient lighting and composition. To a large degree, the printed image is going to be only as good as the source material.

The reason for the qualifier is that the PV-MP10 does allow you to correct for some miscues. You can adjust the color, tint, brightness and sharpness of the image before printing—although not to the degree available on some computer software programs, such as Picture Window or Snappy.

The PV-MP10 also lets you create some special effects. Images can be enlarged and combined. They can also be mirrored, so a print could be heat-transferred to a coffee mug, for example. You can also create wallet-size pictures or customized business cards. And a strobe effect allows you to examine 3 seconds of movement—something for golfers to think about.

Printed images are otherwise limited to 3¼ x 4¼ in. in size. The PV-MP10 uses a thermal dye-transfer process, printing onto special paper in three passes, one each of yellow, magenta and cyan. The resultant images are quite good, although they don't have the richness 35mm film offers. Perhaps the only real disadvantage of the machine is its price tag: \$1300 list. Hopefully, the cost will go down as the quality goes up.

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Platonic Beasts

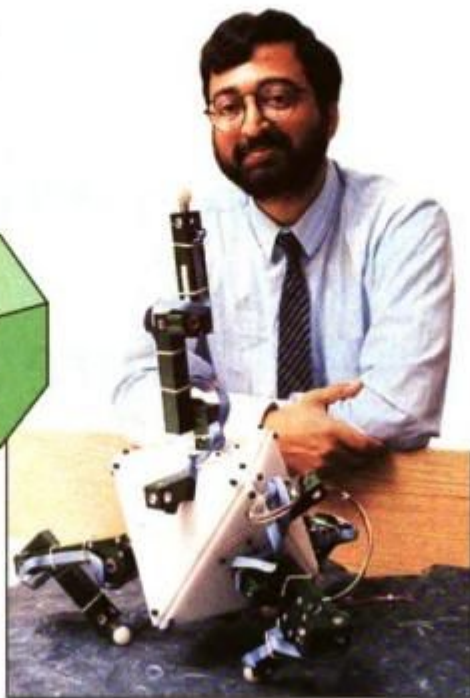
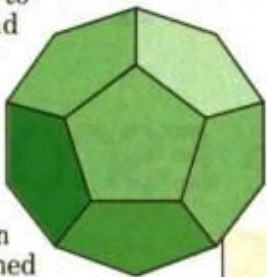
BY GREGORY T. POPE, Science/Technology Editor

● Walking—easy, right? Pound the pavement, and you're combining dynamic balance, eye-to-foot coordination and syncopated muscle action. Sounds complicated, but for most of us, it's second nature. And yet the slightest disruption can throw you flat on your face with a sprained ankle. Only then, as you rehab back into pedestrian mode, do you gain rueful appreciation for the intricacy of your own biomechanics.

Such mishaps are just as vexing to roboticists who have built otherwise sprightly walking machines. Recovery from a topple remains a stumbling block in the development of ambulatory robots. Unlike animals, walking robots lack a full anatomy of muscles with which to pick themselves up and hobble off. Once down, they're out.

But one researcher is designing robots that will never have to say, "I've fallen—and I can't get up!" In doing so, he's creating some of the oddest machines ever to set foot on Earth.

An assistant professor of computer science at the University of British Columbia, Dinesh K. Pai has stepped away from the conventional wisdom that walking machines must mirror biology. Pai's robots look more like crystals than critters. Their bodies aren't mechanical—they're mathematical. Each is a so-called Platonic



solid, such as a cube or an octahedron (eight sides). And from the faces or vertexes of this solid protrude limbs, jutting in every direction.

How did the Platonic beasts, as Pai calls his creations, evolve? "There were two motivations," he recalls. "One was more practical—to have something with no orientation preference, so it could recover from falls. But the other was just curiosity—to build a robot very different from something we see in everyday life."

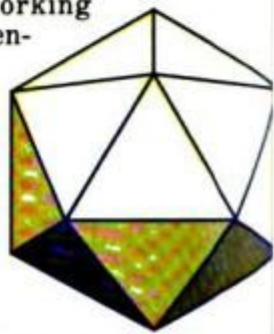
Pai's beasts satisfy both considerations. A Platonic solid is a perfectly regular assemblage of identical, regular surfaces that meet at identical angles. Thus, it

appears unchanged from any number of viewpoints. Flip a sugar cube over and over, and you'll see. A geometrician would say the cube has spherical symmetry, which turns out to be a nifty trait for a walking machine. If you're spherically symmetrical, you don't care which side is up and which is down. So if you're standing in one orientation and roll in any direction, you'll wind up looking the same.

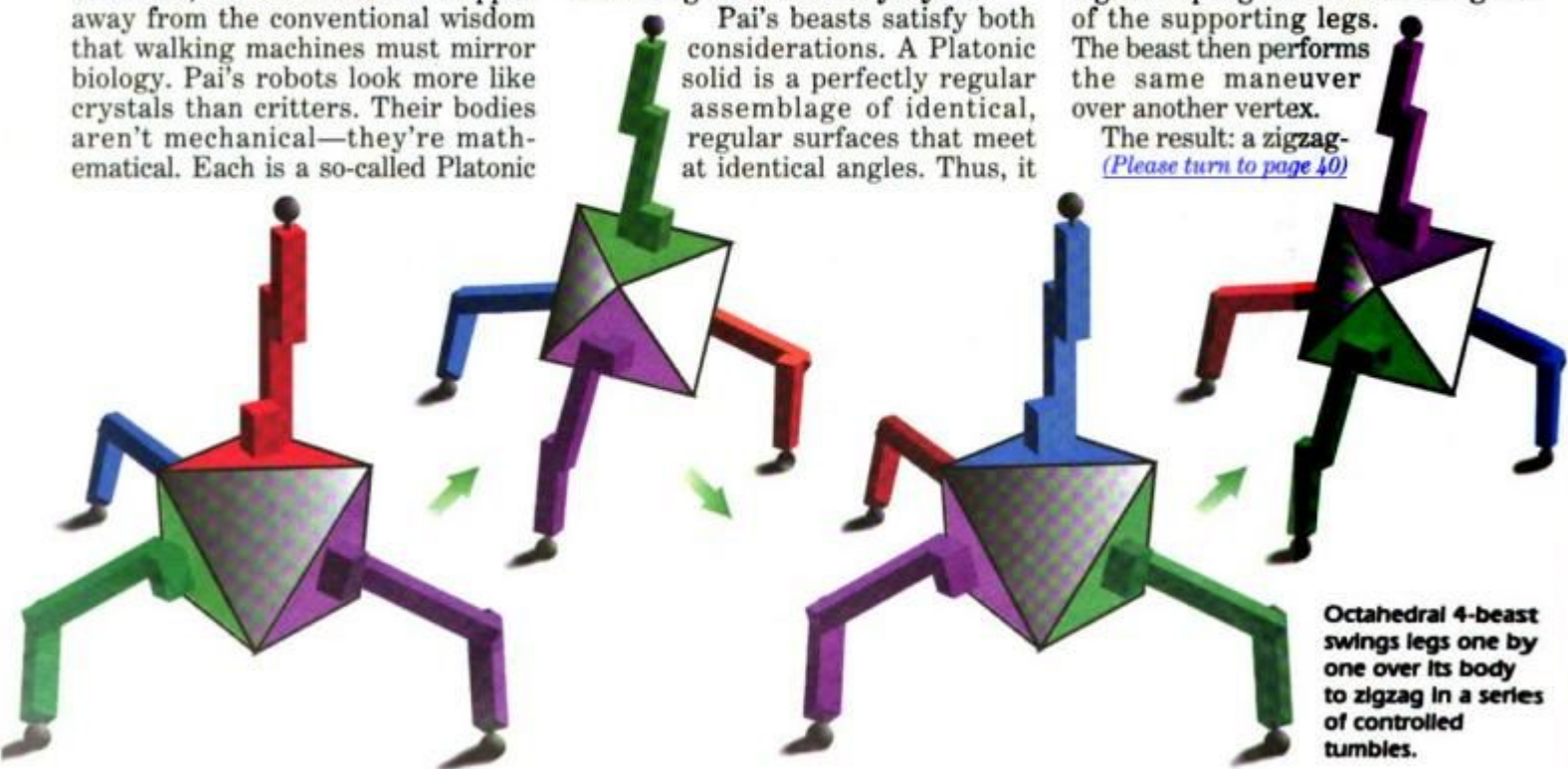
Pai has harnessed this principle to choreograph a jaunty, cartwheeling motion for his Platonic beasts, called a rolling gait. Working

with research scientist Rod Barman and graduate student Scott Ralph, he's demonstrated this gait in his prototype, the 4-beast, an octahedron with four 3-jointed limbs attached to alternate faces. The beast begins with three legs on the ground and one jutting vertically from the top face. It then tumbles over one vertex, swinging the top leg down while lifting one of the supporting legs. The beast then performs the same maneuver over another vertex.

The result: a zigzag—[\(Please turn to page 40\)](#)



Platonic solids: dodecahedron (top left), icosahedron (above).



Octahedral 4-beast swings legs one by one over its body to zigzag in a series of controlled tumbles.

Ford Ranger 4x4

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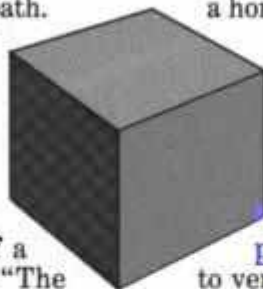
BUILT FORD TOUGH



ging stride that leaves the robot on three legs after each step. This gait guarantees that a stable foot position is available should the robot accidentally keel over in any direction.

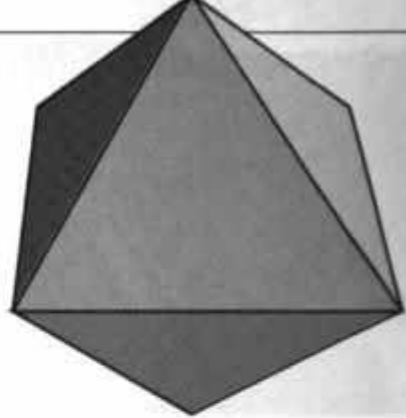
The rolling gait takes robotic walking along an entirely new path.

For decades, roboticists have been analyzing animal locomotion, hoping one day to catch up with Mother Nature. While researchers have made great strides, their walking machines still can't match the agility of a cat—or even a cockroach. "The



problem with many examples from nature," explains roboticist John Bares, "is that they are too complicated to replicate and control. We've never built a robot with limbs anywhere near as dextrous as those of a horse or a human."

A research scientist at Carnegie Mellon University's Field Robotics Center, Bares knows this only too well. As coinvestigator on the 8-legged Dante II project (see [Tech Update, page 24, March '94](#)), he had to venture down a volcano crater



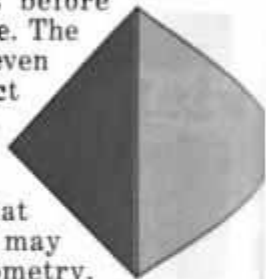
Platonic solids: octahedron (above), tetrahedron (below) and cube (left).

to rescue his robot when treacherous rubble toppled it. Dante's gait was hardly natural—it walked like two overlapped tables sliding against each other. But Dante, an otherwise robust and successful machine, proved vulnerable because it functioned in only one orientation.

Platonic beasts, on the other hand, needn't worry about which end is up. And the beasts boast other advantages. The rolling gait allows a robot to change directions easily, even make a sharp turn around an edge. Equipped with enough limbs, a beast could scuttle across the ground, then stop, poise on some of its appendages and use others to manipulate objects. What's more, should one limb give out, the machine can limp home in a more conventional crawling gait.

Training a Platonic beast, of course, takes some skill. What runs the 4-beast is a quartet of 32-bit microcontrollers, serving as brains for each leg. Each processor governs the actions of the leg's joint motors. To simplify the programming of these chips, Pai and colleagues converted a Silicon Graphics workstation into a dynamic Platonic-beast simulator. With this computer, and its animated depiction of the beast, they can experiment with movement steps before going to hardware. The workstation can even serve as a direct graphic interface to take the beast for a walk.

Pai admits that while his beasts may have perfect geometry, they aren't perfect machines. They aren't optimized for energy efficiency—a key consideration for mobile robots. More important, they can't tote payloads that are sensitive to orientation—such as cameras—without gimbaled platforms or other compensating devices. Still, turned loose in rough terrain, a beast's sure-footedness may overcome these drawbacks. "This robot is designed to be fault tolerant," says Pai. "That's what we've paid the most attention to." **PM**



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Europe Spy Report

BY MIKE ALLEN, Associate Automotive Editor



Home-Grown Bimmer

● This new BMW is scheduled for introduction right after the first of the year at the Detroit Auto Show. Dubbed the Z3, the sports car was captured during undisguised testing in Arizona. Bodywork is steel, unlike predecessor Z1's kooky fiberglass sliding-door roadster. There supposedly will be a removable hardtop available a few months after production begins. To be manufactured in Spartanburg, South Carolina, the 2-seater is based on BMW's 318iS. Engines are reportedly a 150-hp 2.0-liter inline 4-cylinder and, late in 1996 or early in 1997, a 2.8-liter 6-cylinder.

And Right Next Door...

Sitting on an adjacent display stand at the BMW exhibit in Detroit will be the 1996 5-series sedan and station wagon, which BMW refers to as the "Touring." Styling, unchanged on

the 5-series cars since 1988, is unsurprisingly more rounded and aerodynamic. Also, as you might ex-

pect, the cars are wider and have a 2-in.-longer wheelbase and more interior room than the current models. Look for the wagon to appear in showrooms about a year after the sedan.

Flower Child

Lotus Engineering, brainchild of the late Colin Chapman and lately discarded by GM, was purchased in August 1993 by



The Lotus sports car being developed for midwinter introduction, dubbed the M111, has a space-frame midengine and plastic body.



Volkswagen Rises Again

Volkswagen, which builds cars in Germany for import to the States, is at a disadvantage because the



The Volkswagen Derby will come from the Spanish maker SEAT.

German mark is strong against the dollar. This makes the Golf and Jetta cost about as much as many larger midsize domestic and Japanese cars. To gain a foothold in the lower end of the market, VW will bring in an Americanized version of the SEAT Cordoba. (SEAT is Volkswagen's Spanish subsidiary.) Manufactured in Spain at low cost, the small car will be labeled Derby in the United States, and most likely will be available in a year or two. And no, there won't be any rich, Corinthian leather seat upholstery.



BMW introduces new 5-series sedan for 1996. An estate wagon, which is called the Touring, will follow in a year.



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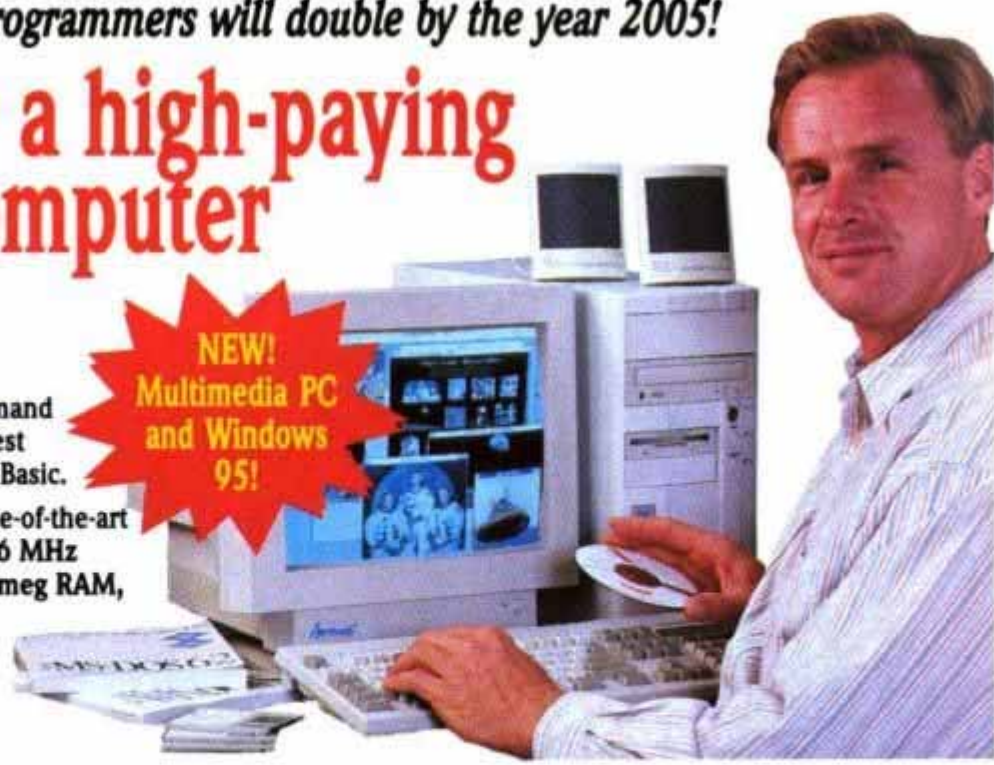
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Riding The Wild Wolverine

BY BILL FEDORKO

● Since you can't knock success, you might as well imitate it. That's the philosophy among current ATV manufacturers. Earlier this year, Kawasaki introduced the Lakota 300, which was billed as a sport/utility all-terrain vehicle (ATV). Now, Yamaha's ATV division follows suit with a sport/ute of its own, the Wolverine. Both are taking a page out of the automotive industry by using the term sport/utility, and why not? Who wouldn't want to capitalize on the long-running success of the Jeep Cherokee, Ford Explorer and Chevy Blazer? As

a result, sport/utility has become a buzzword and a marketing phenomenon for the '90s.

The reason Yamaha attached the sport/utility tag to the Wolverine is that the new ATV is intended to be a machine with a do-it-all capability. The vehicle not only has a spirited, agile sport nature, but also one that's hard working and trail tough.

Although the Wolverine looks like a rugged, hulking 4x4, don't be fooled. It runs like the gazelle of gorillas. Weighing in at 500 pounds, it's about 100 pounds lighter than a full-blown utility bike.

To lighten the load, Yamaha reduced the exterior size of the twin-cylinder 4-stroke cycle air-cooled



384-cc engine. This reduction allowed Yamaha to offer more ground clearance—8.7 in.—and to extend the rear suspension swing arm. Mechanically speaking, an extended swing arm permits easier and longer suspension-wheel travel, which in this case is an impressive 7.1 in. The double-wishbone forward suspension also delivers wheel travel of 7.1 in.

Naturally, any time you lessen weight but maintain horsepower (a figure not supplied by Yamaha), the result is a faster machine. To further aid acceleration and top-end speed, the Wolverine comes with low-profile tires that reduce gear ratio.

While sport riders will love the look and feel of the Wolverine, hard-

working types will appreciate the utility heritage it shares with such other rugged Yamaha models as Big Bear and Kodiak. These features include 4-wheel drive, an easy-to-shift dual-range 5-speed automatic transmission with reverse, and dual hydraulic brakes with drums up front and disc brakes in the rear. The Wolverine retails for \$6099. For an additional \$449, you can get a 2000-pound-capacity Warn winch.

I had a chance to test the Wolverine on the trails of a private ranch in central Oregon. From my perspective, the agile Wolverine should be an attractive package for sport riding, but not necessarily for racing. Also, it will be highly useful for a wide variety of ranch and farm work. While I would prefer a true utility vehicle for towing heavy trailers and for stump pulling, the Wolverine comes as close as is technically possible to fulfilling its aim of offering the best of both worlds—an ATV for work and play.

I also rode Yamaha's Big Bear and Kodiak models, which were updated for '96, through Oregon backcountry. Unlike the Wolverine, Big Bear and Kodiak are true utility bikes.

Big Bear has basically the same engine, transmission and brakes as the Wolverine, but it has slightly less torque. It achieves a boost in ruggedness through different suspension systems and an external oil cooler to help the engine handle heavy loads. Big Bear is capable of towing up to 900 pounds and is able to



A Warn PowerBar winch safely walks a big Yamaha utility ATV up steep, narrow ramps.

handle a whopping 199 pounds of gear on steel carrying racks. Should you find yourself a long way from base camp and unable to turn the engine over, Big Bear has an auxiliary pull start.

Although heavy and somewhat bulky, Big Bear is a mild-mannered off-road machine. I especially like its rock-crawling abilities on backcountry trails. Although a little tight in the suspension department (the rear suspension is adjustable), Big Bear didn't feel too bad on the derriere. Including the optional Warn winch, the price of the unit as tested was \$5699.

The mother of all Yamaha utility ATVs is the Kodiak. Billed as Yamaha's top-of-the-line ATV, this hauler has a hefty air/fan-cooled 4-stroke cycle 386-cc engine. It weighs in at a tad over 600 pounds.

The Kodiak's rugged nature is enhanced by such standard features as front and rear cargo racks that hold 265 pounds and a front bumper that's strong enough to handle a 2000-pound-capacity winch. To beat the heat, the engine's oil cooler is located in the front to benefit from maximum airflow, which is augmented by a thermostatically controlled fan.

Clearly, the Kodiak is a Clydesdale-like laborsaver with stump-pulling torque, but it's also good for slow cruising, trail riding and rock crawling. Retail price is \$6249.

The Big Bear, Kodiak and Wolverine models I tested were all equipped with 2000-pound-capacity Warn winches. This option came in handy during a particularly nasty part of the course called the mudhole test, which was a long, deep, black pit. Winch mounts were nicely designed—nearly out of sight and yet easy to access.

I also had a chance to use another Warn Industries product, the PowerBar, which is a great item for hauling big ATVs into truck beds. The PowerBar is a 1500-pound-rated winch that's mounted to the bed of a pickup truck. A remote-control unit can be plugged into either side of the PowerBar.

The PowerBar has two 55-watt halogen floodlights, cargo tiedowns and a DOT-approved center stoplight. It is constructed of 2½-in.-dia. steel tubing and is available in black or chrome. Suggested retail price for the PowerBar is \$983 (black) and \$1164 (chrome).

Since all tests were conducted on a ranch, there was plenty of opportunity to put the ATVs through work-simulated maneuvers. Afterward, we went trail riding. Can you guess which was my favorite? Let's just say that the Wolverine isn't called a sport/utility (emphasis on the first word) for nothing. **FM**



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REACHING FOR THE SKY

With daring redesigns of bestsellers, Detroit's carmakers are soaring to new heights.

BY DON CHAIKIN, Automotive Editor



CHRYSLER SEBRING CONVERTIBLE

● The domestic carmakers are tired of pussyfootin' around. They're fed up with politely sitting there while critics who hold them up for scrutiny constantly find their products lacking when compared with their overseas competitors. Well folks, in case you spent the better part of the past few years tripping along an astral plane or resting in a comatose state, you should know that Detroit's automakers aren't lagging behind anyone. They've been designing and building cars and trucks that are better than any of their predecessors, and they have closed the gap on foreign competition.

But some critics contend that Detroit's cars and trucks still are just not as good as those from elsewhere. They feel that, maybe, the domestic auto industry has gotten as good as it can get.

Well Virginia, hold onto your proverbial hat. Because now, as we enter the last half of the last decade of this millennium, the domestic carmakers are ready to shatter any glass ceiling and shoot right to the sun.

For '96, all three of Detroit's automakers have brand-new offerings, including all-new versions of the perennial overall bestselling vehicle, the bestselling car and the bestselling minivan.

So stand back and watch as our deadly earnest domestic automakers fly to ever-greater heights.

FORD MOTOR CO.

For the past several years, Ford has been sitting in a very enviable seat: The bestselling passenger car as well as the bestselling vehicle in this country both have Henry's name on them. Now the world's No. 2 carmaker must take the big risk and stand up to see if anyone can take that seat away. You see, this is the year that Ford has boldly chosen to replace both the



MERCURY SABLE WAGON

F-Series pickup and the Taurus/Sable with all-new models.

F-Series

The country's most popular new vehicle for many consecutive years has been Ford's full-size F-Series pickup truck. Coming right around the first of the year, there will be a new one. We haven't yet driven the new truck, nor do we have photos of it to show you. However, you may have already seen it, as we have. If you happened to attend one of the nation's major auto shows during '95, you saw the truck displayed at the Ford exhibit as a concept vehicle. This was a slightly disguised—with some extra trim and



body cladding—version of the genuine article. And from our vantage point, it looks like the new F-Series should have little trouble lifting the gauntlet thrown down by its predecessor. The new truck looks mean yet slick. We will let you know pretty soon how well it does on—and off—the road.

Taurus/Sable

Equally daunting to Ford's family and friends is replacing the bestselling passenger car. When first introduced a decade ago, the Taurus and Sable rocked the auto industry with their revolutionary appearance and distinctly *un-domestic* passenger compartments, ride and handling.

As the coffers swelled in step with the critical acclaim, it became obvious that the big gamble of the mid-1980s had paid off. We'll soon see if upping the ante will pay off as well.

The new Taurus and Sable are really new—they aren't just skin-deep makeovers of their predecessors. If anything, they're larger, more powerful



**FIRST DRIVE
FORD TAURUS**

● The first thing you notice when you slide behind the wheel of a new Taurus or Sable is the strange ovoid-shaped control panel smack dab in the middle of the dash. Don't worry, you get used to it. You also get used to the pleasant surprise that is the car's refined quietness. Ford's engineers paid a lot of attention to reducing NVH. And they succeeded in lowering driveline, body and wind noise.

This car has a much more solid feel than last year's, and you can't help but be aware of the subdued levels of noise rushing by the windows—even at speeds that are bound to attract the attention of the local constabulary. Of course, maybe thanks to the reduced wind noise, you do notice more tire noise than expected.

The other thing that impresses you as you drive the Taurus or Sable is that your right foot can be connected to 200 horsepower. That's 60 more than anything but the SHO used to

have. In fact, it's crowding the 220 horsepower that last year's show Taurus produced. As I said, remember the local constabulary. Matching the new performance from under the hood is the performance from the chassis. The handling of the car is crisper, more nimble and more responsive than before without any penalty in ride comfort.

So what can be bad? Well, for one thing, maybe just getting used to seeing that strangely shaped window in the rearview mirror. —D.C.



FIRST DRIVE

FORD MUSTANG COBRA

● All Mustangs should be Cobras. Oh, don't get me wrong—the base Mustang and the GT are okay in their respective places. But, oh momma, the addition of a couple of camshafts and a slew of valves transform the nicely competent Mustang GT into

the grin-as-you-go Cobra. Run 305 hp and 300 ft.-lb. through the T45 5-speed manual and then run it some more. Add the suspension and structural refinements—including a couple of truly thick antisway bars and some additional body bracing—to the vehicle for quicker turn in, more neutral and forgiving handling, and it's hard to beat the Mustang Cobra. The juicy P245/45ZR17 tires don't hurt things, either. Oh, your pals in their Z28s are

definitely going to try, and some of them will succeed. But, unlike the past few years, the Mustang is going to reel in its share of Chevys.

Of course, you may not be able to find a Cobra at your local friendly Ford dealer unless the store is a certified SVT member. If your dealer isn't certified, keep going until you find one that is. The drive back home will be a whole lot quicker and way more fun. —D.C.

versions of the Contour and Mystique.

Depending on the angle at which you view the '96 Taurus and Sable, you may think that they actually look like somewhat stretched and possibly exaggerated versions of their smaller predecessors. Or, when seen from the front and rear, you may feel that they look like very different automobiles, possibly even totally different ones. In any event, a lot of automotive design water has flowed under the bridge since the originals were introduced, and though the new Taurus and Sable don't look old, they hardly shatter the world of automotive design the way their forebears did.

There are some very notable styling cues, however. First, the Taurus has an elliptical backlite, carrying the theme of ovoid lines to the extreme. Second, the Sable has a grille—an elliptical one—in place of the light-bar nose that had been the car's trademark since its inception.

Those somewhat ovoid shapes define both cars, in total and in the details, inside and out. The headlights are teardrop-shaped. The dashboard panel, which incorporates both the heater/defroster and radio controls, is elliptical. You decide if you like it.

As before, there are sedan and wagon versions of both cars. All have very large, heavily angled windshields, and the sedans have an equally laid-



FIRST DRIVE

FORD EXPLORER V8

● At last there's an option for those of us who tow large trailers and want to do it in Ford's hot-selling compact sport/utility vehicle. Explorer, long the owner of the midsize SUV market, has been available only with a perfectly adequate 4.0-liter V6 engine. This means those who insist on V8 power had to purchase a Grand Cherokee or a Land Rover.

No longer. Now you can specify a 210-hp 280 ft.-lb. 302-cu.-in. (5.0-liter) V8 in your Explorer XLT. The



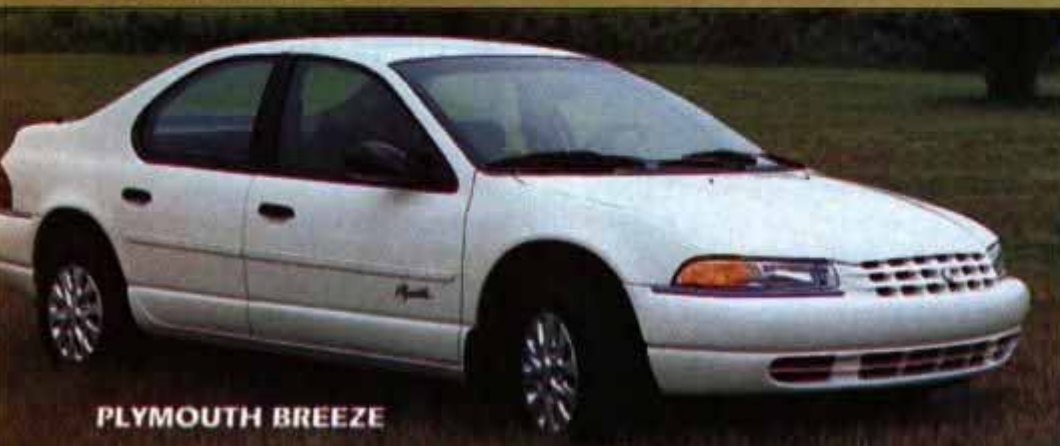
fatal flaw is that it's not going to be available in 4wd versions until much later in the model year, due to the need to develop a new transfer case appropriate to the task.

Driving the V8 XLT is just like driving the V6, except for the sub-10-second 0-60-mph times and the nifty unique teardrop alloy wheels.

—Mike Allen



DODGE VIPER GTS-R



PLYMOUTH BREEZE



back C-pillar. The result is that the side windows create a flattened ovoid. And the station wagon's third side window is a distorted teardrop, thanks to the sharply curving shape of the car's tailgate.

Beneath the sheetmetal is the same basic fully independent suspension that's in the Contour/Mystique, with struts in the front and struts and lateral links in the rear.

Ford's engineers paid careful attention to chassis stiffness and noise isolation to reduce the cars' noise, vibration and harshness (NVH). Under the hood, there's either the latest iteration of the 3.0-liter V6 from the old Taurus/Sable or a new overhead cammer based on the engine in the Contour/Mystique. To see how the new Taurus works in the real world, see our First Drive report on page 50.

There are also new engines in other Ford products. Read on.

Mustang

There's no more 5.0-liter Mustang. The Mustang GT gets an sohc version of the 4.6-liter V8 found in the Continental. That means your basic Mustang GT for '96 is cranking out 215 hp at 4400 rpm and 285 ft.-lb. of torque at 3500 rpm. But more fun is the return of the Mustang Cobra, which gets a 32-valve dohc version of that engine for making smoke on command at the rear tires and for making any arch-rival Camaro small in the rearview mirror. With 305 hp at 5800 rpm and 300 ft.-lb. of torque at 4800 rpm, it should have a fair shot of doing both. For details, see our First Drive report on page 51. The base Mustang still gets a 3.8-liter V6, though for '96 it gains 5 hp.

Explorer

There's more punch to be found in a small number of Ford Explorers also. The bestselling (there's that term again) compact sport/utility is finally available with a V8, the venerable 5.0-liter (see our First Drive report on page 51). What with Mustang engine

FIRST DRIVE DODGE CARAVAN SPORT

● Our first driving impressions of the new short-wheelbase Dodge Caravan Sport and Plymouth Voyager SE are largely favorable. The minivans came with the biggest engine you can get in them: a 166-hp 3.8-liter V6 with the mandatory 4-speed, electronically controlled overdrive automatic.

The major difference between these vans and their corresponding Grand versions is the 6-in.-longer wheelbase. The long-wheelbase vans have 24 cu. ft. of storage tucked behind the third seat versus

just under 16 cu. ft. in the short ones.

Since the powertrain does a fine job of moving the bigger vans, it had no trouble with the shorter models. However, while touring the Maryland countryside, the automatic made many, many shifts between Third and Fourth gears, in both directions. The short-wheelbase versions—happily—offer the optional left-side second door, like the bigger version.

Increased structural rigidity of the new vans provides a stable, solid platform for the suspension and yields a smooth, quiet ride over everything but knife-sharp bumps in the road. There's some body roll when you start to get too carried away, but, hey, remember it is a minivan.

—Jim McCraw



FIRST DRIVE

**CHEVROLET
CORVETTE
GRAND SPORT**

● If there's one word Corvette fans have been reciting since their beloved sports car was born in 1953, it's "more." And Chevy has never disappointed. During this, the last year for the current body style, the factory again offers more. Two special packages—a Grand Sport that bears the same royal-blue body and wide white-stripe paint scheme as the five



famous lightweight racers of 1962-63 with the same name, and a more readily available Collector Edition.

Both are offered as a coupe or convertible. There's also more under the hood. Grand Sport comes stand-

ard with a 330-hp LT4 engine: That's basically a hopped-up LT1 with high-flow heads, new cam and pistons and 10.8:1 compression. Optional on the rest of the Corvette lineup, a 6-speed manual is the only transmission you can get in the LT4. Specific treatments and detailing on the exterior, interior wheels and under the hood make the GS hard to miss. Coupe versions are fitted with humongous P315/35ZR17 rear tires. Only 1000 GS models will be produced, so don't expect to get a bargain on this one.

—Cliff Gromer

bays now getting the overhead cammer, Ford finally has enough 5.0-liters to put in trucks. Trouble is, the big engine is available only in 2-wheel-drive versions for now. Even the Windstar minivan gets a horsepower injection to make it one of the quickest minivans on the road.

CHRYSLER CORP.

Just as Ford stared down the barrel of redoing the Taurus '96, so Chrysler has totally revamped *its* bestseller. And if the Taurus was a watershed car when it was introduced, its impact on the world was still relatively minor to the shock wave that was Chrysler's minivan.

Minivans

For '96, Chrysler has completely redesigned its Caravan/Voyager/Town & Country trio, which defined the genre. We have reported on the '96 Chrysler minivans since the introduction of the long-wheelbase so-called "Grand" versions earlier this year. Now Chrysler is filling the remaining holes in its minivan palette by introducing the short-wheelbase models of the Caravan and Voyager, now at dealerships (see our First Drive report on the opposite page), as well as the all-wheel-drive versions, which are due soon after New Year's Day.

Plymouth Breeze

But don't get lulled into thinking that Chrysler does only minivans right—

which it does. There are new cars coming soon as well. For one thing, the Plymouth shoe is finally ready to drop—Dodge has its Stratus, Chrysler has its Cirrus and soon Plymouth will have its Breeze. This most

And for those of you who want more sky overhead, Chrysler now has a ragtop version of its Sebring. The Sebring convertible, like the coupe, is available with either a 150-hp Four or a 164-hp V6. And, like the large coupe,



CHEVROLET EXPRESS

recent of what's become Chrysler's "weather" cars shares an undeniable resemblance to the Stratus and Cirrus. It also shares its engineering, platform and drivetrain with them.

Viper

For those who would already be driving a Dodge Viper if only there wasn't that awkward folding top to deal with, wait no more. The coupe version, the Viper GTS-R, will be at Dodge dealers soon. Weather-tight—dare we say downright luxurious?—the hardtop version offers all the brute performance found in the Viper coupe. Which has more than it had last year—415 hp and 488 ft.-lb.

it should have no trouble seating you and three of your closest friends.

GENERAL MOTORS

Even on the slowest of news days, the world's largest carmaker has something big brewin'. So, during this, a somewhat more hectic year than usual, you know that General Motors is in the thick of it. There's no way Ford and Chrysler could have all of the new stuff. In fact, there's something new at every one of GM's divisions, particularly the youngest.

Saturn

Maybe the most exciting news from GM comes from Spring Hill, Ten-



GMC SONOMA



nessee, where Saturn's factory is busily churning out the first redone versions of its popular sedan and station wagon since the nameplate's birth.

They're built on the same space frame as before, and are powered by the same two 1.9-liter Fours. But the cars have more room inside and a whole new look outside.

The cars' appearance is up-to-date and sporty. The sedan, in particular, has an aggressive, lean and aerodynamic profile that puts the Saturn squarely in the midst of the good-lookin' pack. There's more glass area and a redesigned roofline, which combine to make the passenger compartment brighter and less cramped. The doors are larger as well, so getting in and out is easier than it used to be.

Though the engines haven't been changed, they've been refined with sequential-port fuel injection and various improvements to further reduce noise and vibration. The availability of

Saturn's low-cost traction control has been expanded to include cars with the maker's superb 5-speed manual, as long as the car is equipped with ABS. The suspension has been retuned as well, though the basic geometry remains the same as it ever was. To find out how well it works, see our First Drive report on page 56.

Chevrolet/Geo And GMC

After the recent major model intros of the Lumina, Monte Carlo, Cavalier and 4-door Tahoe, you'd think maybe

the Chevy folks had shot their load. Think again. For '96, there's an all-new full-size van, along with one from GMC, a 4-door version of the Geo Tracker, as well as new variants of the Camaro and Corvette.

Because '96 is the last year for the Corvette as we know it—the mighty ZR-1 is already history—Chevy is offering a Collector Edition, in coupe and convertible form. Basically, this is a paint and trim package with special badges on the front fenders, wheels, fuel-filler door and hood, as well as on the seats. The car is silver and comes with a choice of either the 300-hp LT1 or the 330-hp LT4 V8s, special 17-in. wheels and some overpoweringly low and wide tires.

Perhaps even more collectible than the Collector Edition is the '96 Corvette Grand Sport. Painted in the white stripe on blue of the famous 'Vette road racers of 30 years ago, the Grand Sport comes as either a coupe



FIRST DRIVE

CHEVROLET CAMARO 3.8

● Chevrolet's Camaro sporty coupe got a considerable power boost recently when Chevy engineers took out the old 60° 3.4-liter V6 engine and installed the L36 90° 3.8-liter V6 in its place. The folks at Chevy call this engine the "3800 System."

The Chevrolet 3.8-liter V6, as installed in the Camaro, makes 200 hp and 225 ft.-lb. of torque. The 3800 engine is so different from the previous design that GM has dubbed it Series II. It uses a balance shaft for smoothness, and has a lighter short-deck block with shorter and lighter rods and pistons and cross-bolted main bearings. It also has a new lightweight valvetrain that enables it to see 6000 rpm. It uses sequential

electronic fuel injection with a larger throttle body and direct ignition, with a higher compression ratio of 9.4:1.

On the road, the new 3800 engine makes an enormous difference, especially darting across intersections from a dead stop and in passing maneuvers on the highway. Quarter-mile and 0-60-mph times are more than a second quicker than before. And it has a brawny exhaust note that imitates big brother Z28. —J.M.

or a convertible with an LT4 V8 driving through a 6-speed manual transmission. We drove one of the only 1000 Grand Sports manufactured. To see how much we liked it, see our First Drive report on page 53.

While ripping away at both ends of the sports-car market, Chevy is one of the first to catch the next wave in sport/utilities. With its Suburban, two different Tahoes and the Blazer, Chevy practically had the SUV universe covered. It does now, thanks to its Geo brand and the new 4-door Tracker. With the coming of Toyota's RAV4 and Kia's Sportage, Chevy is at the right place when it's best to be there—ahead of the other guy. The 4-door Tracker, like the 2-door, has a new look and a new interior for '96. The 4-door Tracker LSi hardtop has a 97.6-in. wheelbase—that's about 8.5 in. longer than the 2-door's—and is 158.7 in. long overall, or just over a foot longer than the 2-door. The 4-door LSi comes equipped with power windows, mirrors and door locks. Both 2-door and 4-door models have dual airbags and offer ABS.

Somewhere north of the Tracker on the GVWR scale sits Chevy's—and GMC's—new vans. It's hard to believe, but the last time Chevrolet came out with a new full-size van was 25 years ago. Not exactly a hot market segment, big rear-drive vans appeal more to commercial users to whom, unlike with pickups, styling takes a back seat to payload capacity



and ease of loading. With a quarter-century of development time on their hands, engineers weren't under the gun to rush the new van and its companion Chevy Express, which replaces the Sportvan, to the market.

Totally redesigned from their longer wheelbase frames up, the vans are powered by the new family of Vortec V6 and V8 engines, including the 7400 big-block with 290 hp. Also debuting in the van power lineup is a 6.5-liter turbodiesel that cranks out 190 horses and an impressive 385 ft.-lb. of torque. Based on wheelbases of 135 and 155 in., for standard and extended versions, the vans offer up to some 317 cu. ft. of cargo space. New wide-opening rear cargo doors that don't block the taillights when swung open permit backing up right to a loading dock. If your cargo is of the 2-legged variety, you can pack in an entire Little League team—actually up to 15 passengers—with less hassle,

as the wheel wells no longer block access to the front seats.

With modern lines, dual airbags (GVWR of 8600 pounds and under), 4-wheel ABS and a new interior and dashboard, these vans have caught up to, if not passed, their only real competition—counterparts from Ford and Dodge.

The other news that Chevy shares with GMC is the introduction of its side-access panels on extended-cab pickup trucks. This small, hinged panel aft of the door provides easy access for passengers and stuff in the rear of the larger-cab trucks. The access panel cannot be opened unless the door is open first.

And last, but hardly least, from Chevrolet, 1996 marks the end of a long and, for many millions, a very happy era: This is the last year of production for the big rear-wheel-drive Caprice and its hot-rod sibling, the Impala SS. In addition, '96 is



FIRST DRIVE
BUICK PARK AVENUE ULTRA

● If you're familiar with the Park Ave, you know that this is one competent 6-person comfy cruiser. And if you're on a first-name basis with the Ultra version of this big Buick front-wheel-drive sedan, you know that under its sedate looks and chrome trim lurks a

potent supercharged engine capable of surprising more than a few hot shoes at stoplights. Well, welcome to the '96 version of the Ultra, which, when asked to, will roll your socks right down to your toes when you tromp the gas pedal.

This pillar of society, this respectable member of the community, is suddenly packing 240 hp under its hood. That's 25 more than the Mustang GT, okay? Darn right okay.

We hereby go on record: We love it. And don't fret, the Buick's chassis is still up to the challenge. Though this is still not the car you'd choose to run Road America with, it gets around turns with dignity and aplomb and doesn't scare the bejeesus out of you or your passengers. Leave that pleasure to the unannounced slam of your right foot and the subsequent squeal of the front tires.

—D.C.

the final year for the other big boys in GM's fleet, the Buick Roadmaster and the Cadillac Fleetwood. The cars have become too expensive for GM to produce, given their relative sales.

Cadillac

Cadillac, however, will have another rear-wheel-drive car in its fleet soon. The new Cadillac Catera is based on the critically acclaimed and successful Opel Omega that GM sells in Europe. The 5-passenger sedan has a 200-hp



OLDSMOBILE BRAVADA

on page 58 for the technical details). The seats in both the Cadillac STS and the Eldorado models

have been engineered for more comfort and have 8-way adjustments that provide localized support for back and bottom. These models have new instrument panels, too, with a center console housing heater and radio controls, and a message center.

As with other GM cars, Cadillac now has key fobs for a remote-entry system



SATURN SW



V6, and it will take its place at the entry level of Caddy's lineup later next year.

Until then, all the news from Cadillac is details about engines, steering, ride and assorted technical specs.

For '96, the DeVille Concours finally gets the big-boy version of the Northstar, the one that makes 300 hp and is used in the STS and ETC. Cadillac claims the '96 Concours goes from zero to 60 mph a full half-second faster than the '95 version did. Forewarned is forearmed.

In addition, the Concours, the STS and ETC now have the magnet-controlled steering system, Magnasteer, which debuted on the Aurora and Riviera last year.

In addition, the STS/ETC/Concours trio has a new continuously variable road-sensing suspension and "rain smart" windshield wipers for '96 (see "Engineering The '96s" starting



**FIRST DRIVE
SATURN SL**

● The Saturn product lineup—SL Sedans, SC Coupes and SW Wagons—remains largely unchanged for 1996. However, the cars themselves are substantially upgraded and improved. The most striking feature is the exterior styling of the sedan and wagons, still conservative and recognizably Saturn, but contemporarily rounder and aerodynamic. Under the plastic skin is pretty much the same old running gear, with two engine options. The coupes shape up next year.

Major improvements have been made in sound deadening and NVH. This includes an industry-unique

sound-deadening Thinsulate blanket in the door panels, extra firewall padding and revised bushings in the suspension and engine mounts, just to touch the high points.

Safety improvements include dual front airbags. In addition, 1997-level side-impact protection is accomplished with foam inserts in the door panels, reinforcing girders inside the doors and a locating pin in the rear door frame that prevents the door from collapsing inward on the occupants during most impacts.

Our driving impression of the new chassis—taken around GM's proving grounds—was positive, with interior noise levels improved. Both the ride and handling are better than before, as well.

—M.A.



FIRST DRIVE

OLDSMOBILE LSS

● Buick has its Park Avenue Ultra and Pontiac has its Bonneville SSEi. Well, Oldsmobile has the LSS. For now, the LSS sort of stands alone as its own model in the Olds 1996 lineup. But the truth is that the car is in position to replace the Ninety Eight next year. There's no denying that the LSS started life as an Eighty Eight derivative. Its exterior styling,

based on the Hammer concept car of 1993 vintage, is more refined than the base Eighty Eight. In fact, the car is cleaner, crisper and more European looking than any Olds sedan—other than the Aurora. This lean, clean and somewhat "purified" exterior design trend is slowly sifting down through the Olds lineup.

The LSS comes in two basic varieties, like other big front-drive sedans from GM, with the base Series II 3800 V6 now good for 205

hp or the way we prefer it, with the 240-hp supercharged 3.8-liter engine. Like the Buick Park Avenue Ultra and the supercharged Bonnevilles, this car scoots in a serious way when prodded. The LSS, however, has a somewhat sharper ride than the Buick—but not nearly as firm as the Pontiac. Unlike the Ultra, though, the LSS looks like an Americanized Euro-sport sedan that might almost be at home tearing down the autobahn.

—Jim Dunne

that, besides locking and unlocking the doors, can also change settings of interior controls to match each driver's preferences.

Buick

Other than the Roadmaster's last hurrah, the story from Buick is one about a new face on the popular Skylark and more power where it counts.

Skylark's makeover discards the shovel-nose look of recent models and, instead, shows a new grille design that displays a smoother, softer face to the public. The new nose is complemented by new side trim and taillights. Standard power under the hood is from the 150-hp dohc 2.4-liter 4-cylinder engine that takes over for the 2.3-liter. A 4-speed automatic replaces the standard 3-speed transmission in all Skylarks. Notable among the options for the '96 Skylark are 16-in. wheels.

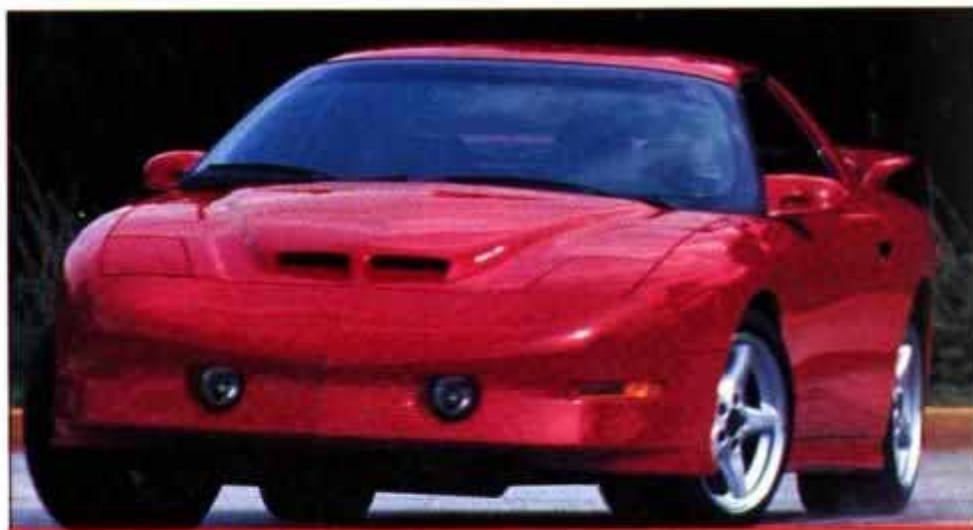
Buick just can't stop improving the 3.8-liter V6. For '96, the supercharged version is up 15 hp to 240—that's more muscle than more than a few V8s.

Now standard in Buick's middle car lineup is the 3800 Series II V6. Horsepower for this engine jumps to 205 from 170 when installed in LeSabre and Regal models.

Oldsmobile

Not having a big-ol' rear drive to retire, Oldsmobile has deleted its ragtop instead. Gone from the lineup is the Cutlass Supreme convertible. Other-

(Please turn to page 110)



FIRST DRIVE

PONTIAC FIREBIRD RAM AIR

● Welcome back to the days of dust, tire smoke and glory, compliments of your friends at Pontiac. Take your basic Firebird, stuff a 305-hp V8 into the engine bay and make sure that the engine can breathe by installing a twin-scoop hood that feeds a new intake system. Under those scoops is a large Corvette-style air cleaner, and next to each of the scoop openings are the words "Ram Air"—just in case your pals down at Hot Dog Hut thought that it was all for show. Ha!

To ensure that the flow of gases through the engine is unimpeded, the car uses dual catalytic converters on the downside.

And to make sure that the rest of the Firebird is up for what the engine wants it to do, the WS6 option also brings with it stiffer springs and shocks, and hefty antiroll bars. The large 17 x 9-in. alloy wheels are shod with super sticky P275/40ZR17 Goodyear Eagle GS-C tires. The suspension and tires work to keep the car going where you point, even when you stand on it.

It's such a shame to shorten those big tires' life by smoking them at every stoplight. But then again, it's such a big temptation, too.

—C.G.

ENGINEERING

High-tech engineering advancements give Detroit's new cars more power *and* efficiency

BY PAUL WEISSLER

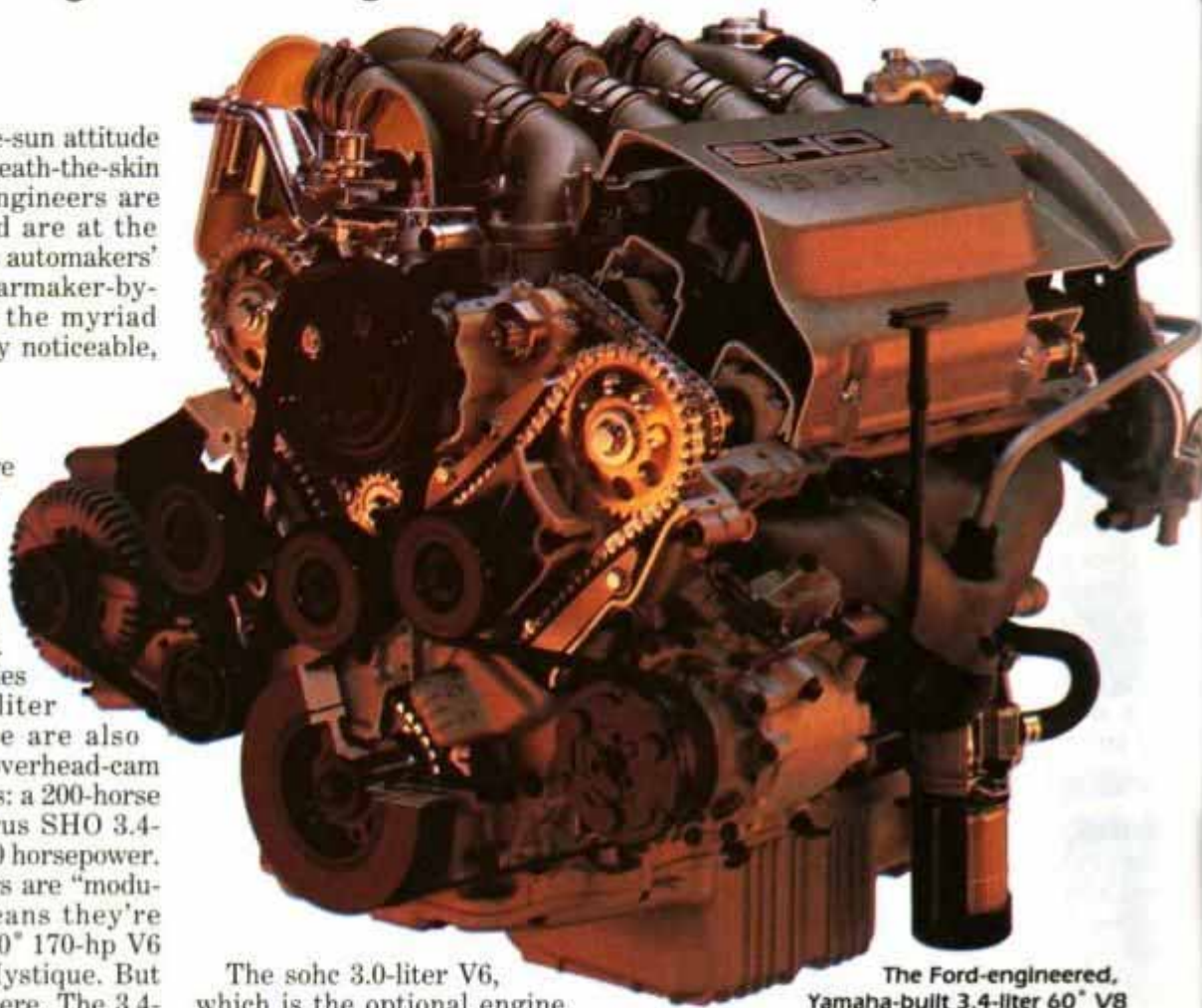
● Detroit's shoot-for-the-sun attitude has its basis in solid, beneath-the-skin engineering. In fact, engineers are leading the charge and are at the forefront of the domestic automakers' resurgence. Here's a carmaker-by-carmaker rundown of the myriad of unseen, but definitely noticeable, refinements for '96.

Ford Motor Co.

The Taurus and Sable are more than restyled—they're new under the skin and under the hood, too. When you lift the hood, you'll find the first V8 in the class. Sure, there's still a no-fries version with the 3.0-liter pushrod V6, but there are also two new all-aluminum overhead-cam multivalve deluxe models: a 200-horse 3.0-liter V6 and a Taurus SHO 3.4-liter V8 that develops 230 horsepower.

Both of the hot motors are "modular" engines. That means they're based on the 2.5-liter 60° 170-hp V6 found in the Contour/Mystique. But the relationship ends there. The 3.4-liter V8 is the world's first mass-production 60° (not 90°) V8. And although 60° produces perfect balance in a V6, a balance shaft is necessary to smooth out a V8. Though the new V8 is all Ford, it will be produced by Yamaha, which built the dohc V6 for the previous Taurus SHO.

This engine is Ford's first with a reverse-flow cooling system and inlet-side thermostat. Coolant temperature is controlled at the water pump inlet instead of at the engine coolant outlet. Coolant flows from the rear-of-engine pump to the cylinder head, which runs hotter than the block, so the coolant heats up faster. It then flows down into the block and out to the radiator. This race-proven design, first used in production on the Corvette V8, results in more uniform metal temperatures in the block, reducing cylinder distortion.



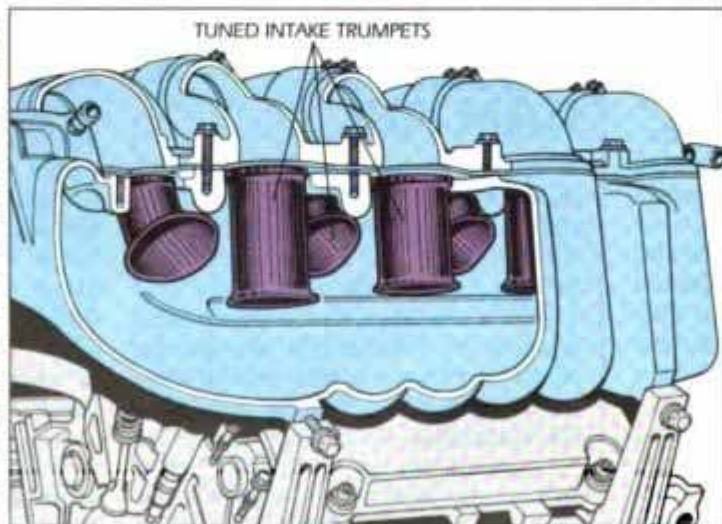
The sohc 3.0-liter V6, which is the optional engine for the standard Taurus/Sable, is similar to the 2.5-liter V6. However, internally it has a bigger bore, ports and valves, and externally the water pump is at the front instead of the rear, as it is on the 2.5-liter for packaging reasons. Bottom line: 30 more

The Ford-engineered, Yamaha-built 3.4-liter 60° V8 Taurus SHO motor uses balance shaft for smooth operation, and generates 230 hp.

horsepower and 35 ft.-lb. more torque than the Contour/Mystique engine.

Taurus/Sable has Ford's stiffest chassis, and it includes a cross-car beam at the cowl (firewall). Because the chassis flexes less, parts can be precisely located and surrounded by softer bushings that keep road harshness from reaching the driver and the passengers. That includes the steering column, which mounts to the under-cowl beam. The beam also provides a positive location for all of the dashboard parts, so they line up with a high degree of precision.

And the front lower control arms are mounted in bushings of a synthetic rubber that varies in stiffness over the bushing's circumference. So the side sections of a bushing are relatively stiff

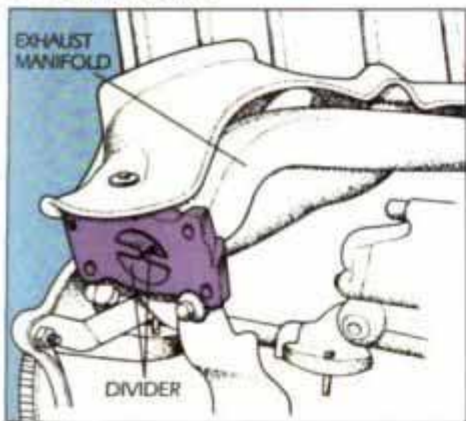


The intake trumpets extending into the intake plenum of Ford's Taurus SHO V8 lower torque peak for better driveability.

THE '96s

for good handling, the rear is soft to absorb road impacts and the front is somewhere in between to provide just enough stiffness to reduce torque steer and wander.

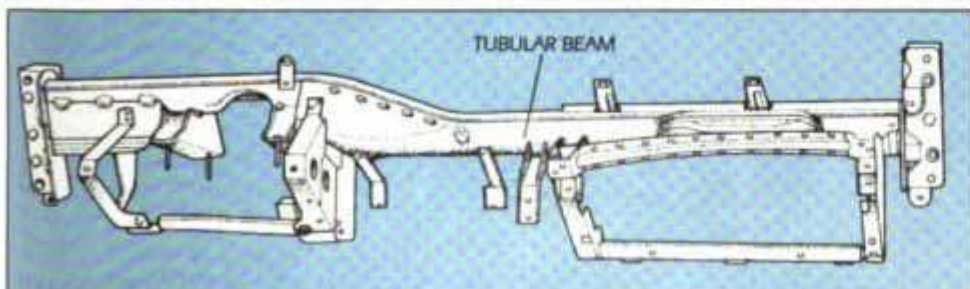
Taurus/Sable also has a hunky cast-aluminum member that holds the wiper motor, linkage and wiper-arm posts. Ordinary wiper posts flex on the sheetmetal when the blades drag from friction in light rain, which is a major cause of chatter. These sit rigidly on the aluminum member so the blades may drag slightly, but operate smoothly.



GM's Quad-4 engine now has a split exhaust manifold for increased power.

General Motors

GM has given the truck side of the business some real attention for '96, with major-league performance improvements. The central fuel injection in GM's 4.3-liter truck V6 was a slick idea when it was introduced four years ago: a top-of-intake-manifold, electronically controlled fuel distributor, with hoses to individual spray nozzles at each intake port. Simple, inexpensive and, because the fuel distributor was away from the cylinders'



'96 Ford Taurus and Mercury Sable get a tubular cross-car beam inside the dashboard for more rigidity, which reduces squeaks and rattles throughout the car.

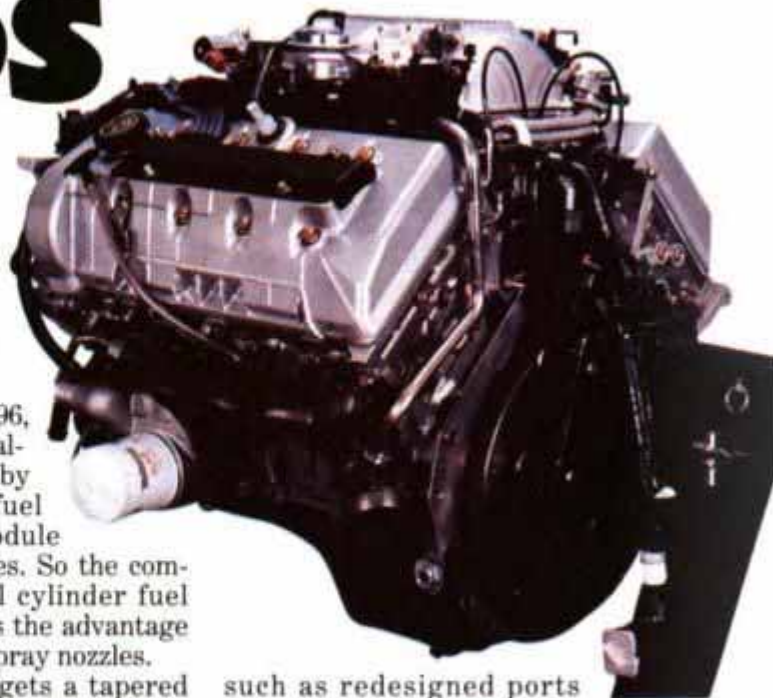
Mustang gets a 300-hp version of the 4.6-liter modular V8 from Crown Victoria and Town Car.

heat, reliable too. For '96, it becomes a sequential-port injection system, by turning the central fuel distributor into a module with six solenoid valves. So the computer gets individual cylinder fuel control, and GM keeps the advantage of the simple, plastic spray nozzles.

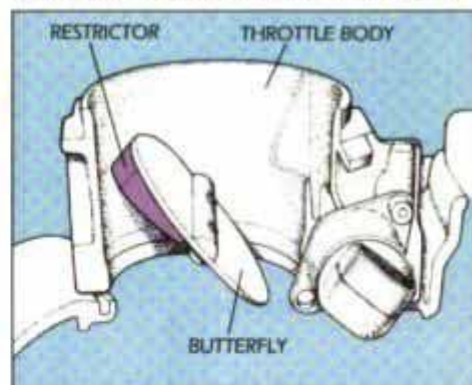
The throttle plate gets a tapered half-cup appendage that restricts the airflow past half the plate as it just starts to open. This gives the driver precise control as he maneuvers at ultralow speed, such as when backing a trailer into position. When the throttle is opened more, the effect of the half-cup fades from the picture. The effect is similar to Chrysler's half-reshaped venturi of truck engines five years ago. The central-injection idea is used on the 5.0-liter and 5.7-liter V8s in the '96 C/K trucks.

GM did more than just improve the ability to feather the throttle. It recalibrated all three truck V8s for increased performance. The 5.0-liter goes from 175 horsepower and 265 ft.-lb. of torque to 220 hp and 285 ft.-lb. The 5.7-liter is up from 200 hp and 310 ft.-lb. to 250 hp and 335 ft.-lb. And the 7.4-liter (the big-block 454) gets a boost from 230 hp and 385 ft.-lb. to 290 hp and 410 ft.-lb.

The General has not neglected its passenger cars for '96. Not by a long shot. For one thing, there's an optional new version of the 5.7-liter Corvette V8, with 30 more horses than the standard 300. It's done with a lot of traditional hot-rodding techniques,



such as redesigned ports and chambers, large hollow (sodium-filled) valves, higher compression (up from 10.4:1 to 10.8:1) and roller-rocker arms. In a less traditional, more innovative breakaway, the piston rings are cut so that they twist upward when installed in the cylinder. Piston rings are pushed down by high gas pressures, particularly at higher



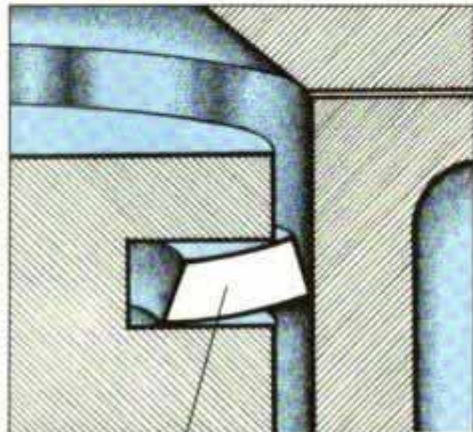
GM trucks with central point fuel injection use a restrictor on the throttle plate for smoother off-idle acceleration.

rpm, but because of the upward twist, those in the 330-horse engine end up level and seal well. Without the twist, they would be pushed downward and seal only at a narrow edge. The emission-control air pump is electric with electronic control—much more expensive than a belt-driven pump, but it operates only when needed, so power draw is miniscule.

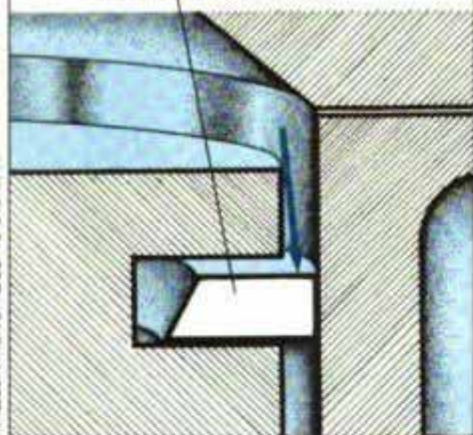
GM also reworked the Quad-4 multivalve engine to get some V6-like off-the-line launch in the Cavalier/Sunfire and Grand Am/Achieva/Sky-lark. High final-drive ratios are used more liberally (the lowest ones from '95 are gone). Displacement goes from

2.3 to 2.4 liters—not much, but the bore actually was reduced (from 3.62 to 3.54 in.) and the stroke went up over a third of an inch (from 3.35 to 3.70 in.). So now it's a long-stroke, a design characteristic that improves low-end torque because the cylinder fills better with air/fuel mixture at lower rpm.

The smaller bore increases the distance between cylinders, so the coolant passages can be made larger, lowering cylinder peak temperatures. This not only permits tuning for better performance, but allows moving



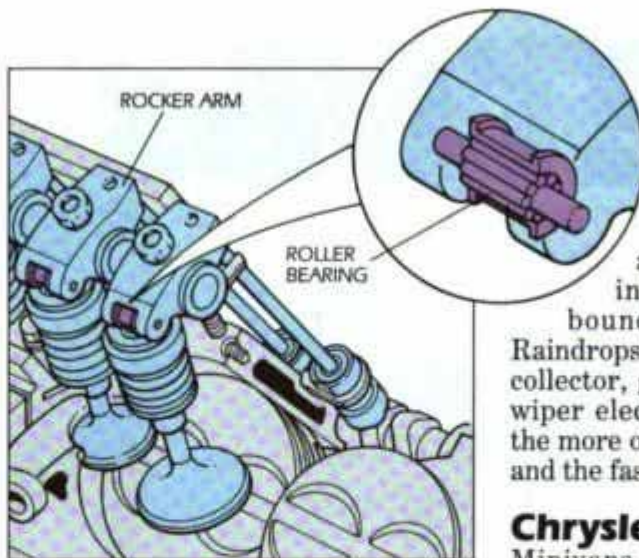
EXAGGERATED PROFILE OF STATIC PISTON RING
PROFILE OF LOADED RING



The Quad-4 engine has pretwisted top compression rings that seal better under full-throttle conditions.

the top compression ring slightly closer to the top of the piston. Doing so reduces the crevice between the piston and the top ring, where gases do not burn fully and therefore contribute to exhaust emissions. Lower emissions from this area permit overall tuning for better performance.

The exhaust manifold was split, so the flows from cylinders one and four, and two and three, are separate until they leave the



Roller-top rockers, long used by racers, give the Corvette less friction, longer valve guide life and more power.

manifold for the exhaust pipe. This reduces gas turbulence at the joint, so exhaust flow is smoother—and faster, resulting in better performance.

Cadillac continues the leading-edge integration of its Northstar V8 engine and transaxle with its chassis, suspension, braking and full-speed acceleration control systems. For '96, the Seville STS, Eldorado Touring Coupe and DeVille Concours get continuously variable, electronically controlled shock absorbers—a major upgrade from the simpler firm-soft switching shocks still used on the other models. The new system is so close to an active suspension that active suspension may never really make the grade. Later this year, Cadillac is expected to add the Bosch "yaw-sensing" control to keep the car from fishtailing when the driver is pushing it past its adhesion limits.

This innovative system, already in use by European luxury-car manufacturers, uses the antilock-brake system and an additional yaw sensor to determine if the car is understeering or oversteering into a skid. It then briefly locks just one of the wheels to point the car in a direction more in line with the driver's intent, as determined by the steering-wheel position. Cadillac also has introduced a rain

sensor, an electronic module that controls wiper speed according to the amount of rain hitting the windshield. The module has an emitter that sprays a section of windshield with infrared rays, which then

bounce back into a collector. Raindrops deflect the rays from the collector, generating a signal to the wiper electronics. The more drops, the more often the rays are deflected, and the faster the wipers move.

Chrysler Corp.

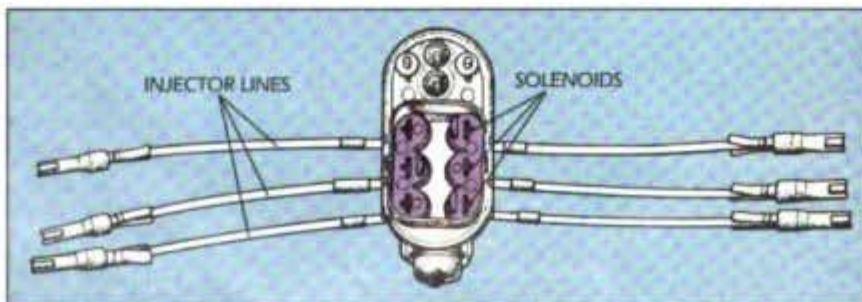
Minivans are Chrysler's improved product line for '96, and they reflect the company's attempt to build in the kind of "slickness" characteristic of the Japanese competition.

The chassis is stiffer than before for reduced vibration and harshness, helped by the use of the first U.S.-made cast-aluminum front-suspension crossmember. Body dimensions are plus/minus 1mm (0.039 in.)—the kind of tolerance only the Japanese had been achieving.

And although there are 3.3- and 3.8-liter V6 engines available, the base 2.4-liter multivalve 4-cylinder (similar to what's used in Cirrus/Stratus) develops horsepower and torque close to the 3.0-liter V6 from Mitsubishi (150 horses each, 167 ft.-lb. versus 176 for the V6). So the Japanese-supplied engine will soon be phased out.

Electrical and electronic components are Chrysler strong suits, and the minivans have such items as a tiny defroster grid at the base of the windshield to heat the wiper blades if they freeze to the glass. And instead of electromechanical circuit breakers, there are PTO (positive temperature coefficient) solid-state devices, whose resistance becomes so great when there's too much current flow that they block the flow almost completely.

Chrysler didn't ignore its profitable Jeep Grand Cherokee. The engine block, which rests on retuned mounts, has new ribbing on both inner and outer walls to stiffen it, and a main bearing girdle for all the caps (so they don't move noisily in opposite directions during engine operation). And instead of metal buttons as torque limiters around the bolt holes, the valve cover gasket now uses hardened rubber buttons to absorb vibration.



Central point fuel injection uses six solenoid valves mounted under the cool intake manifold, instead of six separate injectors on the cylinder heads.

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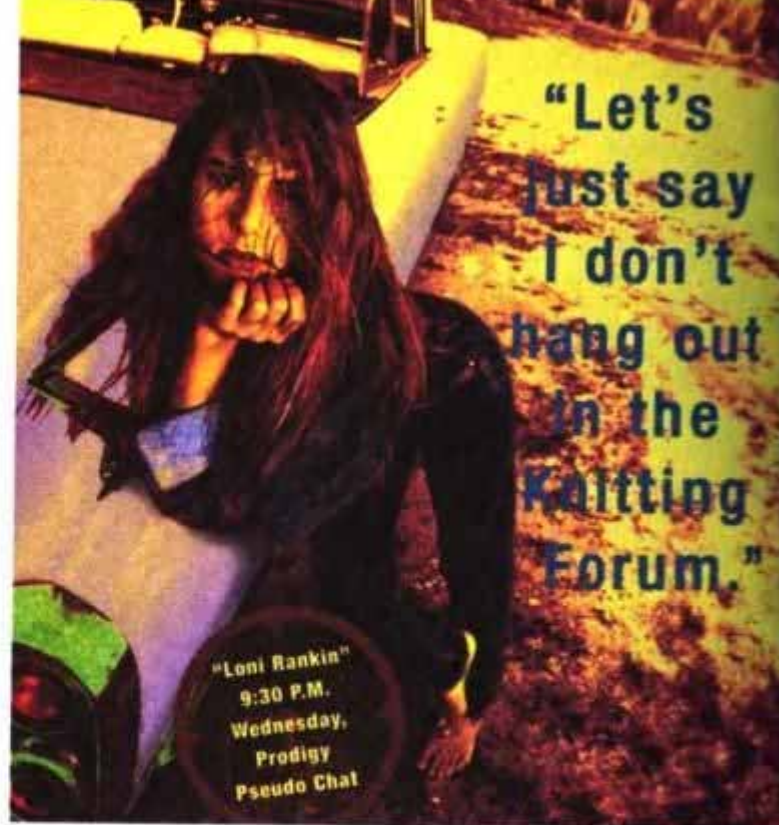
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HOW TO BECOME A CYBERSPACE HOMEBODY

Make your own home page
on the Internet's World Wide Web.

BY GREGORY T. POPE, Science/Technology Editor; PM Illustration by John Youssi

• It's three in the morning. You're 4 hours into an espresso-fueled World Wide Web surf. Like millions of once computer-shy people, you've discovered the Internet's most seductive element: the Web, with its ballooning, interlinked collection of sites known as home pages. These public computer files packed with data and graphics—even sound and video—are yours for perusal with a high-speed modem and a nifty piece of software known as a Web browser.

Propelling you across cyberspace, your modem guzzles the data stream. You began at the usual hot spots: NASA, The Ultimate Band List, The PM Zone. But something always draws you to the more idiosyncratic reaches of the Web—the home pages of individuals. They're so personal. They're so weird. Best of all, they offer stepping stones to even quirkier sites that you'd never find from the bureaucracy-sanctioned home pages of government agencies and corporations.

But as you vault from site to site, you start thinking, "Hey, do I really care about Jennifer's Siamese cats, or Jay's beer-can collection, or some rocket scientist's crush on Kate Moss? Isn't *my* life more interesting than theirs? Why don't *I* have a home page on the World Wide Web?"

Yo, homeboy, why don't you? It's easier than ever to carve out your own corner of cyberspace. Online services and software companies are rushing to come out with snazzy products to make home-page building a snap. The Web itself overflows with tools that you can download to construct your own home page.

And for the true do-it-yourselfer, the formatting codes that turn text and pictures into a cool site are far from intimidating. Remember how annoying DOS was? If you could handle DOS commands, or even a DOS-based word processor such as Xy-Write, you'll breeze through HTML—the Hyper Text Markup Language that underlies every Web page. I did it, even though I'm a cyberspace tenderfoot. Within hours of firing up my new Web browser, I was obsessively hammering out a home page with as many HTML features as I could marshal.

So where do you begin? Content. To be a cyberspace homeboy is to be a content provider. So provide. What can you bring to the information superhighway that no one else can? The fastest way to get across Chicago during rush hour? A killer barbecue-sauce recipe? A personally researched history of steamrollers? You'll want to polish your text before you start building.

Don't ignore the urge to jazz things up, to add some visual verve to your page. Web surfers love pictures. You'll need graphic files in the .GIF format. These can be photos digitized with a scanner or images you've downloaded or created with paint or draw software. Wrong format? No problem. The Web brims with handy

shareware that can convert graphics from one format to another. Digitized sound clips and video footage judiciously abbreviated to byte-size portions will lend further pizzazz.

Once you have your home-page blueprints drawn up and your multimedia building materials at hand, you can launch the construction process. Now you must decide how close to the nuts and bolts of HTML you want

gy hadn't yet added the capacity to include graphics, but insisted this upgrade was coming.

An alternative comes from competing service America Online (AOL), which has a similar deal called My Home Page. Temporarily one-upping Prodigy, AOL is also offering a package called My Place, giving members 2MB of space in which to place their own creations on the Web. Prodigy's coming upgrade will rival this capacity with a free-form template that supports homebuilt pages. In either instance, you can put up both a home page and some separate but linked files—the typical approach to publishing on the Web. It's virtually a given that the third major online service, CompuServe, will follow suit.

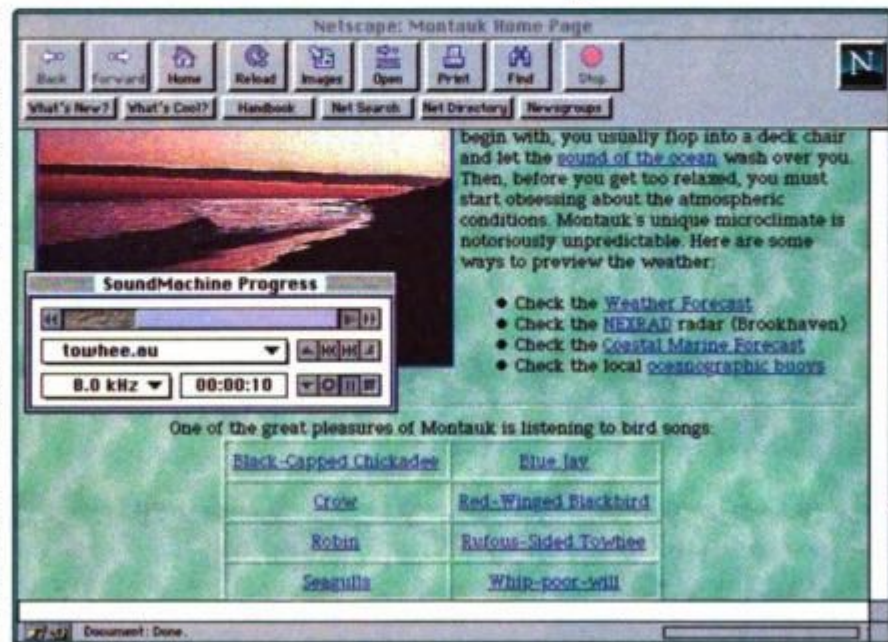
Yes, programs such as Home Page Creator and My Home Page give you instant cyberspace-homeboy credentials. But their paint-by-numbers simplicity can thwart creativity. It's far more rewarding to build your own home page with the toolbox of authoring software that is available today.

You can put together a respectable home page without ever laying eyes on the angle brackets and slashes that festoon a document coded in HTML. Commercial products such as Microsoft's free Internet Assistant (<http://www.microsoft.com>) and Quarterdeck's WebAuthor work with Word For Windows. They present the various HTML options

as familiar menus and toolbars, while giving you the features of Word with which to create your content.

The resulting home page develops more or less the way it would look while being viewed by a Web browser. I gave WebAuthor a spin and found it easy to grasp without the manual cocked open on a knee.

Drawbacks? There are two. First, by keeping the HTML tags hidden in the background as you create, these programs don't really teach you any-



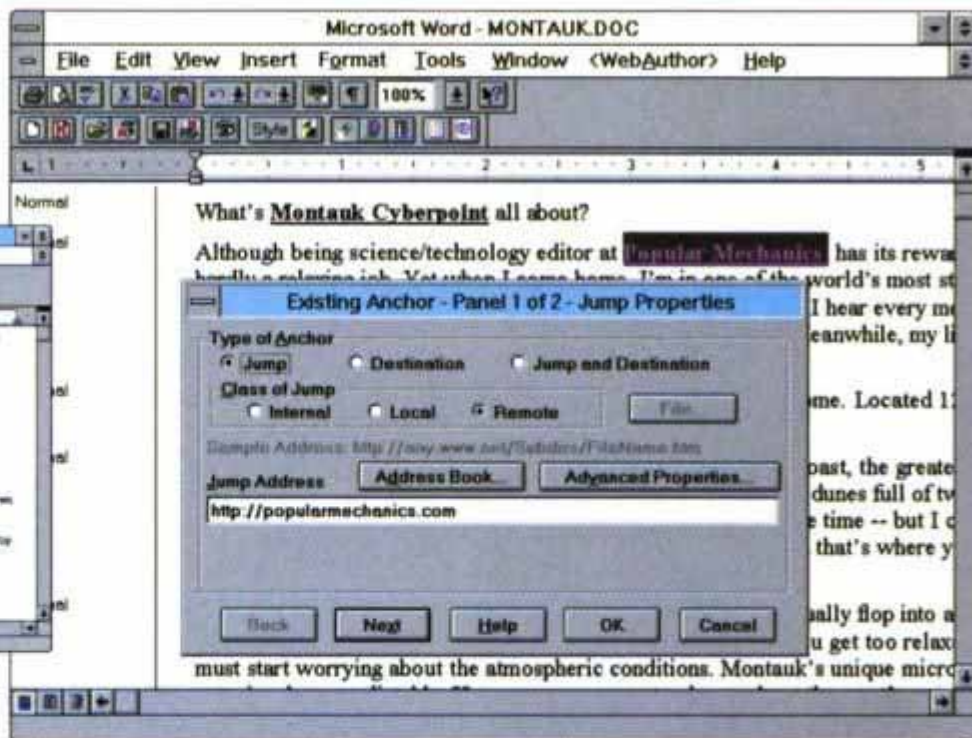
Home Page (above) was created with HTML Editor For The Macintosh (shown in window below). This \$25 shareware program, offering HTML tags in menus and dialog boxes, highlights code as it appears in text.



to work. If you shun computer arcana and just want results, consider the Home Page Creator feature offered by the Prodigy online service. By filling in blanks in a formlike template, Prodigy members can list personal interests, links to favorite Web sites and other home-page material. The service transforms the template into a real home page—a site accessible to all Web surfers—maintained on Prodigy's server computers for no extra charge. As of press time, Prodi-

thing. Although you can view the HTML markup of your page once you're done, it's like learning to play guitar by only reading sheet music.

Second, HTML isn't written in stone. Right now, the creators of the World Wide Web—a collective of



WebAuthor (right) works within Microsoft Word For Windows to convert text into HTML document (above).

computer scientists at Switzerland's CERN particle-physics laboratory—are drawing up specifications for the next version of the language: HTML 3.0 (<http://www.w3.org/hypertext/www/MarkUp/html3/CoverPage.html>). This iteration will include the ability to create tables, with text organized into rows and columns—a dramatic improvement in visual presentation. Authoring tools aren't yet up to speed on these extras.

In the meantime, Netscape Communications has raced ahead of CERN. Maker of the dominant Web browser Navigator 1.1, Netscape has already concocted a series of enhancements to HTML, including table specs that can be used now (http://home.netscape.com/assist/net_sites/html_extensions.html).

These so-called Netscape extensions govern how you can use background effects, graphic-image size and positioning, and other features. They are wonderful additions, no doubt. But, again, authoring programs won't hand-feed you these options. You have to know about them independently in order to take advantage of them.

HTML 3.0 and the Netscape extensions offer powerful incentives to simply bite the bullet and learn HTML. I seized on a way of doing this without grinding through documentation.

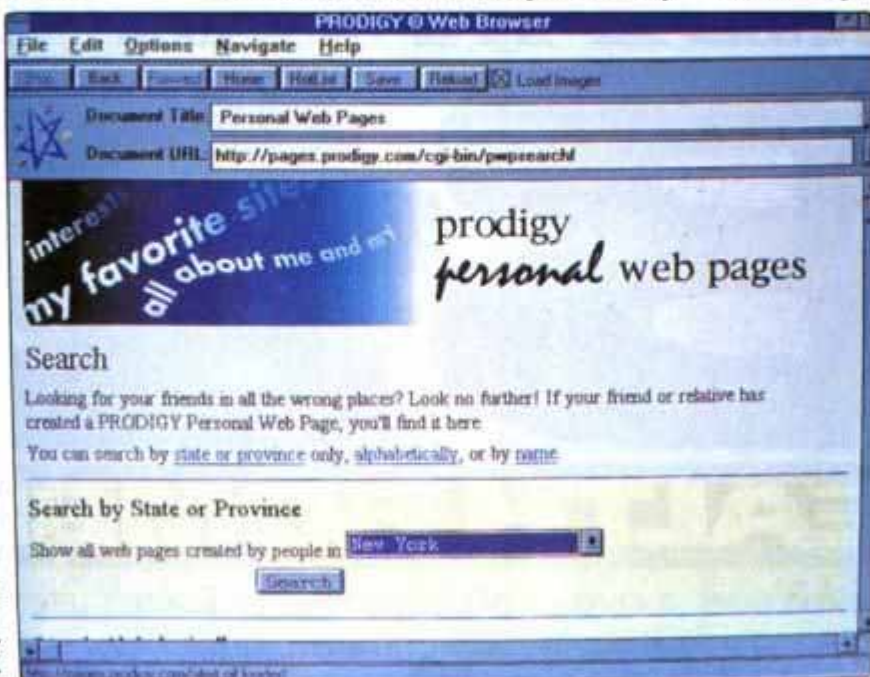
loading from numerous sites on the Web are basic freeware and shareware HTML editors that helpful computer whizzes posted long before the big-money software houses moved in (<http://www.w3.org/hypertext/www/Tools/Overview.html>). These small programs combine a rudimentary text editor with point-and-click buttons and menus that bring in the HTML tags. But unlike commercial software, these programs show you the tags as they appear in the HTML markup of your document. In doing so, they expose you to HTML coding in a gradual, interactive way.

As you add tags, you can then turn to your Web browser to see how your home page is developing. After flipping back and forth between browser and editor a few times, you'll likely

gain enough confidence to start typing in HTML tags without using the point-and-click buttons and menus. Then, if you like, splice in the Netscape extensions.

In building my first home page this way, I discovered that HTML tags have a consistent flavor and quickly become second nature. For example, to turn a chunk of text into a link to another file, you simply sandwich the text between two tags: `` to the left, and `` to the right. I used these tags to link a table of birds to audio files that reproduced their songs. The same tags can mark a link to another home page on the Web.

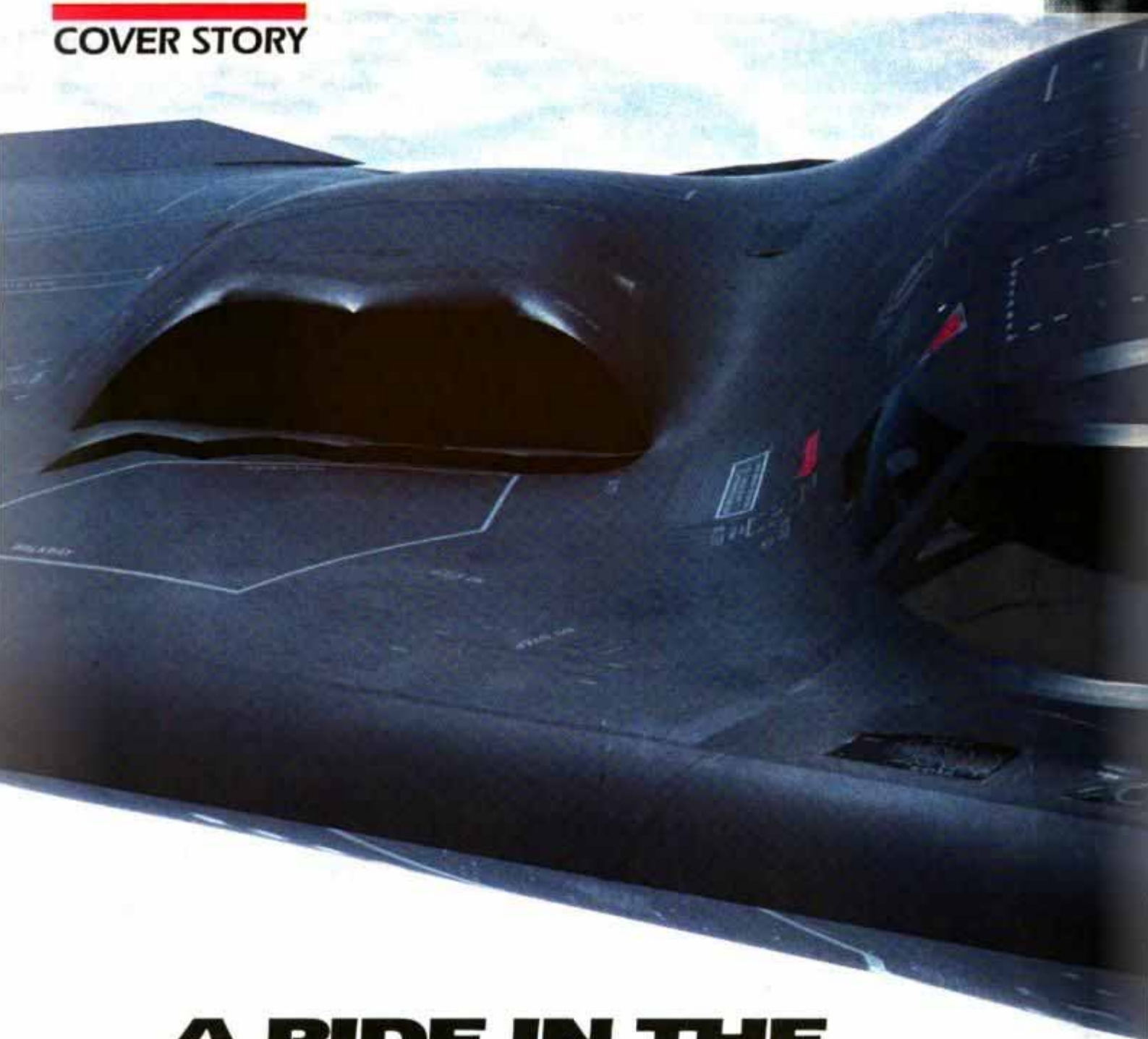
No matter how you build it, you'll eventually have a home page that you're ready to share with the rest of the homeys. Your Internet-access



Prodigy's Home Page Creator walks you through a series of menus and forms as it helps you build a personal site accessible to any Web browser.

provider will be happy to rent you some cyber real estate to do just that. There are also philanthropic hackers out there willing to provide space for free, but waiting lists are already formidable. A third option is to get a spare phone line and an Internet-access account, and turn your extra computer into a Web server. Like buying instead of renting real estate, it's an expensive alternative.

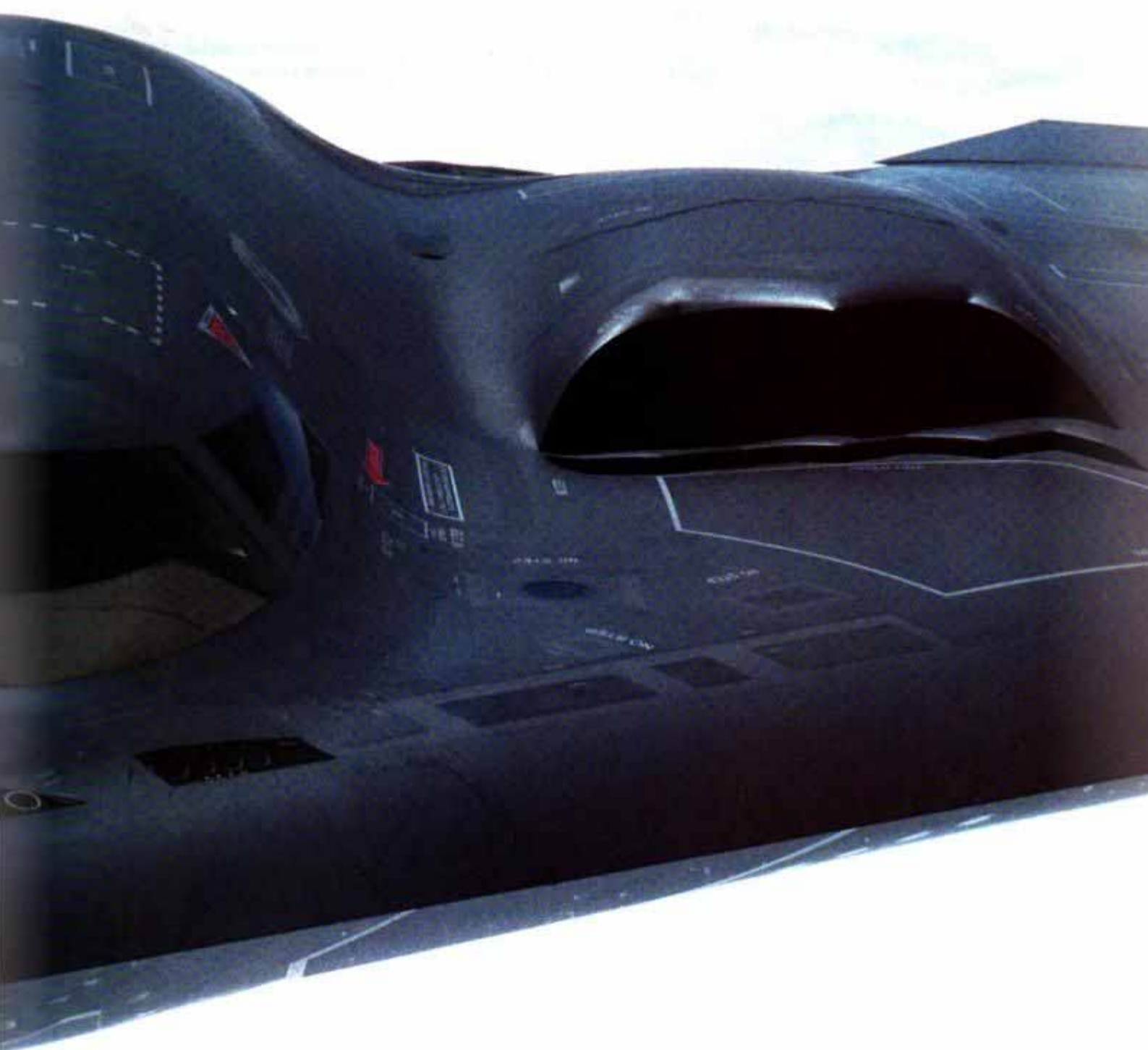
Still, the day is fast approaching when having a Web page will be like having an answering machine: You can't imagine what life was like without one. **PM**



A RIDE IN THE B-2 STEALTH BOMBER

For the first time ever, a civilian pilot flies the Air Force's latest weapon.
And you're along for the ride.

BY DAVID M. NORTH; PM Photo by Jim Benson/Check Six



● On the outside, it's the most radical machine in the Air Force inventory. On the inside, it's scarcely different from an Airbus or Boeing airliner. While the B-2 Spirit—the stealth bomber—may boast a silhouette unique to contemporary aviation, it flies much like any other modern aircraft.

I found this out on March 22, when I became the first pilot not affiliated with Northrop Grumman, the Air Force or the Department of Defense to fly the B-2. I had put in a request six years ago, shortly after the Air Force unveiled the bomber in Palmdale, California. My approval to fly the B-2 came in late December 1994, from Gen. Mike Loh of Air Combat Command.

By the time I flew, the 509th Bomb Wing—based at Whiteman Air Force Base in Missouri—had received six B-2s. It now has a seventh. Meanwhile, Congress continues to debate whether any more than 20 B-2s will be built and assigned to the 509th.

Our preparation to fly the B-2 began with an opera-

David M. North is the managing editor of Aviation Week & Space Technology.

tions brief on the aircraft's mission, conducted by 509th Wing commander Brig. Gen. Ron Marcotte. This was followed by a detailed systems analysis and the opportunity to try out the CAE-Link B-2 flight simulator. Maj. Jim Smithers—instructor pilot for the actual flight—joined me in the simulator. Looking back, I'd say the machine mirrored the B-2 very well, except for the fact that in-flight refueling was more difficult when we performed it the next day.

Our preflight walk-around also took place the day before the actual flight, because the engines would already be running when Smithers and I manned the bomber. The Air Force wanted to be dead sure that all systems were operational—bad form, after all, if a maintenance problem forced the first journalist to fly the B-2 into changing aircraft. The 509th pilots and maintenance personnel, by the way, give the B-2 high marks for reliability. In fact, they compare themselves to the “Maytag repairman” who has nothing to do.

As I approached the bomber in its maintenance dock, I was struck by the aircraft's size. From a dis-

B-2 RIDE

tance, the long 172-ft. wingspan, flat profile and black color suggest a smaller plane. The B-2's wingspan rivals that of the B-52, but its length is only slightly greater than that of an F-15.

Because I've been around aircraft and hangars for many years, the first thing that caught my eye was the lack of hydraulic fluid or fuel on the deck of the aircraft's maintenance bay. There wasn't even a hint of fuel seepage on the underside of the wing. Nor had personnel reported any

leaks in more than 750 hours of flying.

As I peered down one of the S-shaped inlets at a pair of General Electric F118-GE-100 turbofans, I was surprised to see virtually the entire top halves of the powerplants. Usually, you can see only the fan section of an installed aircraft engine.

Another revelation: The plane's deceptive contours concealed the large size of the bomb bay. The B-2 can carry 16 Mk.84 conventional 2000-pound bombs on two rotary launchers—with

space for nearly 16 more. Next year, the bomber will be cleared to carry nuclear weapons.

Up and away

The next morning, Smithers and I were briefed on weather, and



then we climbed aboard the *Spirit Of Washington*. Although B-2s are named for states, not cities, Air Force officials assigned me this aircraft because I work in Washington, D.C. They figured it was close enough.

The B-2 is a 2-person aircraft. The mission commander straps into the right seat and is the senior officer. The pilot flies from the left seat. The crew positions are nearly identical, although the navigation and weapons systems are accessed through a keypad located more conveniently to the right side. As pilot, I had the landing-gear handle on my side.

While provision exists for a third seat—with an ejection hatch already cut into the fuselage—there is none

installed. The Air Force is holding the option to put one in, if long-range missions dictate a relief pilot. The B-2 can cover more than 6000 nautical miles on one tank of fuel—10,000 with a refueling rendezvous. For such marathon flights, ample room behind the crew seats permits a stretch or rest.

The bomber's gross weight in the maintenance dock came to 277,000 pounds, which included 124,700 pounds of fuel. The fuel load was high because a second crew was scheduled



B-2 pilot seat (left) and mission commander seat (right) are nearly identical, except that the data-entry keypad is more accessible from the right side. Each crew member has a center stick and left-side throttles.



to take over the *Spirit Of Washington* after our flight, and they did not plan to refuel.

From the maintenance dock, I taxied the aircraft at speeds between 10 and 15 knots. I steered the B-2's nose-wheel through the rudder pedals, not from a tiller bar as in many commercial aircraft. Following the B-1's design, the B-2 is equipped with a center stick and a combined throttle that powers the four engines. But control of a single engine can be isolated from the power lever by separate action.

Once on the active runway, I advanced power on the four engines while holding the brakes for about 10 seconds, to check the engine instruments.

Fuel flow for takeoff rose to 8000 pounds per hour to each engine.

The B-2 quickly accelerated to its 139-knot rotation speed. Our takeoff run was 5500 ft. At a climb speed of 280 knots, the plane ascended at close to 3000 ft. per minute.

Bank accounts

When we reached 9000 ft. and 300 knots, I leveled the aircraft. The first thing I wanted to do—the first move any pilot would want to make in a flying-wing design—was launch

into a steep bank. But I could also envision that maneuver turning the B-2 into a 172-ft.-high monument to stealth. With no tail to help it maintain altitude, a flying wing could easily plummet during a tight turn. As it turns out, 509th pilots are limited to 60° bank turns. No heavy bomber need exceed that in normal flying.

So I established a 10° nose-high attitude and rolled into a 30° bank, then a second bank that approached 60°. The aircraft's neutral stability held the B-2 at the bank angle without the need for a hard tug on the stick. The aircraft is limited to 2 g's, and that's what you pull for a sharp roll rate.

My multifunction display showed that the elevons in the wing's trailing edge were moving to maintain the desired attitude. That activity revealed the quadruple digital flight-

Slim frontal silhouette belies B-2's broad planform. Trailing-edge flaps work with digital flight-control system to maintain stability. Inside, the bomb bay packs twin rotary launchers, capable of carrying eight 2000-pound bombs apiece.

control system at work.

From a pilot's perspective, the flight-control system was well harmonized. The artificial "feel" in stick response provided just what an airman would expect when commanding either pitch or roll movement—more than expected, in fact, for a heavy bomber. Overall, the plane felt more like a heavy fighter.

Meanwhile, the ergonomics incorporated into the cockpit stood out. The multifunction displays illuminated basic flight and navigation formats, while any aircraft system schematic popped up with the push of a button on the display's perimeter. Stick and throttle proved easy to operate.

While the Air Force has opened up in its discussion of the B-2's capabilities, there were functions I was not permitted to observe. I was not able to call up the Hughes AN/APQ-181 radar presentation. Pilots, however, give high praise to this low-probability-of-intercept radar system. In addition, I could not call up any weapons display. I didn't activate "penetration mode," a button on the eyebrow panel that reduces elevon and rudder movement during an attack. And at least one other button on the panel was taped over for my flight.



KENNY JOLLY PHOTO

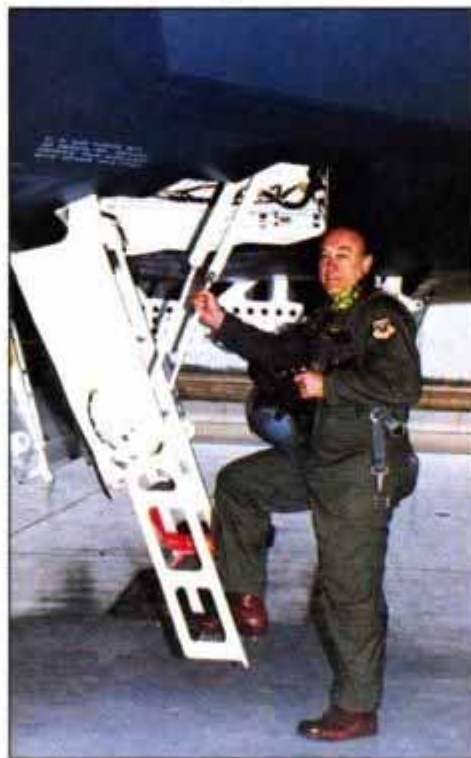
Fill 'er up

The next maneuver we performed was in-flight refueling. First, we contacted the KC-135R from the 19th Air Refueling Wing to ascertain the tanker's position. I then flew the rendezvous to within 200 ft., at which point Smithers took the aircraft and performed a flawless approach for hookup. A former B-52 instructor pilot, Smithers displayed expertise in the aircraft throughout the flight.

I found maneuvering the B-2 behind the tanker at 255 knots a more challenging experience than in the simulator. Unlike most aircraft, the B-2 dips its nose slightly when power is increased. This phenomenon—coupled with the airflow interaction between the two close aircraft—requires a positive pull up on the stick to stay in position. I told Smithers I was reluctant to bring up the nose of this \$600-million aircraft (\$2.2 billion, if you count development costs) to the tanker. I finally did get one short plug-in and decided that was enough.

During the descent to Whiteman, I reached Mach 0.80 and found control response as positive as it had been at lower speeds. I marveled at what neutral stability and a digital flight-

Refueling proved difficult, because the position of the B-2's receptacle forces the pilot to pull under the tanker, triggering airflow interaction. Below, author climbs into cockpit via self-contained ladder. Note brown flight shoes, reflecting author's Navy background.



APRIL 2000 WEEK 6 SPACE TECHNOLOGY PHOTO

control system can do for an aircraft.

While I anticipated the bomber's good acceleration response, the B-2's slowness to decelerate showed me just how cleanly the aircraft's design shaves drag. During a landing pattern, the pilot deploys the rudder elevons 90° to lend a more conventional response to engine deceleration.

The B-2 is equipped with a gust load alleviation system directly behind the cockpit. This surface trims the plane in pitch axis during flight. With the gear down, it deploys some 11° to help with landing attitude.

I flew the approach to landing at 145 knots and found the aircraft responsive to small inputs. Touchdown came at 135 knots without a flare, and because of the large ground effect generated by the flying-wing shape, the landing was extremely smooth. During a second landing, I reduced power to idle at the runway's end and flared slightly to float 1500 ft. down the runway to another smooth landing.

Because you can't see the aircraft's nose through the cockpit window, I wished for a way to judge yaw during landings in crosswinds. The B-2 has no head-up display—the Air Force judged it unnecessary for bombers.

The B-2 is designed to take off, fly to a target, drop its bombs and return to its base automatically. All a pilot need do is maintain speed, since the plane lacks an autothrottle. I found the B-2 easy to fly. Not only was handling predictable, but flight information was easily accessible and understandably portrayed. Designers had obviously paid attention to situational awareness. In terms of responsiveness and flow of data, flying the B-2 was not unlike flying the Airbus A340. It wasn't until I walked away—and looked back at the black, tailless profile—that I realized with some awe that I had just logged 2 hours in the stealth bomber. **FM**



WE'RE ON THE AIR!

POPULAR MECHANICS' new TV show premieres September 25 on The Discovery Channel. Watch for it.

BY CLIFF GROMER, Contributing Editor

● You've read the book, now see the movie. Okay, it's not a movie. It's television—a new dimension in TV, really. Our new television program, "The POPULAR MECHANICS Show," debuts Monday, September 25, on The Discovery Channel from 5 to 6 pm (Eastern and Pacific time). The show will offer up a diverse menu of cutting-edge technology, home improvement and car care tips, plus much more, Monday through Friday in the same time slot and also on Sundays from noon to 1 pm ET/PT.

As a magazine, we've catered to America's love affair with technology for 93 years, and there's no indication that your desire for this kind of knowledge is waning. So POPULAR MECHANICS, the TV show, is a natural extension of the magazine's unique, informative and entertaining way of presenting technical information.

Show host Ted Reinstein, a popular television personality with an easygoing and engaging manner, works with a number of experts in their respective fields to make the information come alive in all the areas you're used to reading about in each monthly issue of PM.

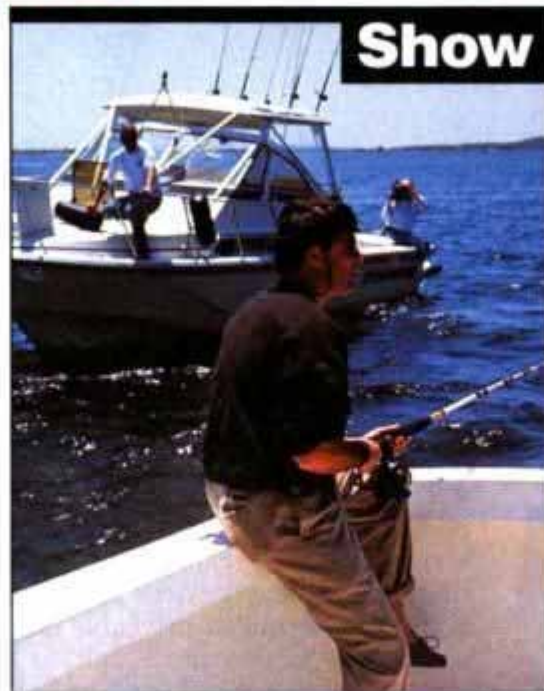
So, what can you expect to see on "The POPULAR MECHANICS Show"? Features about favorite topics like lawn and garden, electronics, aviation, military technology, outdoors, boating, home electronics and more. Car care and home improvement are two subjects widely read in PM, and our step-by-step, how-to approach to solving auto-related problems and projects around the home will be popular segments on every PM show.

And just like its magazine namesake, "The POPULAR MECHANICS Show" will feature a top story focusing on some fascinating aspect of technology.

For example: Ever wonder how a roller coaster is designed? It's a



The
**Popular
Mechanics**



Top: Host of the show Ted Reinstein (right) and series electronics expert Chris Bauer (left) get the lowdown on a high-tech guitar. Above: A fishing segment describes how to go about chartering your own boat.

delicate balance of thrills without spills. You might want to keep a supply of motion-sickness pills handy for this segment.

Looking for something more down to earth? Tune in for a run-down on the technology of today's athletic footwear to learn about the science of its design.

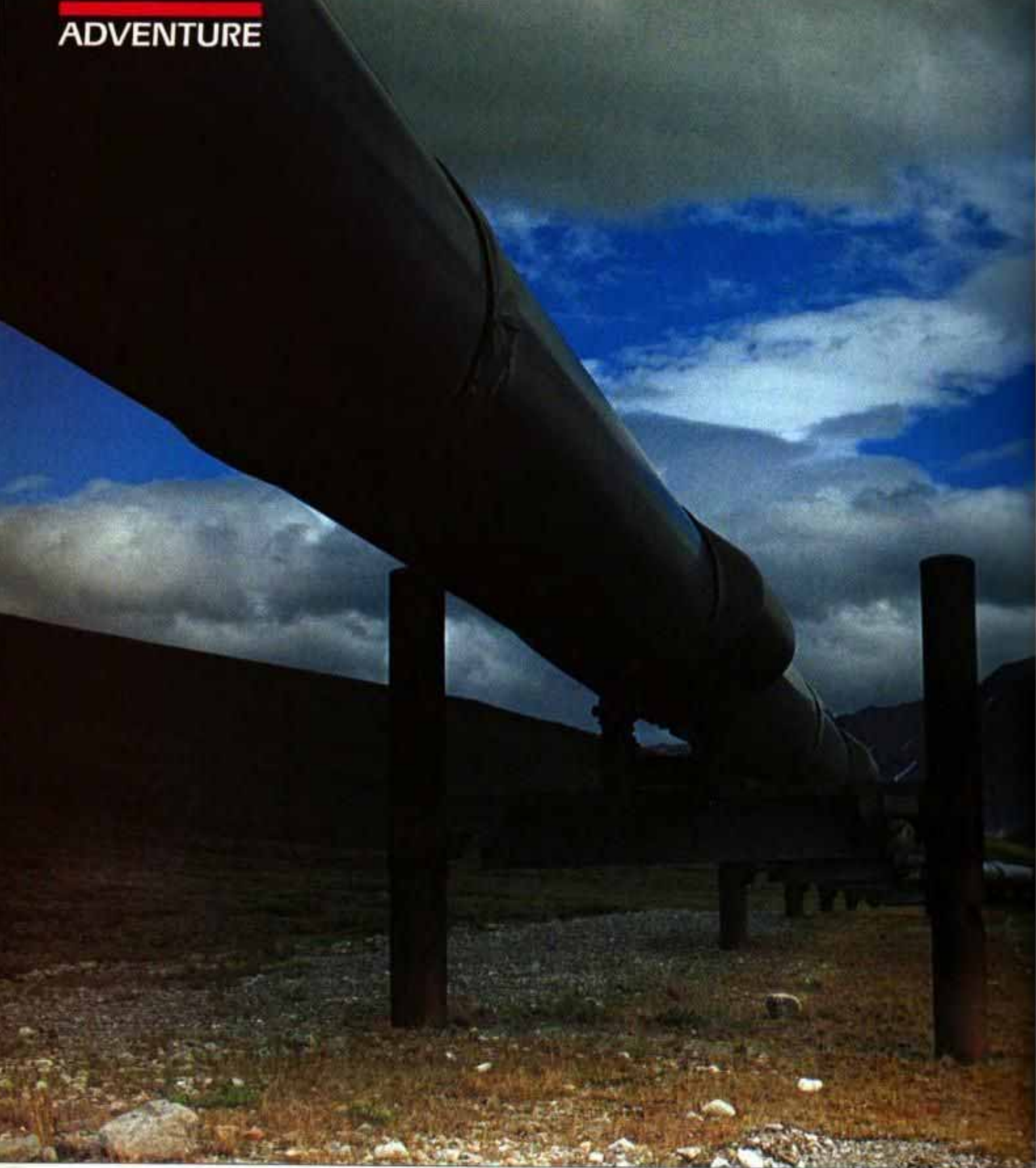
"The POPULAR MECHANICS Show" will take you from the heights of outer space in a story covering the practical colonizing of the vast, forbidding expanse around our planet, to the depths of Boston, as we look at how engineers are overcoming the challenges of the Boston Harbor Tunnel project.

Back on the surface, we'll profile the formation of America's new robotic army. Then, we'll pick up the pace by taking you into the pits for the Indy 500 to focus on the newest technical developments in IndyCar racing, from which a lot of exotic racing technology has filtered down into your very own passenger car. You'll also see how passenger-car designers have shown the way to racers.

Closer to home, we'll take you through some of the latest in family house designs, ranging from an energy-efficient model with a low-cost deck made from recycled yogurt containers to a state-of-the-art, high-tech showpiece home that uses infrared sensors to monitor the number of people in the house and their locations, so it can automatically adjust the indoor climate accordingly.

Then, watch as science and medicine team up to provide artificial sight and hearing for the disabled.

You'll find "The POPULAR MECHANICS Show" to be the perfect complement to the magazine. Together, we offer readers and viewers a unique opportunity to understand the immense amount of change in today's world—and be entertained at the same time. Tune in and see for yourself. **PM**



NEXT SERVICES
244 MILES

● The sign reads “Next services 244 miles.” Two flat tires later, copilot Cliff Gromer and I roll into Deadhorse, gateway to the northern terminus of the trans-Alaska pipeline at Prudhoe Bay. The reason there are so few services along the unpaved route is that Deadhorse is the northernmost driveable outpost on the continent. Other places are located farther north, but, as locals say, you can’t get there from here—at least not by land. The reason we got two flats is that, well, it’s a lousy road.

Yesterday, in Fairbanks, it was a brilliant, blazing 82° F. Today, it’s a chilly, fog-enshrouded 33° F. Interestingly, today is the longest day of the year, June 21, which makes it one of several days here that the

DRIVING THE ALASKA PIPELINE ROAD

We bang out 1800 rugged miles at the top of the world to torture test the new Toyota Tacoma pickup.

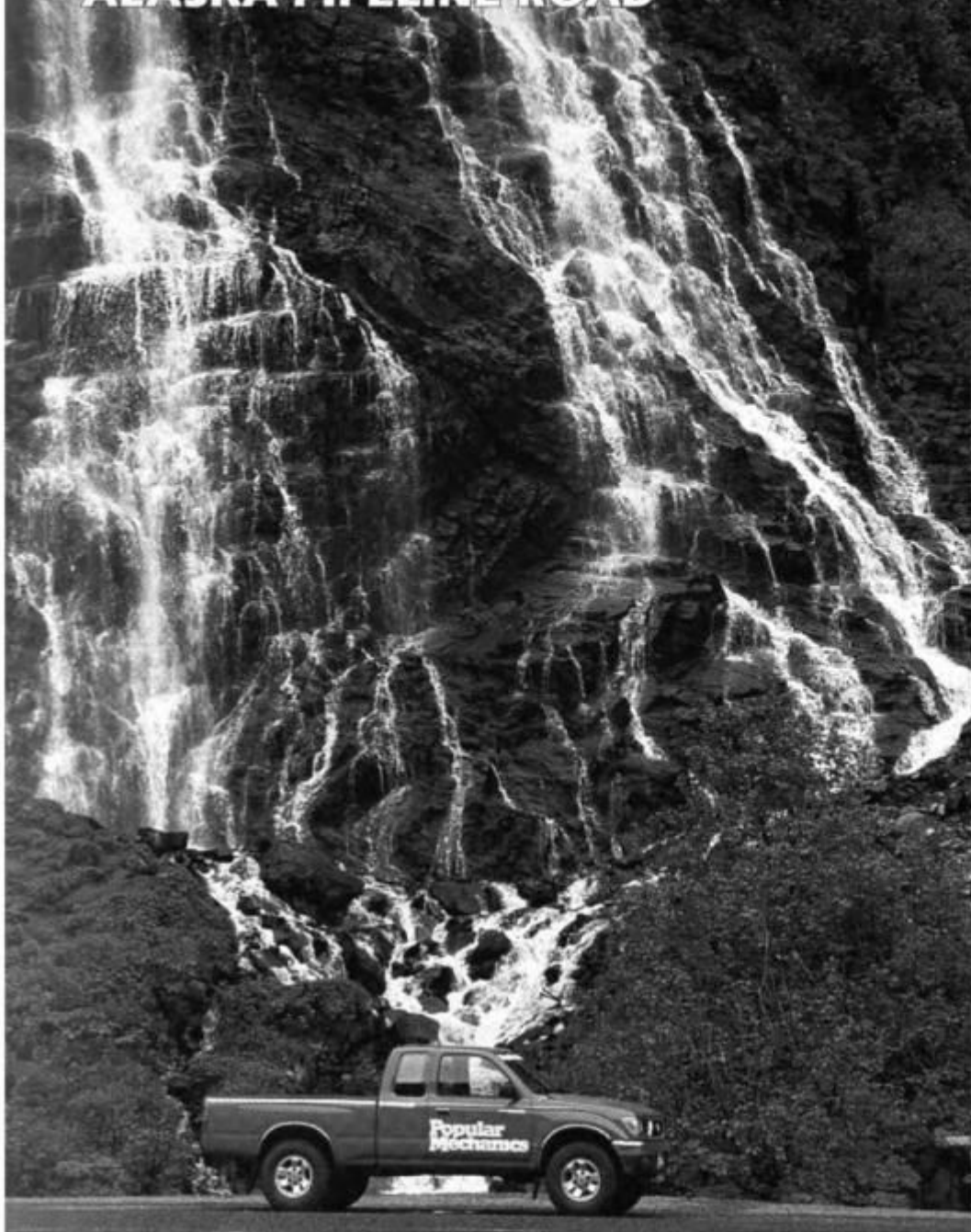
BY JOE SKORUPA, Boating/Outdoors Editor; PM Photos by Cliff Gromer



sun never sets. But the near-permanent, ocean-effect clouds are so thick that I can't tell if the sun ever rose.

Despite the bleak, industrial grimness of the oilfield town, I couldn't be happier to arrive. Today's leg of the pipeline road was a 13-hour 500-mile grind behind the wheel of an all-new Toyota Tacoma pickup. Most of the miles were on the infamous Haul Road, which winds through a stunning stretch of country that crosses the Yukon River, the Arctic Circle, the Brooks Range and hundreds of miles of alpine meadows and tundra. But big-rig truckers don't call it the Haul Road for nothing.

Constructed in 1974 to service the North Slope oilfields, the unpaved Haul Road (officially called the Dalton Highway) is a 441-mile tire shredder and windshield breaker. Three things make it uniquely challenging: There are no towns along the way, there are only two service stops and the road is dominated by fast-moving tractor-trailers that hurl a nimbus of rocks and dust at oncoming vehicles. For these reasons, plus concerns for visitor safety and pipeline security, the Haul Road was formerly closed to the public. This status changed last November as part of a plan to



qualify it for federal highway funds, so this is the first full year the road has been open to everyone.

And the timing couldn't be more perfect. What better place to torture test the recently introduced Toyota Tacoma? The model we picked up in Fairbanks is the sixth generation of the spunky compact pickup that Toyota introduced as the Stout in 1964. Our LX model came with a long list of features that are ideal for bashing around in the boondocks: a powerful 3.4-liter V6 engine, reassuring 4-wheel ABS, a versatile 5-speed manual transmission, go-anywhere 4wd, a roomy extended cab, a whopping 12 in. of ground clearance and a smooth 7.7 in. of front-suspension travel. All of these components were wrung out during an 1800-mile round-trip run on the trans-Alaska pipeline road from Valdez to Prudhoe Bay, which included 1000 miles of driving on dirt.

True Alaska story: While getting the Tacoma's tires fixed in Deadhorse, the mechanic tells us about a Corvette

that recently pulled into town. The 'Vette survived the Haul Road in one piece, but was forced to drive the last 100 miles on a donut spare. The driver was so ticked off, he ordered a second spare flown in on the next flight from Fairbanks.

Flats are a way of life on the Haul Road, especially for rear tires, which get battered by a steady hammering of rocks kicked up by the front tires. Under typical conditions—pavement, mud, sand and deep-woods trail riding—our sturdy, thick-walled 31x10.5R15 Goodyear mud-and-snow tires performed admirably. As a matter of fact, I didn't notice the second flat until I came out of the manager's office at the Arctic Caribou Inn in Deadhorse, where a slow leak finally caught up to us at journey's end.

But the Haul Road isn't a typical road. The mechanic estimates that the average vehicle gets 2.5 flats per run—half get two, half get three. I'm sure he's right. Yesterday in Coldfoot, the last northbound service area,



Postcards from Alaska: Horsetail Falls (left) and statue honoring pipeline workers (top), both in Valdez, and fixing a flat in Deadhorse (above). Opposite page: Worthington Glacier (top) and moose (right), both along Richardson Highway, and author at the Arctic Circle (far right).

there were people waiting in line for hours to get tires repaired. One driver at the back of the line was working on his fifth flat of the day.

Since I'd driven the Haul Road before, while on assignment for PM in 1987, I made sure we carried an extra spare. Aside from that, I was counting on Toyota's well-deserved reputation for reliability and the all-new Tacoma's package of technical improvements to get us through. In the end, it was all we needed.

Clearly, the most significant upgrade in the Tacoma is the new 190-hp 3.4-liter 6-cylinder engine. (A 2.7-liter Four is standard in 4wd models.) This new powerplant provides a substantial increase in horsepower and torque over the compact's previous big-engine option, a 3.0-liter Six. The greater output enables Toyota to bump the Tacoma's standard towing capacity from 3500 to 5000 pounds for V6 engine models.

Power delivery is a major factor in workhorse pickups, and it was put to the test during our trip, especially while climbing the steep glacier-capped mountains of the Coastal Range near Valdez and on the snow-covered Brooks Range farther north. Fortunately, the Tacoma effortlessly ate up most of these inclines, some of which were 10-percent grades, in Fifth gear. Low-gear acceleration was crisp in all situations, as was midrange power for passing. Overall, the big dohc 24-valve Six moves the Tacoma



beyond simple workhorse duty into the realm of aggressive, sport driving.

True Alaska story: An adventurer recently set out on the Haul Road in a new pickup. Two flats and several dozen hood and windshield dings later, he arrived in Deadhorse. He looked at the damage to his beloved vehicle and became so angry that he directed the mechanic to install the deepest lugged, rock-throwing tires available in stock. He said he wanted to exact revenge on his return trip.

To be fair, most truckers observe the unwritten rule of the Haul Road: If you slow down and move to the side, they will too. Still, there are times when the road is so dry and covered with loose gravel that pebbles fly at virtually any speed. Also,

truckers sometimes hog the middle of the road and don't slow down. Although we reduced speed and pulled over for every passing truck, we still wound up with a nice ding in the windshield at the end of the trip.

While it's true that just about any vehicle (including recreational vehicles) can complete the entire pipeline-road journey in a matter of days, it's not like taking a long drive to grandma's house. For one thing, you need a vehicle with a range of at least 300 miles. The Tacoma, which has an 18-gal. fuel tank, easily surpassed this

requirement. It averaged an economical 19.2 mpg throughout the trip, for a range of just under 350 miles. And we needed it. One run between refills was 284 miles.

Another thing required on a long road trip such as this is interior comfort. After spending more than 48 hours in *(Please turn to page 119)*



BATTLE HELMETS

On the gridiron, the helmet is a football player's first line of defense against injury.

BY ANDREW GAFFNEY; PM Illustrations by Paul Kratter

● Those grainy old black-and-white film clips of players roaming the gridiron without anything covering their heads may seem prehistoric today, but it has been only a little more than 50 years since helmets became mandatory in the National Football League and in college pigskin programs.

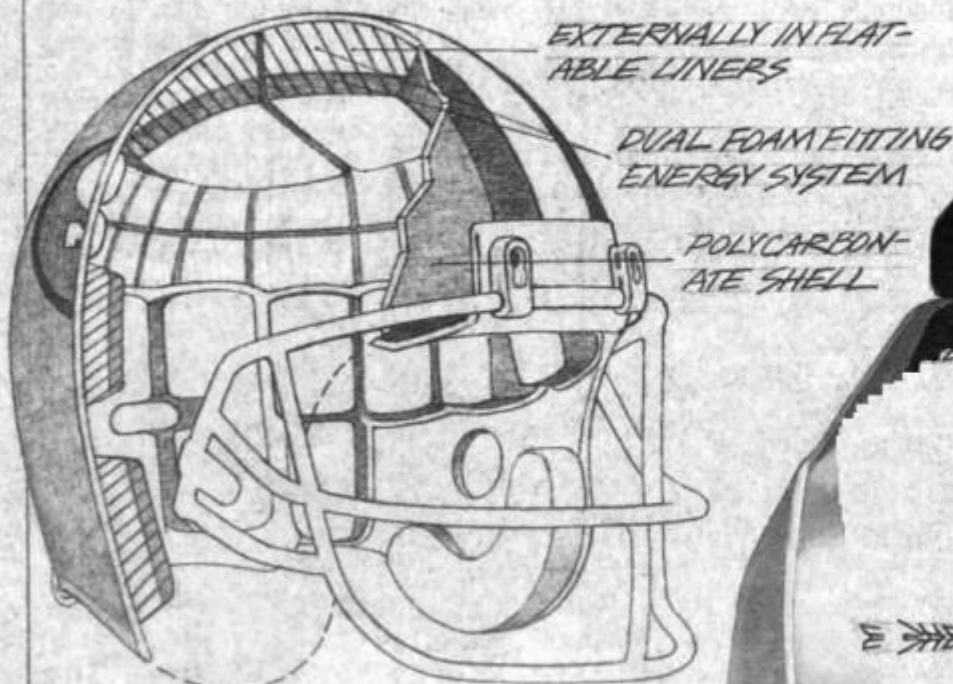
In fact, former President Gerald Ford was one of those players who braved the game without a helmet, in the late 1930s as a center for the Michigan Wolverines. And while that opens the door to many one-liners about the need for helmets, it also shows that head protection for players has come a long way during the past five decades. Indeed, even as the NFL marks its 76th anniversary, the football helmet is still evolving as manufacturers consider even safer designs for upcoming seasons.

Although helmets did not become standard gear until after World War II, some pioneering players wore primitive head coverings as far back as the early 1900s. The earliest versions, called "head harnesses," were made out of

soft leather and were predominantly designed to cover the ears. Because the flaps on the original head harnesses covered the ear completely, however, they were criticized for hindering communication on the playing field.

The first helmets offering full protection of the skull and featuring holes in the ear flaps came on the scene between 1915 and 1917. Although the flat-top caps were still made of soft leather, they offered some suspension, rather than resting directly on the skull.

During the 1920s and '30s, makers began to utilize harder leathers and some fabric cushioning for greater protection. Helmets also began evolving from the flat-top shape, adopting more of the teardrop shape of the skull and allowing the



Today's helmets are designed to absorb impacts in much the same way as car bumpers reduce the effects of collisions.



Yesterday, Today...



Early 1900s
Soft leather harness style.
YMCA team from Latrobe,
Pennsylvania.



1915
Soft leather flat-top style.
Typical of early pro team
Canton Bull Dogs.



1920s
Soft leather helmet.
Typical of the NFL's
Duluth Eskimos.



1930s, Early '40s
Hard leather style.
Typical of the NFL's
Chicago Bears.



1940s
Hard leather, first graphics.
Los Angeles Rams.



1950s, 1960s
Plastic helmet.
Detroit Lions.



1970s, Early '80s
Plastic helmet.
St. Louis Cardinals.



1980s To Present
Plastic helmet.
Minnesota Vikings.

impact of a blow to slide to one side rather than being absorbed head-on.

The granddaddy of helmet innovations, however, came in 1939, when the John T. Riddell Co., of Chicago, Illinois, introduced the first plastic football helmet. In addition to being stronger than leather models, the plastic helmet proved to be more durable. In 1940, Riddell was credited with adding the first face mask, also plastic, and moving the helmet strap from the Adam's apple to the chin.

Despite its performance improvements, the plastic helmet did have to overcome some hurdles before it would drastically change the game. Because plastics and other materials were scarce during World War II, some of Riddell's early models were not particularly well made. In fact, after Fred Naumetz of the Los Angeles Rams split nine in one season, plastic helmets were banned from the NFL in 1948. (Meanwhile, that same year, Fred Gehrke, another Rams player and a former art student, became the first to paint a team logo on his helmet.)

Riddell quickly made some refinements in the types of synthetics used for construction, and with some lobbying from coach George Halas of the Chicago Bears, plastic helmets were reinstated in 1949 and soon after became the official battle helmets of the

NFL. Riddell's earliest molded shells still serve as close models for modern-day energy-absorbing helmets, which feature specially molded polycarbonate plastic construction and high-tech cushioning systems.

Face masks evolved along the same lines—with early versions often shattering—until the development of the tubular bar in 1955. Popularized by legendary Cleveland Browns quarterback Otto Graham, the single bar soon blossomed into the virtual bird cage worn by today's players. Dark visors were added in the mid-1980s for use by players with eye injuries.

For all of the advancements made in the middle of the century, football helmets have remained nearly identical in construction and appearance since the 1970s. But that trend is about to change, according to some product designers. With head and neck injuries continuing to pile up at an alarming rate all the way from the Pop Warner to the pro levels, a few companies are addressing growing safety concerns with dramatic new concepts in head protection. Considering the transformation that helmets have made in the past 50 years, you can safely envision tuning in on Sundays in the next millennium to running backs who look more like Neil Armstrong walking on the Moon than Red Grange crossing the goal line.

One of the most dramatic propositions is from Des Plaines, Illinois-based Protec Field Gear, which has developed a one-piece system designed to replace the conventional helmet, shoulder pads and rib guard. The product, which is still in the prototype phase, is intended to reduce the risk of catastrophic injuries by lessening the forces on a player's neck from a headfirst impact, transferring the force of impact from the head and dispersing it throughout the upper torso.

Protec President Michael Field claims the one-piece gear actually improves a player's range of motion and visibility, but traditional helmet manufacturers argue that its double-helmet design is far too heavy, cumbersome and restrictive.

After extensive testing on the product, Field intends to supply it to a limited number of high schools for the 1996 season. Its price tag is expected to be comparable to the three separate pieces of equipment—in the \$200 range. The combined helmet and pads weigh about 8 pounds. Field claims that the NFL's Chicago Bears and several major college teams have offered assistance in the concept's development, and predicts it will make its way onto the pro field by 1998.

A relatively new innovation in helmets that is already on the field is the

.. And Tomorrow



One new concept, developed by Protec, combines the helmet, shoulder pads and rib guard into a single piece of equipment. While the helmet is rigid, the player is still able to rotate his head inside of it. See-through panels on the top enhance the player's field of vision.

ProCap from Protective Sports Equipment, in Erie, Pennsylvania. In fact, the polyurethane semihard pad that attaches to the outside of a standard football helmet has appeared in the past five Super Bowls.

Buffalo Bills trainer Ed Abramowski first recommended the pad to safety Mark Kelso in 1990 after he had suffered a string of concussions. Kelso went on to play for five more seasons with the ProCap, and became such a supporter of the product that he predicts it will "one day be the standard in the helmet industry." In addition to Kelso, Steve Wallace, an offensive tackle with the San Francisco 49ers, wore the ProCap in the last Super Bowl. The product is also currently in use by more than 2000 youth, high-school and college programs.

ProCap was designed by Bert Strauss, a former industrial design consultant, who saw a need for more protection from concussions and other head injuries in football. Strauss claims that ProCap absorbs "30% more energy than whatever helmet it sits on, reducing the impact and trauma to the head." He compares the foam device to the softer car bumpers that are now standard in the automobile industry.

Although ProCap is currently only available for \$49 list as an add-on to existing helmets, the company is

working on an integrated helmet design that incorporates a semihard shell to absorb even more energy.

Despite the advances being proposed by relative newcomers, the football helmet industry is still domi-



ProCap, a polyurethane pad that attaches to the outside of a helmet, is an added safeguard against concussions.

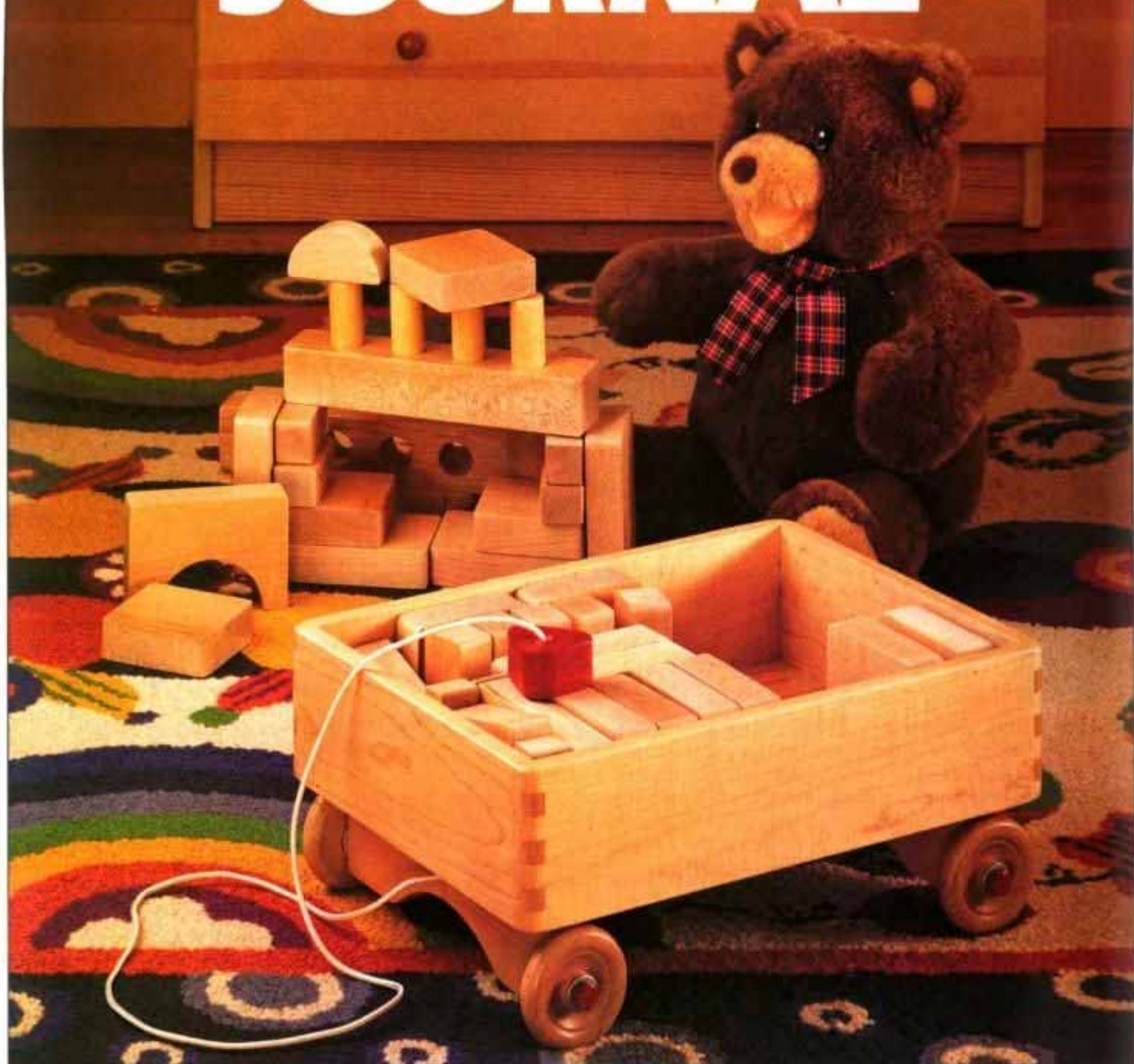
nated by two players—Riddell and Schutt Sports Group (manufacturers of AIR brand helmets). The two companies have raised the bar slightly over the years by using new materials in helmets. But slow sales, due to liability worries and budget cuts in school and recreation programs, are reducing capital available for re-

search and development. Julie Nimmons, Schutt's president, points out that while material and labor costs have risen during the past decade, the price of a helmet has fallen more than \$10 on average. While this limits innovations, Nimmons says the company is looking into new plastics used in the aerospace industry that "are as strong as existing materials, but lighter." Kevlar, the material in bulletproof vests, is also being considered for use in helmets.

Another potential area of development is communications. NFL coaches have been searching for decades for ways to communicate with players on the field. In fact, renowned

Cleveland Browns coach Paul Brown placed a citizens band radio in his quarterback's helmet in 1956. Coaches are still looking for a technological solution to hand signals and players-cum-mailmen.

While radios and double helmets may seem like futuristic fodder to football purists, simply turning back the pages to the days when Ivy Leaguers grew their hair long to protect themselves from head injuries is solid evidence that technology typically wins out over toughness—even on the gridiron. **FM**



SHOP PROJECT

Block Party

An easy-to-build child's block wagon made out of solid maple.

BY ROSARIO CAPOTOSTO,
Contributing Editor

● This wagon, with its cargo of 45 differently shaped hardwood blocks, provides youngsters with the pleasure of delivering the materials to the site and then building with them.

The toy reminds us of a time when playthings were neither plastic nor complicated. Made from maple, it's built to last more than one generation. And the finger joints used to join the sides and ends are not only attractive, but also exceptionally strong and easy to make on the table saw using a simple miter gauge jig and a dado blade.

If you're a beginning woodworker, this is an ideal project because it involves basic joinery and machine use. If you're an experienced woodworker, you'll like it because you can finish most of it in a weekend.

Wagon building

Begin by ripping and crosscutting the ½-in.-thick stock to length. Also cut two scrap pieces to test the jig when making the finger joints.

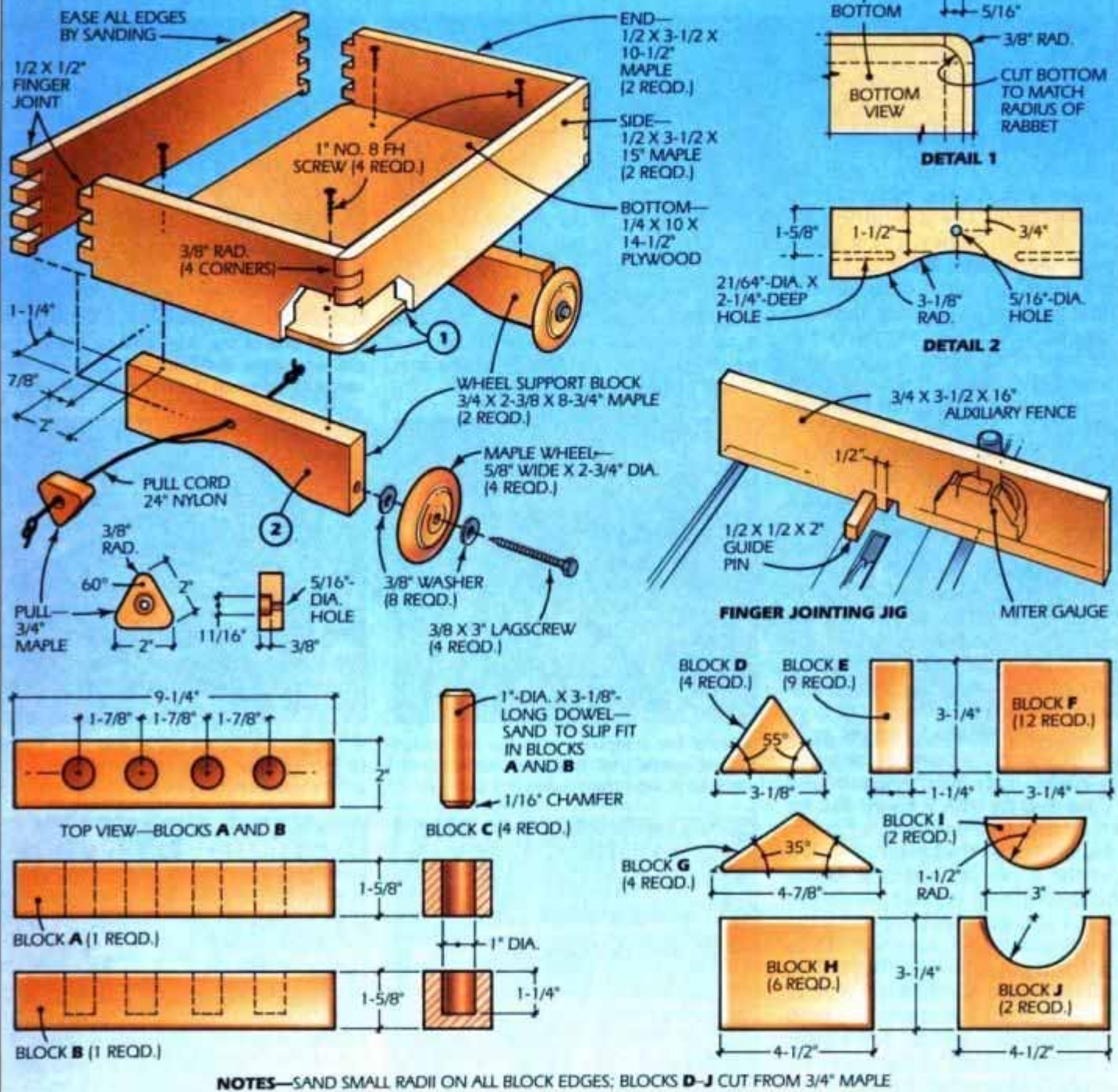
Before switching to a dado blade, rip and crosscut the piece for the auxiliary miter gauge fence and the guide pin, as shown in the drawing (opposite). Also cut a ½-in.-thick × 1-in.-wide × 6-in.-long spacer strip.

Set up the dado blade in the table saw to cut a notch precisely as wide and as deep as the stock thickness. Hold the fence firmly against the miter gauge and cut a notch into it.

Lead photo: J.R. Rost
Step-by-step photos: Rosario Capotosto
Technical art: Eugene Thompson
Photo stylist: Gabe Herrick

BLOCK WAGON

6-1/2" HIGH x 10-3/4" WIDE x 15" LONG



Then, glue the guide pin into the notch. Next, stand the spacer strip on its 1/2-in.-wide face, and butt it against the dado blade. Slide the auxiliary fence sideways, and butt the pin against the spacer strip (Photo 1). Screw the auxiliary fence to the miter gauge.

To make the notches that form the fingers, hold a sidepiece firmly against the fence with its edge butted against the pin. Make the first cut (Photo 2). Now place the notch just formed over the guide pin. This positions the work for your next cut. Repeat the step for the final cut, and with the last notch positioned on the pin, butt the edge of the endpiece against the edge of the first workpiece (Photo 3). Make the first cut in the endpiece, then remove the

first workpiece. Continue making cuts in the endpiece until it's finished, and then repeat this procedure on the other three corners.

There is one thing you should bear in mind when using this jig. It will cut accurately only if the workpiece butts squarely against the pin, or if the workpieces butt squarely against each other. Make sure that you brush away any sawdust that collects around the guide pin.

Note that the notches in each workpiece may be cut slightly deeper than 1/2 in. to allow the fingers to project slightly and to be sanded flush. To gain this extra projection, adjust the dado blade to a height of about 17/32 in. above the table.

Apply glue to the finger joints of

each workpiece. This is best accomplished by pouring some glue into a plastic cup and using a small "acid" brush to spread it (this brush is available through woodworking catalogs and in hardware stores). Bring the joints together using hand pressure, and then use masking tape to hold the joint closed. Apply the tape



diagonally across the corners, as shown, and let the glue dry (Photo 4). We inserted two wood strips under the workpiece. They prevent any glue drippings from bonding the workpiece to the workbench.

Next, install a rabbeting bit in the router, and cut the rabbet in the bottom edge of the assembly. To make this step easier, cut a small support board from scrap. Rip this piece to equal the width of the assembly, and crosscut it so it fits between the wagon ends. This supports the router base on a common plane with the assembly (Photo 5). In doing so, the router will not tip and leave an erratic cut.

After the rabbet is cut along the assembly's length, recut the support board so it fits across the wagon's width, then continue around to complete the rabbet. Note that the rabbet will have rounded corners. Here you have two options: You can chisel the corners square or leave them rounded and plan to round the corners of the bottom panel to match.

Now cut the wheel support blocks to size, and use a doweling jig to bore the body holes for the lagscrew axles (Photo 6). Since the lagscrew requires a $\frac{21}{64}$ -in.-dia. body hole, you must use the doweling jig with a $\frac{5}{16}$ -in.-dia. bit and then drill freehand with a $\frac{21}{64}$ -in.-dia. bit to enlarge the hole.

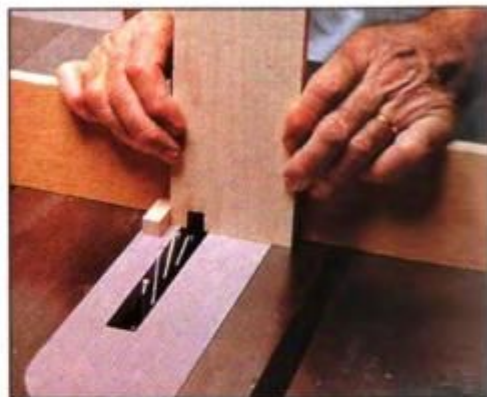
Cut the plywood bottom to fit the rabbet, and glue it in place. When the glue has set, glue and screw in the wheel supports, and use a wrench to install the wheels (Photo 7). The wheels are part No. WW5. You can order them from Constantine's, 2050 Eastchester Rd., Bronx, NY 10461; (800) 223-8087. A set of four costs \$3, plus \$4.95 shipping. Remove the wheels to permit them to be finished. Apply bright red paint to the axle heads and the pull-cord block.

Cut the blocks to size, then sand a small radius on all corners (Photo 8). Sand the wagon with 120- and 220-grit sandpaper. Ease all edges by hand sanding with a padded block. Wipe off any sawdust, then apply two coats of satin polyurethane finish to the wagon, wheels and blocks. Lightly sand the first coat of polyurethane and wipe off the sanding dust before applying the next coat. Reinstall the wheels.

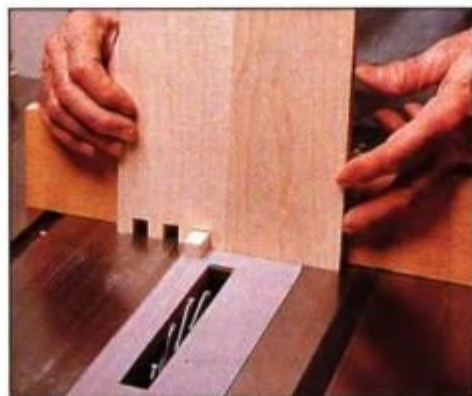
Finally, bore the hole for the pull cord in the front wheel support. Cut the pull cord to length with a utility knife that has a fresh blade in it. Install the pull cord and the pull block. Tighten the cord knots with a pair of pliers, and you're done. **PM**



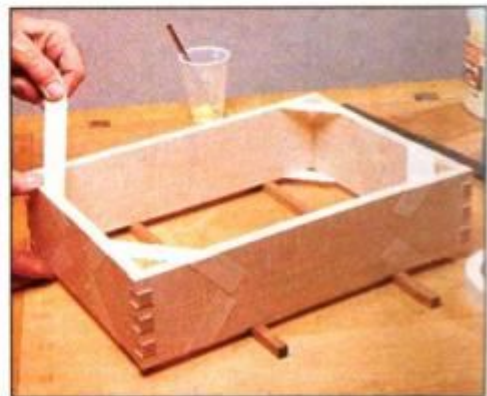
1 To position the auxiliary fence, butt the fence's guide pin against the spacer strip placed beside the dado blade.



2 Butt one of the sides against the guide pin, and make the first cut. Clean out the sawdust between the pin and workpiece.



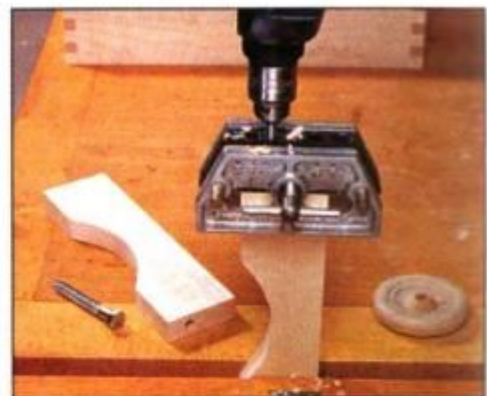
3 Hold the sidepiece with the last notch on the guide pin. Butt the mating endpiece to it, and then make the cut.



4 Apply glue to the joints and hold them together with masking tape stretched across the corners until the glue is dry.



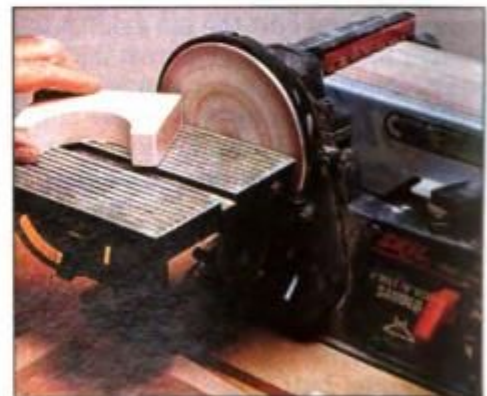
5 Place a length of scrap inside the assembly to support the router when you cut the rabbet in the sides and ends.



6 Use a doweling jig to bore the pilot hole for the axle. Follow this by boring freehand to enlarge the hole slightly.



7 Attach the bottom and the wheel support blocks. Don't forget to use a washer on each side of the wheels.



8 Round off the sharp edges and corners on each of the blocks and on the wagon by sanding. Finish with polyurethane.

TOOL TEST

Snow Business

Honda's HS 621A and John Deere's TRS26 receive high marks on winter ground-clearing chores.

● Here in the Northeast, we color winter white. And, unless hibernation is a realistic alternative, surviving the cold months means having the right kind of snow-removal tools.

Last year, we sampled two different approaches to easing winter woes. Honda's new offering, the model HS 621A, is aimed at light- to medium-duty applications and places a premium on maneuverability and ease of operation. John Deere's TRS26, on the other hand, is a traditional 2-stage machine that's suited to the heavier accumulations typical of Snow Belt regions.



The midscale, 2-stage John Deere TRS26 (left) features an 8-horsepower engine and a 26-in.-wide x 20-in.-high auger housing. The Honda HS 621A (right) handles lighter snow accumulations with a single-stage auger, manual drive and a 5.5-hp engine.

Honda HS 621A

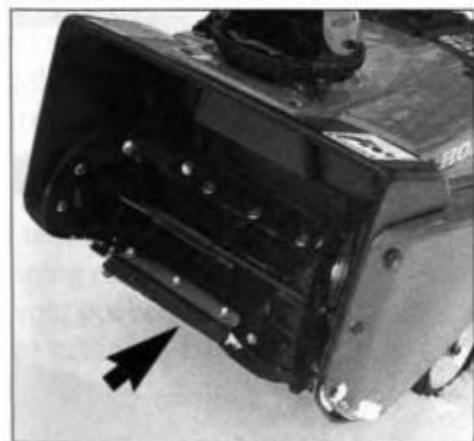
Shoveling snow is not fun and shoveling a lot of snow is really not fun. But before you check out the big snow-removal rigs, you should look at a basic machine—like this Honda HS 621A—to see if it will fulfill your needs. The HS 621A features a 5.5-hp ohv engine, manual drive, a recoil start, a clearing width that's relatively narrow at 20.6 in. and an overall weight of just 93 pounds. It's a single-stage design, and, according to Honda, it can throw snow up to 33 ft.

All of these features seem tailored for light-duty suburban use where the ground is flat, the driveways are short and the town sees no need for sidewalks in front of your house. When tested in these conditions, the unit performed admirably. It was easy to start, kicking in on the first pull, and ran very quietly afterward. It gave 6 in. of wet snow a ride of just over 20 ft. and proved very maneuverable in tight spots. And the manual drive never seemed to be a shortcoming. The manufacturer correctly claims

that the drive on this machine is "auger-assisted." The auger action did help pull the unit along as it was pushed from behind.

In fact, the machine did so well that we tried it in harsher conditions. Instead of on asphalt, the second test was conducted on a 200-ft., sloping, packed-soil driveway that has a 10-percent grade. The snow was also deeper, about 10 in., but it was much drier than that of our first test.

The HS 621A walked right through this snow and even threw it farther—



The flat, resilient scree (arrow) at the bottom of the HS 621A scrapes a clean path along asphalt and concrete.



The machine features a fuel shutoff valve that must be opened before starting and then closed when finished.



There is an ignition switch that must be turned on to start the unit. When turned off, the switch kills the engine.

by about 5 ft.—than in our first test. When we worked our way down the drive, performance was excellent. But the trips back up were quite a bit more difficult. The self-feeding characteristics of the auger can help only so much.

If you have a lot of area to cover and it's steep in places, you should look into a larger, self-propelled machine. But for those with less extreme requirements, the HS 621A is an excellent choice. It sells for about \$740 at Honda power equipment dealers. Contact American Honda, 4475 River Garden Pkwy., Duluth, GA 30136; (800) 426-7701. —Steven Willson

John Deere TRS26

In upstate New York, snowblowers are more the rule than the exception. With accumulations sometimes exceeding 16 in., a machine that's too small can be more trouble than it's worth. In light of our heavy-duty requirements, the John Deere model TRS26 seemed to strike a good balance between price and performance.

The test model came fully equipped with optional tire chains, a headlight and plug-in electric start—there's no



The last step before pulling the starter cord is to pull out the choke switch, located just behind the oversize fuel fill cap.



The recoil starter cord—located in a comfortable position—was easy to pull, and the engine fired on the first pull every time.

battery. Simply plug the starter into the nearest 20-amp outlet. Although the electric start worked fine, we had no trouble with manual starting.

The TRS26 has an 8-hp engine and cuts a 26-in. swath. It's a 2-stage machine—the 12-in. front auger drives the snow back into a 12-in. impeller that propels the white stuff up through the chute. The front auger is linked to the drive by shear pins that are designed to break if you pick up a branch or other type of obstacle.

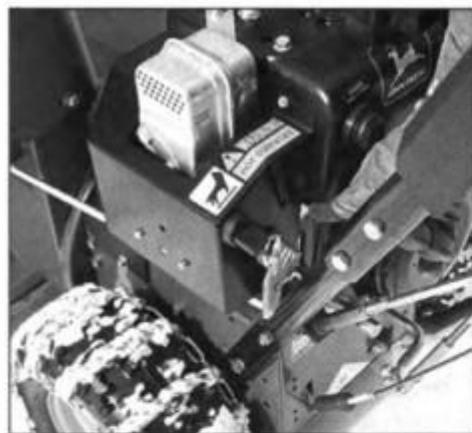
Power is sent to the wheels via belts and a transmission with six forward speeds and reverse. The blower easily handles 10-in.-deep snow in Third gear, leaving the two lower gears for heavier accumulations.

The controls are well placed and logical. A handle lever on one side controls the forward motion, and one on the other side engages the augers. A crank on the top of the console directs the chute up to 100° to the right or left, and a lever-operated cable angles the blown snow up or down.

For our conditions, the TRS26 performed admirably. It handled modest inclines without a whimper and even churned through day-old snowbanks left by the plow. For extra traction, the wheels, normally driven through a differential, can be locked to the axle.

The John Deere TRS26 has a suggested retail price of \$1199 and is sold through the company's chain of dealers. Optional electric start adds about \$118, tire chains about \$27, and the headlight about \$24. Write to Inquiry Dept., John Deere Lawn and Grounds Care Division, P.O. Box 12795, Research Triangle Park, NC 27709.

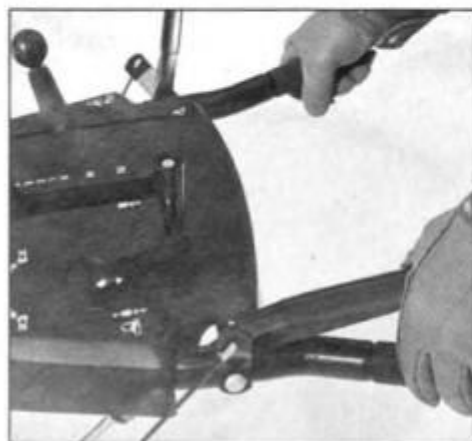
—Thomas Klenck



The machine's choke, throttle and ignition key are located at the side of the engine. A primer button facilitates cold starts.



The TRS26's recoil starter features an oversize handle for winter gripping. An electric starter is available as an option.



The left handle lever engages wheels, and the right controls the auger. Either hand can be removed while blower is operating.



The rotating hand crank directs snow chute up to 100° right or left. Crank is linked to the chute by rod and U-joints.



To control height and distance of blown snow, chute spout is adjusted up and down with lever on handle console.

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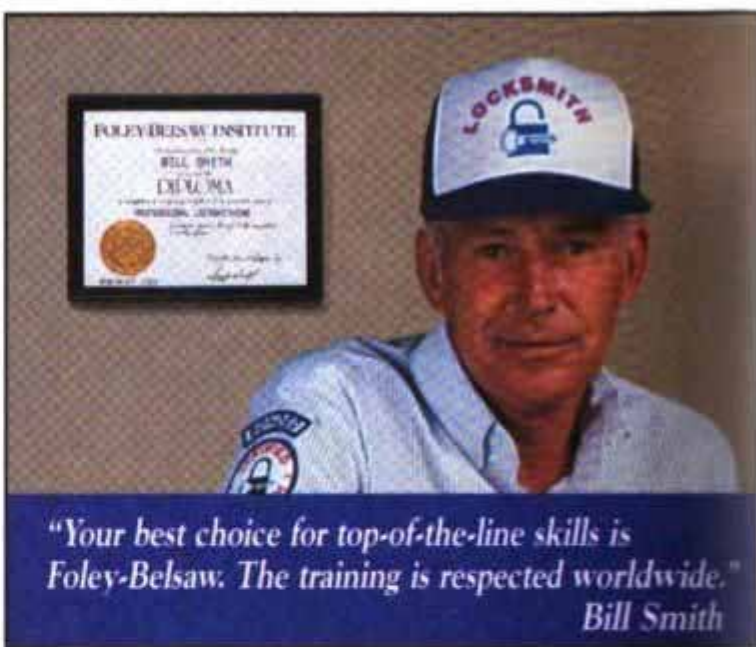
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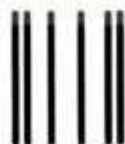
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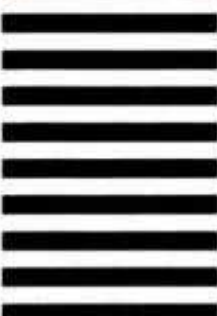
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SHOP PROJECT

Sabre Saw Table

It's a shopmade accessory that converts your sabre saw into a stationary machine.

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor



● Nearly every portable power tool available today has a stationary counterpart—a machine that does everything the portable version can handle but with considerably more precision and control. When it comes to the sabre saw, its big brother is the stationary scroll saw—a tool capable of fine, small-scale woodworking and fretwork.

If you've been yearning for one of these versatile machines, you don't have to buy one. Our sabre saw table is designed to convert your portable tool into a full-fledged scroll saw. And it's able to do this without re-

stricting utility—you can easily remove the sabre saw for portable use.

Our sabre saw table provides a 16-in. cutting capacity and uses conventional 5-in. pin-end scroll saw blades. It works with just about any sabre saw model that has electronically controlled preset variable speed.

Electronic circuitry is important because it helps the tool maintain speed under load, and the preset feature is necessary for locking the tool at the required speed. Our sabre saw table works best at low to moderate speeds. While making the sabre saw table requires a few special parts, you

can find most of them at any well-equipped hardware store.

The table is surfaced with plastic laminate for friction-free operation and boasts a slot that accommodates a standard miter gauge. To provide stability, the two oversize footpads can be clamped to your worksurface. A convenient switch wired to the table's own outlet receptacle allows you to turn the machine on and off without touching the sabre saw controls.

We used birch plywood and solid oak to build our version of the table, but any other quality plywood and hardwood will work just as well.

Building The Arm

Begin by making cardboard templates of all the contoured arm parts. Cut the plywood arm with your sabre saw using a hollow-ground blade (Photo 1). Then smooth the sawn edges with drum and disc sanders, or hand sand them with a sanding block.

Next, trace the arm-cheek pieces onto $\frac{3}{4}$ -in.-thick oak stock (Photo 2). Note that the grain direction of these two parts is vertical. Allow about 1 in. of extra stock at the forward end of the L-shaped pattern to help during assembly. Then, cut out the shapes with your sabre saw.

Cut the oak cheek spacer to size, leaving about 1 in. of extra material at one end to match the cheek pieces. Orient the grain direction of the spacer horizontally. Check the actual spacer thickness and compare it to the plywood arm thickness. If the plywood is slightly thinner, plane the cheek spacer to match.

Align the cheeks with the spacer in between and temporarily tape them together. Bore two $\frac{1}{8}$ -in.-dia. holes through the 1-in. waste area at the front of the assembly. Remove the

tape, separate the pieces and apply glue to the mating surfaces. Reassemble the pieces, drive 3-in. finishing nails into the holes to ensure alignment and keep the parts from shifting, and then clamp them (Photo 3). When the glue is dry, pull out the nails and cut off the waste area.

Next, use a drill press to bore the $1\frac{1}{16}$ -in.-dia. hole for the pipe that serves as the plunger housing (Photo 4). After marking the hole location, clamp the work squarely to the drill press table. If you don't have a $1\frac{1}{16}$ -in. bit, grind $\frac{1}{2}$ in. from each edge of a $1\frac{1}{8}$ -in. spade bit. Bore a test hole to check for a good fit with the pipe before boring the workpiece. Then, bore the hole for the lock-knob bolt.

Use a table saw to cut the kerf in the center of the cheek assembly (see the top view in the Arm Pattern assembly on the drawing). To hold the piece during the cut, clamp it to a simple jig that straddles the table saw fence (Photo 5). Place a scrap block between the cheeks before tightening the clamp.

With the slot cut, apply glue to the inner faces of the cheeks and the mating surfaces on the plywood arm, join

the components and clamp them until the glue is dry (Photo 6).

To install the threaded inserts that allow the bearing block to be secured, bore two $\frac{1}{2}$ -in.-dia. \times $\frac{5}{8}$ -in.-deep holes into the bottom of the cheek assembly, as shown. You can do the job on a drill press, but we used a portable drill and doweling jig (Photo 7). Apply epoxy to the insert threads, place them into the holes and let the adhesive cure (Photo 8).

MATERIALS LIST—SABRE SAW TABLE

Key	No.	Size and description (use)
A	1	$\frac{3}{4} \times 10\frac{1}{2} \times 19\frac{5}{8}$ " plywood (arm)
B1	2	$\frac{3}{4} \times 5\frac{1}{2} \times 5\frac{1}{2}$ " oak (arm cheek)
B2	1	$\frac{3}{4} \times 2 \times 3$ " oak (spacer)
C	2	$1 \times 4\frac{3}{8} \times 4\frac{3}{8}$ " oak (arm block)
D1	1	$\frac{3}{4} \times 14 \times 27$ " plywood (table)
D2	1	$1\frac{1}{8}$ "-dia. \times $\frac{1}{4}$ " plywood (insert)
E1	1	$\frac{3}{4} \times 6\frac{1}{2} \times 9$ " plywood (mounting plate)
E2	1	$\frac{3}{4} \times 6\frac{1}{2} \times 9$ " plywood (mounting plate)
F	4	$\frac{3}{4} \times 3 \times 23\frac{3}{8}$ " plywood (frame side)
G	4	$\frac{3}{4} \times 3 \times 10\frac{1}{2}$ " plywood (leg)
H	2	$\frac{3}{4} \times 3 \times 12$ " plywood (front tie)
I	2	$\frac{3}{4} \times 3 \times 4$ " plywood (rear tie)
J	1	$\frac{3}{4} \times 5\frac{1}{2} \times 14$ " plywood (front pad)
K	1	$\frac{3}{4} \times 4 \times 14$ " plywood (rear pad)
L	1	$\frac{3}{8}$ "-dia. \times $10\frac{1}{2}$ " steel rod (plunger)
M	1	$\frac{3}{4} \times 8$ " pipe nipple (plunger housing)
N	2	$\frac{3}{4}$ " pipe cap (housing cap)
O	1	$\frac{3}{8}$ " locknut
P	1	$\frac{3}{8}$ " SAE washer
Q	1	$6\frac{1}{2}$ "-long compression spring*
R	1	$\frac{3}{8}$ "-dia. \times 2" dowel (bushing)
S	1	$\frac{1}{8} \times \frac{1}{2} \times 2\frac{1}{2}$ " steel (blade holder)
T	1	$1 \times 2\frac{3}{4} \times 2\frac{3}{4}$ " oak (bearing block)
U	1	$\frac{1}{4} \times \frac{3}{4}$ "-dia., $\frac{1}{4}$ "-bore bearing**
V	As reqd.	plastic laminate (table surface)
W	As reqd.	$1\frac{1}{4}$ " finishing nail
X	3	$2\frac{1}{2} \times \frac{1}{4}$ "-20 carriage bolt, washer, nut
Y	1	$2\frac{1}{2} \times \frac{3}{16}$ "-18 carriage bolt, washer
Z	1	5-star through-hole $\frac{3}{16}$ " knob***
AA	3	$1\frac{1}{4}$ " 10-32 rh screw
BB	4	$\frac{1}{4}$ "-20 Teenut, washer, $1\frac{1}{2} \times \frac{1}{4}$ "-20 thumbscrew
CC	4	$1\frac{1}{4}$ " No. 6 drywall screw
DD	22	$1\frac{1}{2}$ " No. 6 drywall screw
EE	9	2" No. 6 drywall screw
FF	1	$2\frac{1}{2} \times \frac{1}{4}$ "-20 hexhead bolt, 3 washers, nut
GG	2	$1\frac{1}{2} \times \frac{1}{4}$ "-20 hexhead bolt, washers
HH	2	$\frac{1}{4}$ "-20 threaded insert

* Ajax No. 60, $9\frac{3}{4} \times \frac{1}{16}$ " OD, cut to $6\frac{1}{2}$ " long. Ajax Wire Specialty Co. Inc., 119 Bloomingdale Rd., Hicksville, NY 11801.

** Router bit pilot bearing.

*** Available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, MN 55374.

Misc: 16/3 wire; wire staples; plug; single receptacle; receptacle box; surface-mount switch.



1 Mark the arm outline on $\frac{3}{4}$ -in. plywood. Then, cut to the line with a sabre saw and sand the sawn edges smooth.



2 Make templates for contoured pieces. Trace cheek template on oak stock. Hole at corner handles inside radius cut.



3 When gluing cheeks to spacer, use nails to maintain alignment. The spacer thickness should match the arm thickness.

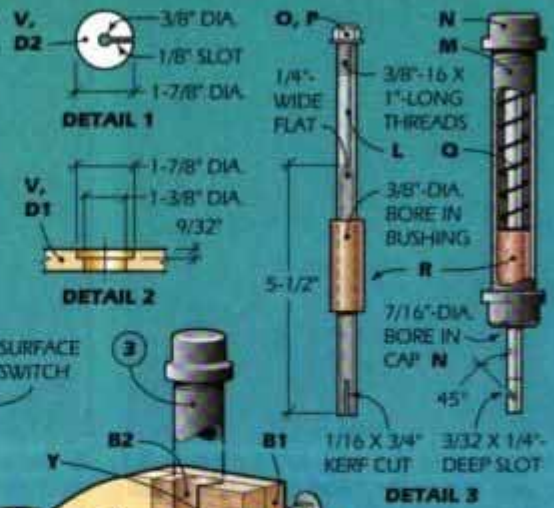
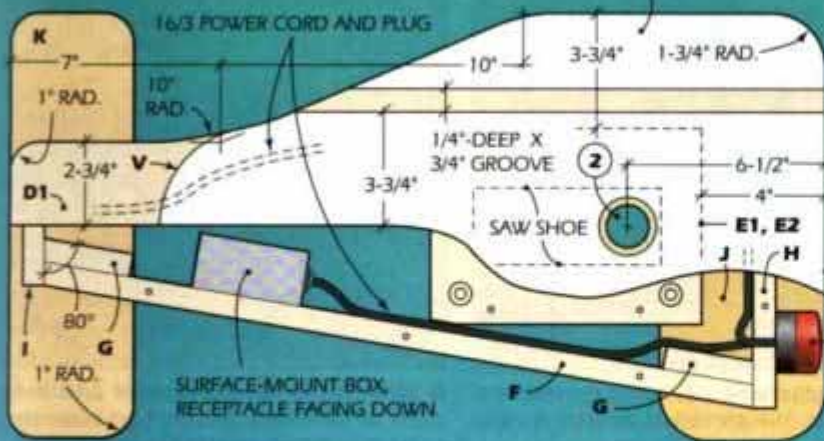


4 Use a $1\frac{1}{16}$ -in.-dia. spade bit ground down to $1\frac{1}{16}$ in. to make the hole for the $\frac{3}{4}$ -in. plunger-assembly pipe.

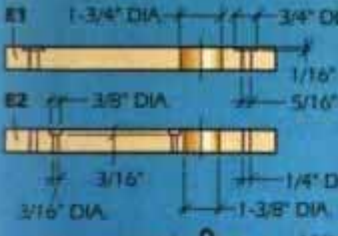
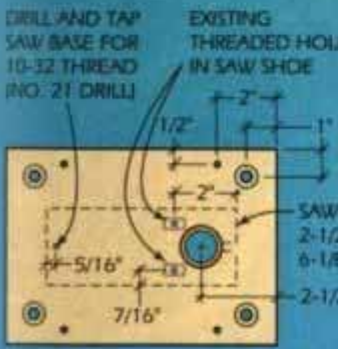


5 Use a table saw to cut the kerf in the arm head assembly. A jig that straddles the fence makes the cut safe and secure.

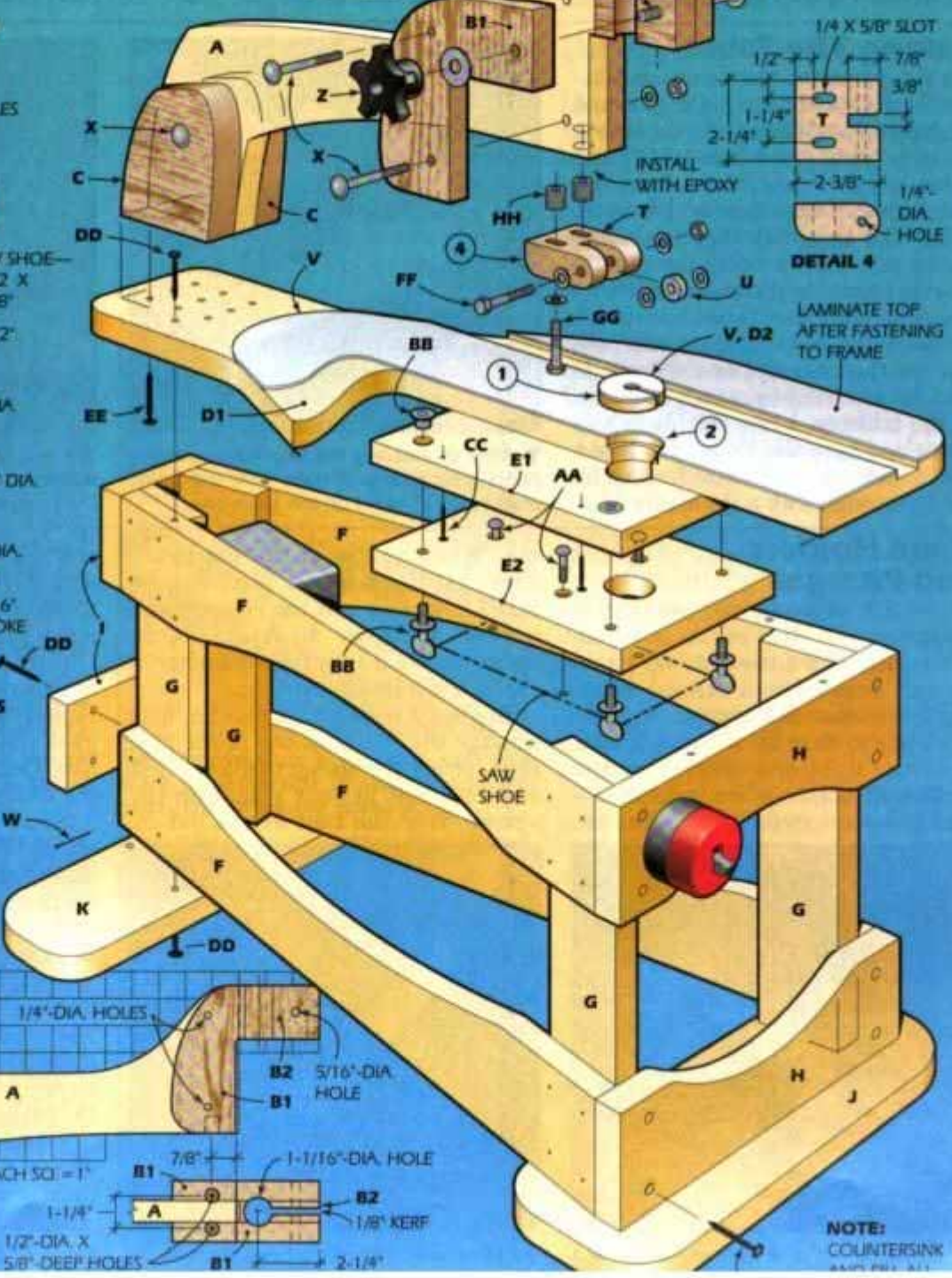
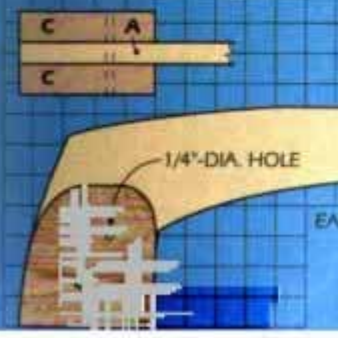
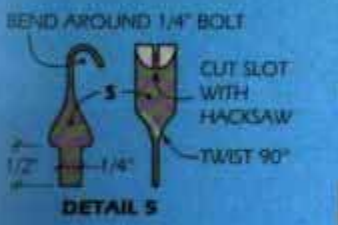
SABRE SAW TABLE

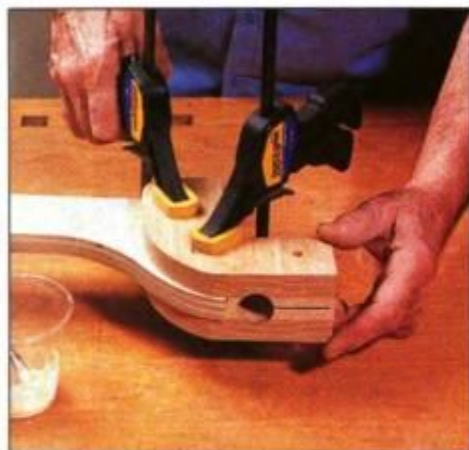


TOP VIEW OF TABLE ASSEMBLY

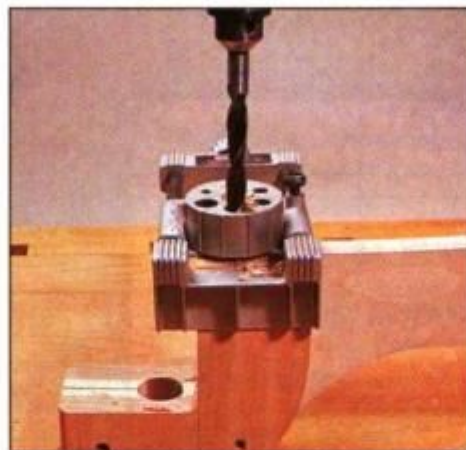


SABRE SAW MOUNTING DETAILS

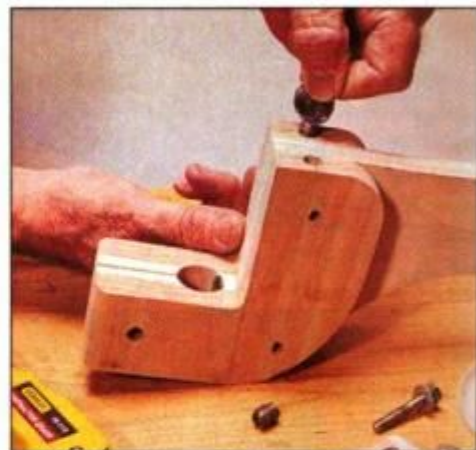




6 After boring the lock-knob bolt hole, glue and clamp the head assembly to the arm. Reinforcing bolts are added later.



7 Use an adjustable doweling jig to bore the holes for the threaded inserts. A drill press will also work for this job.



8 Dab epoxy on the inserts and install them in the holes. Inserts seat squarely in holes that match insert diameter.

Making The Table

Cut the parts for the table, and assemble the side frames with glue and finishing nails. When the glue is dry, tilt your table saw blade to 10° and make the bevel cuts on the front and rear edges of each frame (Photo 9). Clamp the assembly together while boring screw pilot holes for joining the side frames to the end rails (Photo 10). Assemble the table base with screws and glue. Do not, however, use glue on the rear upper end rail. It must be removed to attach the arm. On the tabletop, locate the blade-hole center and bore the 1 7/8-in.-dia. insert recess 3/32 in. deep. Finish the hole by boring through with a 1 3/8-in.-dia. bit.



9 After assembling the side-frame components with glue and nails, trim the frame ends to a 10° bevel on the table saw.



10 Use pipe clamps to hold base together while the end rails are glued and screwed. Don't glue the rear upper end rail.

Blade Holders And Plunger

The upper blade holder/plunger is comprised of a steel rod, a compression spring and a wood dowel bushing—all encased in a capped, 8-in.-long x 3/4-in.-dia. pipe nipple.

When you shop for the pipe, hold it up to the light and check that the inside wall is free of irregularities—most pipes are smooth, but some are

not. While you're at the hardware store, get the 3/8-in.-dia. steel rod, 3/8-in. SAE washer and the compression spring. We used an Ajax No. 60 spring that had an outside diameter of 1 1/16 in. and a length of 9 3/4 in.

Begin by boring a 7/16-in.-dia. hole through the center of one of the pipe caps. To cut the spring to 6 1/2 in., first secure a bolt in your vise. Slip the spring over the bolt at the 6 1/2-in.

mark on the spring. Stretch the waste end of the spring away from the bolt to allow room for a diagonal cutter to make the cut (Photo 11).

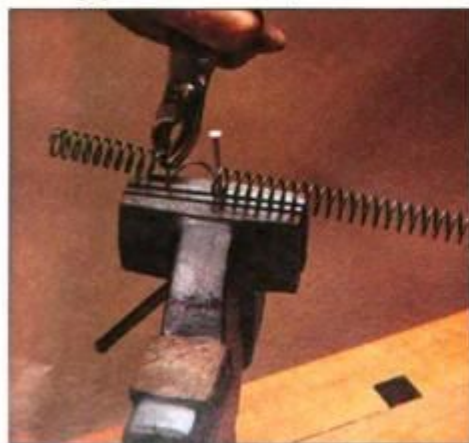
Cut the 3/8-in. rod to 10 1/2 in. long and thread 1 in. of one end with a 3/8-in.-16 die. Follow by cutting the angled and straight slots with a hacksaw. Double the hacksaw blade to cut the wider, angled slot.

Secure the rod in your vise and shape the flat area by draw filing, using a single-cut bastard file. Hold the file perpendicular to the work with both hands and move the file back and forth with even pressure (Photo 12).

Make the lower blade holder from a piece of 1/16 x 1/2 x 2 1/2-in. steel stock. Form the hooked end by bending the metal around a 1/4-in. bolt. Then, using an adjustable wrench as a lever, twist the bar 90° (Photo 13).

When the bends have been completed, use a hacksaw to cut the shank end to fit your sabre saw's blade holder.

Because the inside diameter of the pipe nipple is 5/16 in., the 7/8-in.-dia. wood dowel bushing will need to be trimmed slightly to fit. First, bore the



11 To cut spring to length, place it over a bolt. Then, stretch waste side away from bolt and cut with diagonal cutter.



12 Use draw filing to produce flat on plunger rod. Hold file perpendicular to work. Push and pull with even pressure.

centered $\frac{3}{8}$ -in. hole for the plunger rod on a drill press. Then, install a carriage bolt in the hole and secure it with a nut. Chuck the bolt in the drill press and use a coarse file to trim the dowel while it's spinning.

Cut the bearing block to size and shape, as shown in Detail 4 on the drawing. Use a drill press to bore the hole for the bearing bolt. Begin the slotted holes by boring overlapping $\frac{1}{4}$ -in.-dia. holes. Then, remove the waste with a sharp chisel. The $\frac{3}{4}$ -in. bearing is generally available where router bits are sold.

When all of the blade holder/plunger components are finished (Photo 14), you're ready to begin final assembly.

Final Stages

Start by cutting the two oak rear arm-mounting blocks to size and shape, and then bolt them to the arm with a single bolt.

Note that the mounting-block grain orientation is horizontal. Locate and bore the pilot holes in the tabletop for attaching the arm to the table and the table to the base.

To align the arm, first temporarily



15 Clamp arm to table and use a square to align plunger rod with hole in table. Then bore pilot holes for mounting.



17 Make sure Teenuts are installed in upper plate before gluing to table. Lower plate holds sabre saw.



13 Bend the end of a steel strip around a bolt to form hook on lower blade holder. Use a wrench to twist shank 90°.



14 Completed blade holder/plunger components. Bearing block at upper right reinforces plunger rod.

install the plunger assembly. Then, use clamps to hold the arm in position on the tabletop. Place a square on the tabletop so its edge is aligned with the center of the table hole (Photo 15). Then, position the arm so the plunger rod is aligned with the blade of the square. Adjust the arm angle by pivoting the arm at the single rear mounting block bolt. Then bore the pilot holes in the mounting blocks



16 Remove shoe from sabre saw and place on underside of lower mounting plate. Then mark the screwholes.



18 After attaching the outlet box, single receptacle and switch to the base, connect switch and receptacle with 16/3 wire.

guided by the pilot holes in the table.

The sabre saw is secured to a double mounting plate that allows it to be easily removed. The saw base is attached to the lower mounting plate with three 10-32 screws—two of which are threaded into the existing holes in the tool's base that were originally intended for an accessory fence. The third screw requires a new threaded hole. After boring the hole with a No. 21 bit, use a 10-32 tap to cut the threads (see Sabre Saw Mounting Details on the drawing).

After cutting both mounting plates to size, locate and bore holes in the top plate for the Teenuts and in the bottom plate for the thumbscrews that hold the pieces together. After driving the Teenuts into place, screw the plates together and mark the center of the blade access hole.

Bore a $\frac{3}{16}$ -in. hole through both plates. Then, separate the assembly and, using the $\frac{3}{16}$ -in. hole as a pilot hole, bore a $1\frac{1}{4}$ -in. hole through the top plate and a $1\frac{3}{8}$ -in. hole through the bottom plate.

Remove the base from the sabre saw and lay out the hole positions for the 10-32 rh screws on the underside of the lower mounting plate (Photo 16). Then, bore $\frac{3}{16}$ -in.-dia. holes for the screws. From the top, counter-bore $\frac{3}{8}$ -in.-dia. recesses for the screwheads. Reassemble the saw and mounting plates, and check for fit (Photo 17).

Glue and screw the tabletop to the front and side top base rails. Cut the plastic laminate slightly oversize and glue it to the top with contact cement. Then, trim with a router and flush-trimming bit. Remove the rear top rail to provide screwdriver access, and glue and screw the arm to the tabletop.

Finally, cut and install the base pads, attach the switch and receptacle, and run the 16/3 cable (Photo 18). **PM**

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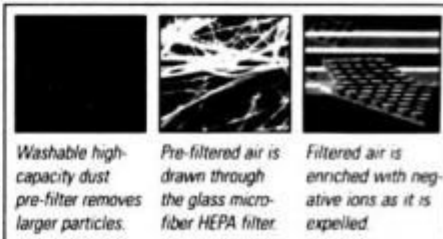
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Homeowners Clinic

BY NORMAN BECKER, P.E.,
 Contributing Editor
 PM Illustrations by
 George Retseck

Chimney Flashing

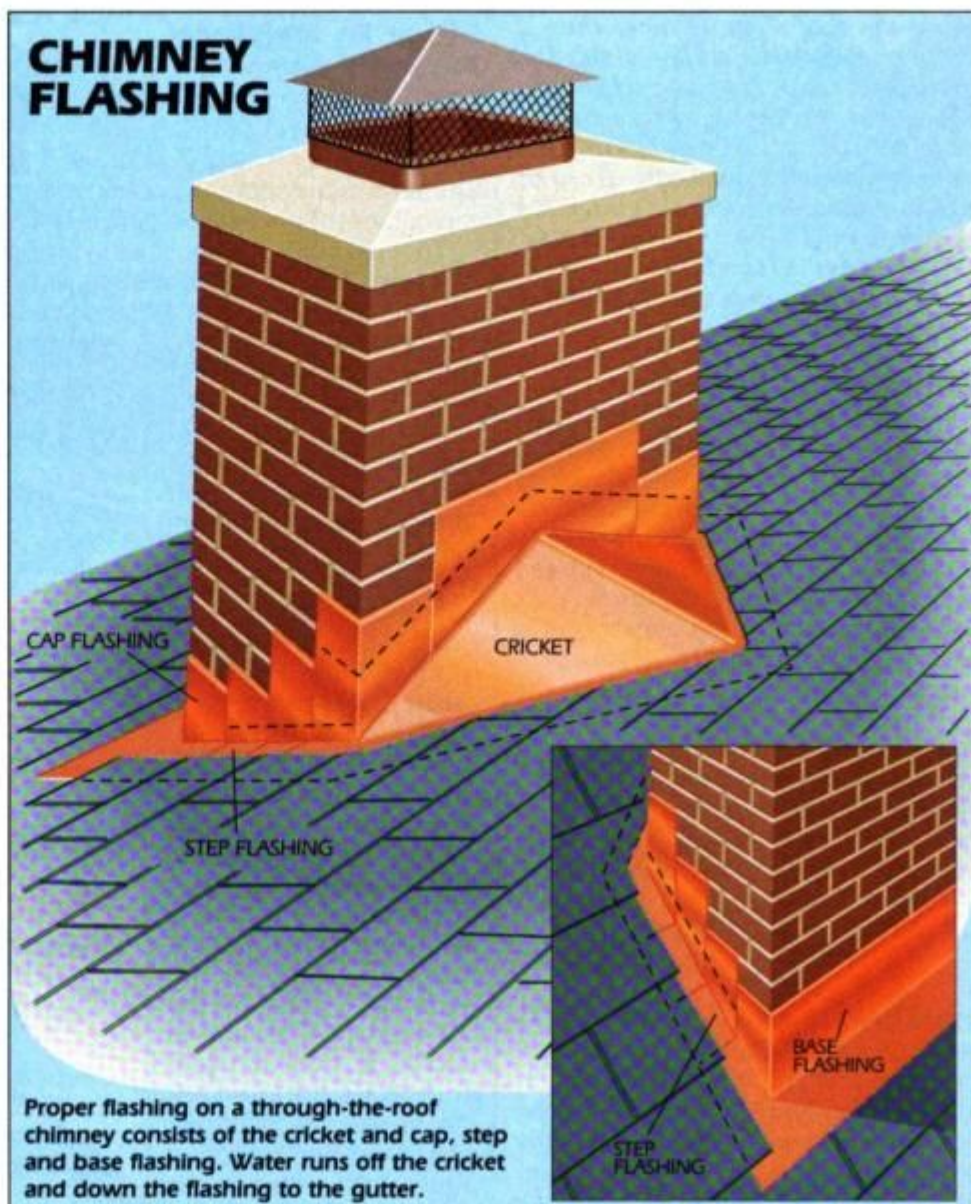
I'm writing in regard to a persistent water leak around my fireplace. All four sides of the fireplace chimney extend through the sloped roof. The chimney flashing has recently been replaced, but rainwater still leaks down the outside of the bricks inside the house. This occurs only after a steady or heavy rain. I'm not sure how the water is making its way inside the house and down the face of the fireplace. I would appreciate any help you can offer.

BRUCE D. SNYDER
 NICEVILLE, FL

The leak is probably due to inadequate or faulty flashing between the chimney and the roof. Chimney flashing serves two functions: It seals the joint between the chimney and the roof to protect against rain or melting snow, and it accommodates any movement between the masonry and the roof.

Chimney flashing has four components. First is the base flashing on the lower face that covers the front and wraps around the chimney sides. Then comes the step flashing, which is nailed to the roof deck and bent up along the side of the chimney. This is followed by the cricket behind the chimney. Last is the cap flashing set into the chimney mortar joints and bent over the step flashing and the sides of the base flashing. Water runs off the cricket (and off the cap flashing) down the roof, and over the step and base flashing.

Check the flashing



Proper flashing on a through-the-roof chimney consists of the cricket and cap, step and base flashing. Water runs off the cricket and down the flashing to the gutter.

at the chimney joints for the source of the leak. The flashing may not be installed properly or it may be only partially installed. I have seen a number of chimneys without cap flashing, a somewhat common occurrence in reroofing jobs. In this case, asphalt cement is used to seal the joint between the step flashing and the chimney, but this frequently results in roof leaks, because water is able to penetrate at the point where

the flashing meets the chimney.

If this is the case with your chimney, you can correct it by removing mortar and setting cap flashing into the joints. Then, tuck point mortar back into the joint and bend down the cap flashing. This is hard and skilled work, and in most cases it's best done by an experienced mason.

Water can also leak in if the chimney was installed without a cricket. Whenever the width of a chimney



Pruning Advice

● Pruning is one of the least glamorous and most frequently overlooked aspects of gardening. That's why we were glad to see this free brochure from Ames, a garden tool manufacturer. Authored by Joe Freeman, chief horticulturist for Cypress Gardens, a botanical theme park in Florida,

the 4-page brochure is a thorough look at this important skill. It unfolds to tell you about basic pruning for trees, shrubs and hedges. On the same side, you learn how to cut with a pair of hand pruners, where to cut in relation to buds and how to remove heavy limbs and pinch off light growth. The other side explains how to prune just about any plant through all four seasons and what tools to use. For a copy of this brochure, send a business-size self-addressed envelope with a 32-cent stamp to: Ames Lawn & Garden Tools, P.O. Box 1774, Parkersburg, WV 26101.

—Roy Berendsohn

along the roof slope is more than 2 ft., a cricket (also called a saddle) should join the roof and chimney. The cricket prevents debris or snow and ice from piling up behind the chimney, which would cause rain or melting snow to back up under the shingles and leak into the house. The cricket also deflects water around the chimney and then down the roof to the gutters.

Oil Burner Location

I have steam heat in my home, and when the boiler was converted from coal to oil, the burner was placed at the bottom of the boiler and fired directly into the firebox. However, a service technician later determined that this setup wore out the firebox and said it would be more energy efficient to fill the box with pellets and relocate the burner to the middle of the boiler. The system now produces steam in half the time it took before, but I am concerned about this new arrangement. The burner fires directly on the cast-iron water jacket as opposed to the firebox. Will this reduce the life of the boiler?

PAUL J. GIORGIO
PROVIDENCE, RI

There are two good reasons why the oil burner should not fire on the cast-iron jacket: First, it results in incomplete combustion. To burn completely, oil must be burned so that the tiny particles vaporize. The large amount of water in the jacket absorbs the flame's heat. This reduction in flame temperature results in dirty and inefficient combustion and the formation of soot (unburned carbon). Second, the flame brushing against the cool metal sides of the jacket results in uneven heating of the metal surface. This induces stresses and strains that shorten boiler life.

You should be able to correct the problem by adjusting the tilt of the burner so it fires away from the jacket or by changing the burner nozzle.

How To Replace A Door Gasket

A refrigerator door that has a worn-out gasket leaks cool air, which wastes energy and can cause condensation to form on the cabinet. This excess moisture can lead to unsightly mildew and rust.

To replace the gasket, unplug the appliance and place its contents into coolers. Next, to ease its installation, soften the new gasket by soaking it in warm water. Pull up the old gasket and use a nut driver or screwdriver to loosen—but not remove—the screws that hold the retainer strip. Pull out the gasket.

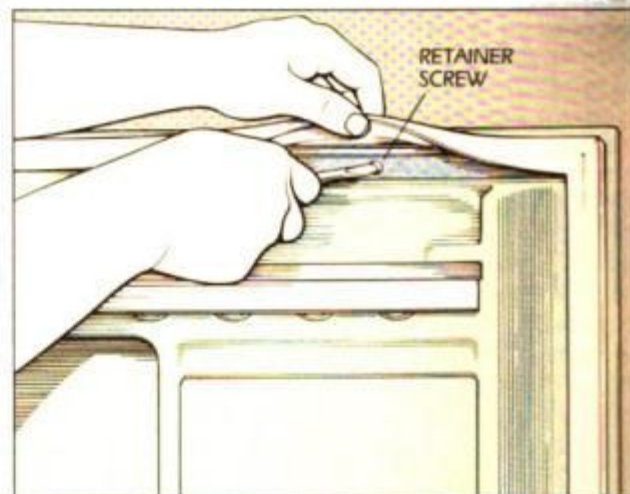
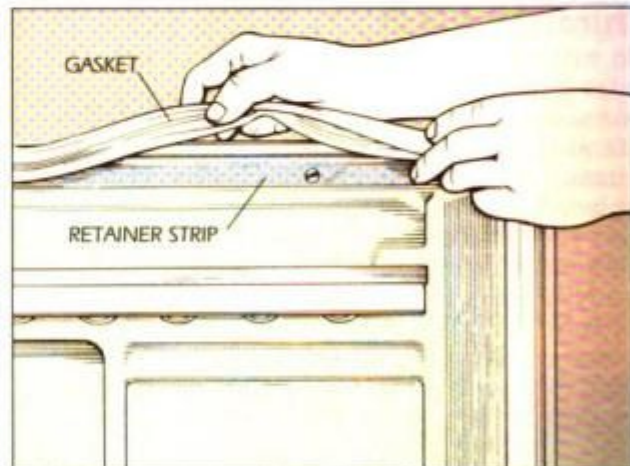
Dry the new gasket and place it over the top corners of the door. Start at the top of the door in either corner, and gently press the lip on the gasket's back edge behind the rolled edge of the retainer strip. Work the gasket behind the strip along the top of the door, then fold back the gasket near the door's center to tighten the retainer screws. Do not overtighten these screws—that could crack the plastic inner door panel. Repeat this procedure on the door sides, then on the bottom. Once the gasket is in place, close the door and check to see that the gasket fits squarely and is properly aligned against the refrigerator cabinet front.

If it tests okay, tighten the remaining screws.

—Steve Toth



APPLIANCE CARE TIP



Lead Paint Info

I read with great interest your response to a letter concerning lead-based paint contamination. Is there a federal office that can provide me with more information on this topic?

WENDELL S. STOLZ
HUNTSVILLE, TX

The National Lead Information Center has two toll-free hotlines that can assist you. The center is funded by the federal Environmental Protection Agency.

Call (800) 532-3394 to request a general information packet that explains how to prevent lead poisoning. It also includes a list of state and local agencies that can provide additional help. If you have a specific question, call (800) 424-5323 and speak with an information specialist. This hotline is staffed between 8:30 am and 5 pm Eastern time on weekdays.

PM

BUZZWORD

Inshot Burner

● Inshot burners have become the dominant burner in residential gas furnaces, according to the American Gas Association. The burners have a single port, and fire into a pipelike heat exchanger. They differ markedly from older designs that had multiple burner ports with 2-part heat exchangers, known as clamshells.

Inshot burners have resulted in smaller furnace cabinets, a handy feature when remodeling a basement. Also, they allow horizontally and vertically configured appliances with the same type of burner. This makes for easier and more reliable service, because gas-appliance companies need to stock fewer parts.

—R.B.

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.

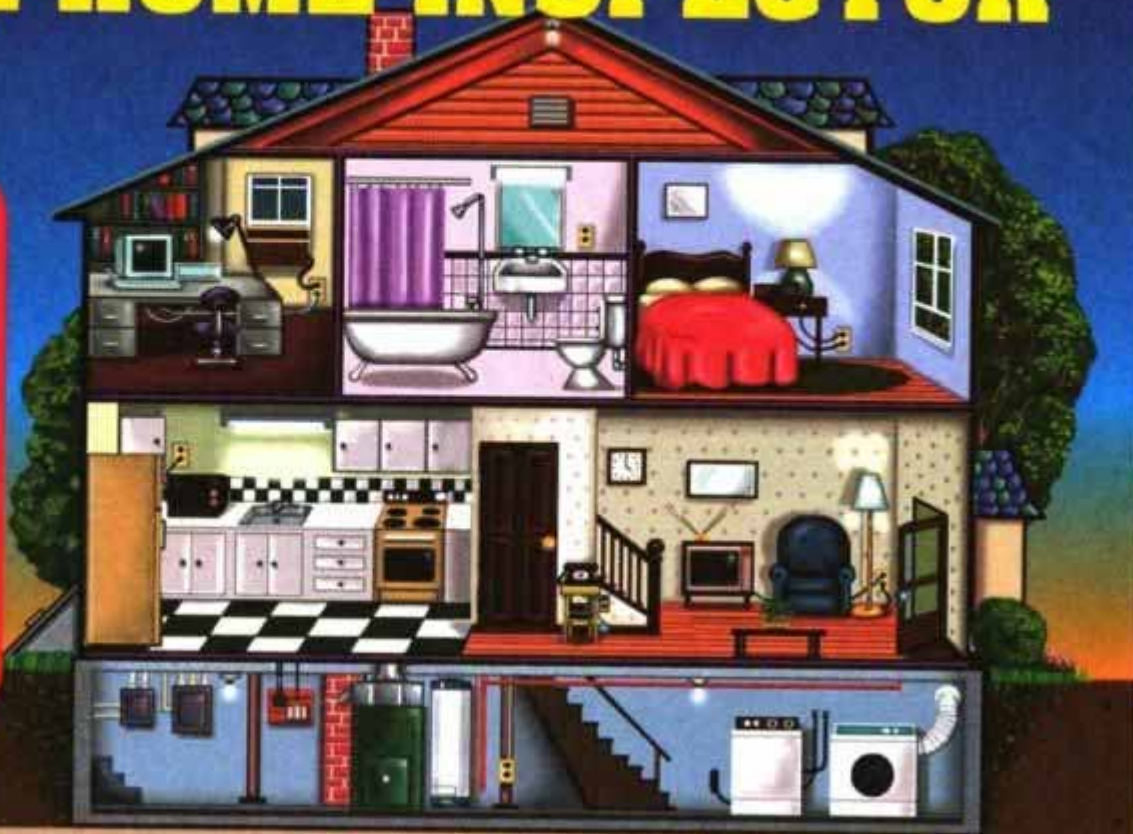
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If you've outgrown your chipper/shredder and are shopping for a bigger machine, the Murray Ultra is worth considering. It comes in two versions: 8 horsepower and 10 horsepower. The machine doesn't force material through a screen in the cutting process. Instead, material enters the shredder compartment and is pulverized by a rotor assembly with 12 replaceable flails, a reversible shredder blade and 16 stationary knives welded to the wall of the chamber. Another good feature on the Murray Ultra is the hopper—it rotates to ground level. The 8-horsepower model costs about \$600, and the 10-horsepower model about \$700. Both versions of this chipper/shredder are available at home centers and hardware stores. For more information, write Murray, 219 Franklin Rd., Brentwood, TN 37027, or call (800) 251-8007.



Think Ahead

Picture this: It's spring and you're wondering whether you should get an electric mower. By early next season, Toro will have three machines for your review: 36-volt and 24-volt cordless models and a 12-amp 120-volt corded product. Each has an 18-in.-dia. plastic deck lined with 20-ga. steel. The cordless mowers recharge overnight with an on-board system that monitors the process and alerts you if a charging problem exists, the company says. All have 2-point height adjustment and a full-width bail across the handle. The 36-volt cordless model runs 1½ hours and costs about \$470. The 24-volt version has a 1-hour run time and costs about \$370. The corded mower costs about \$270. They are sold at Toro dealers. For more information, write Toro, 8111 Lyndale Ave. S., Bloomington, MN 55420.



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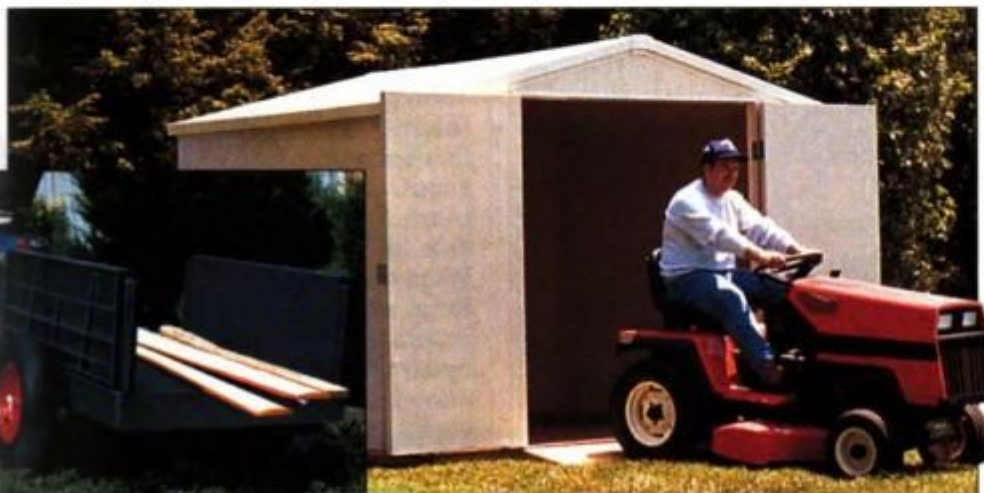
A Day At The Drive In

Solve your winter storage problems with a day's work—that's all the time it takes to set up this plastic storage shed. Build the base out of pressure-treated lumber (4 hours, let's say), and then erect the shed, which is designed to be put together in about 4 hours as well. The shed costs about \$1300 at home centers, and comes in a package that can be moved in a pickup truck or van. Its base measures 8 ft. wide and 10 ft. long, and the completed shed is about 7 ft. high at the ridge. It assembles with slide-lock panels and threaded fasteners. Contact Royal Rubbermaid Structures Ltd., 1147 Akron Rd., Wooster, OH 44691, or call (800) 949-7410. The plastic tractor cart (inset) costs about \$180 at home centers, hardware stores and farm supply stores. It has removable side and end panels, reinforced ribbing, a solid-steel axle with pneumatic tires and a 400-pound payload capacity. Contact Rubbermaid Commercial Products, 3124 Valley Ave., Winchester, VA 22601, or call (800) 964-1336.



Snow Stormin'

You can turn your Honda Harmony lawn tractor into an all-season machine with the addition of this 40-in.-wide 2-stage snowthrower. Powered by the tractor's 13-hp overhead-valve engine and a drive system designed with maximum belt contact at the pulleys, it can move up to 73 tons of snow per hour, and throws it up to 26 ft., according to Honda. Another heavy-duty feature: The chain drive that powers the auger and impeller is nickel plated to reduce susceptibility to corrosion. The snowthrower costs about \$900 at Honda dealers. For more information, write Honda, 4474 River Green Pkwy., Duluth, GA 30136.



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If you spend more time fiddling than cutting with your chain saw, consider the Stihl 023C. The saw has a unique chain-adjustment fea-

ture that works like this: Flip up the circular adjustment lever on the side of the saw body (arrow) and turn it counterclockwise, then tighten or loosen the chain by turning a small thumbwheel located above the lever. To make the saw easier to start, Stihl added an elastic shock absorber to the starter grip, a primer bulb and a compression release valve. It has a 14-in.-long guide bar and a 40-cc engine. It costs about \$400 at Stihl dealers. Write Stihl Inc., P.O. Box 2015, Virginia Beach, VA 23452, or call (800) 486-9100.

Expansion Team

Ryobi has expanded the functionality of its TrimmerPlus so it can handle fall and winter work. Specifically, the company has added accessories for tree-pruning and snowthrowing.

The machine consists of a corded electric or a 2-cycle or 4-cycle powerhead and boom to which you can add a variety of attachments. The 2-piece tree-pruning attachment shown below (about \$65) has a reciprocating saw blade for up to 4-in.-dia. limbs. With the 2-ft.-long extension in place, it can reach up to 15 ft. And for winter, the snowthrower attachment (above) works in snow up to 5 in. deep, cuts a 12-in.-wide path and has a 20-ft. throwing distance, the company says. The throwing direction can be adjusted by sliding the knob on its front. Both products are sold at hardware stores and home centers. For more information, write Customer Service, Ryobi, 5201 Pearman Dairy Rd., P.O. Box 1207, Anderson, SC 29622, or call (800) 525-2579.

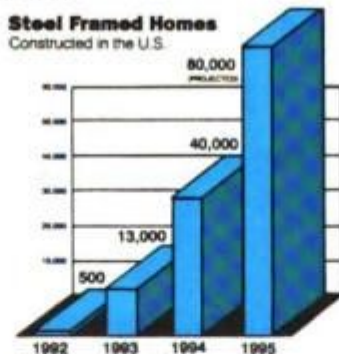


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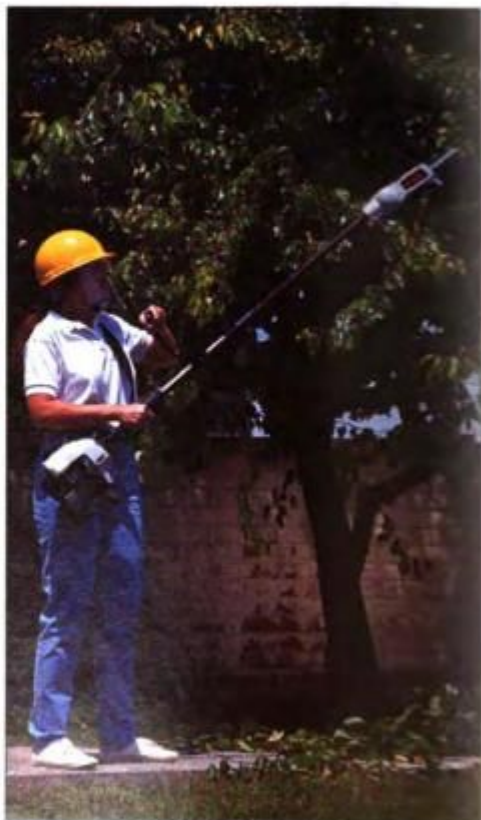
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Oct. 12 Las Vegas, NV
Oct. 18 Denton, TX

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Logger Rhythm

If the sound of a splitting log is music to your ears, consider the Clarke Log Buster. Rest a log on its cradle (a welded assembly that conceals the oil reservoir) and pull the handle to activate the ram. If the ram bogs down, ease up on the handle, let engine speed build, then pull on the handle to finish the job. After the split, release the handle, and an internal spring reels in the hydraulic piston. The design eliminates the need for control valves—oil flows back into the reservoir after the split is complete. And if the wedge encounters something immovable inside the log, the engine stalls, acting as a safety relief valve in the process. The splitter is powered by a 3.75-hp engine and produces the 20 tons of pressure typical of large splitters. Its other high-quality features include a wedge fitted into and welded to the cradle and a 3/4-in.-thick ram plate. It costs \$600 to \$700 at home centers and outdoor power tool dealers. Contact Clarke Power Products Inc., 500 Lehman Ave., Bowling Green, OH 43402, or call (800) 227-9603.



Start Cold

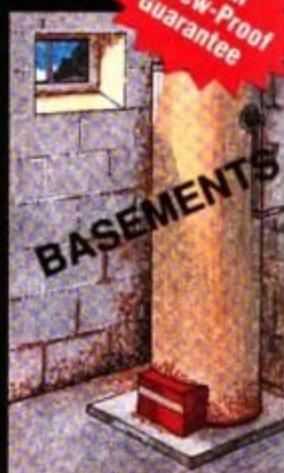
Husqvarna equipped its new snowthrower with the Tecumseh Snow King engine, a side-valve powerplant that's so popular it's been produced for decades. Consider this: Fuel runs by gravity to a float-bowl carburetor. It's the simplest way to provide maximum fuel to the carburetor venturi, says Tecumseh. Further, three things help it start in cold weather, says the



company: a primer bulb to squirt fuel directly into the combustion chamber, a manual choke to ensure a fuel-rich mix and a capacitor-discharge ignition that provides a hot spark at low engine speed. For increased durability, its compression release mechanism runs in an oil bath. The snowthrower comes in 6-hp and 9-hp versions. The former clears a 23-in.-wide path, the latter a 26-in.-wide path. Both have a ball-bearing-supported auger, a cast-aluminum axle and a fully enclosed transmission with cut-steel gears. The 6-hp model costs about \$1215, and the 9-hp version about \$1540, at Husqvarna dealers. For more information, write Husqvarna, 9006-J Perimeter Woods Dr. (PR), Charlotte, NC 28216, or call (800) 487-5962.

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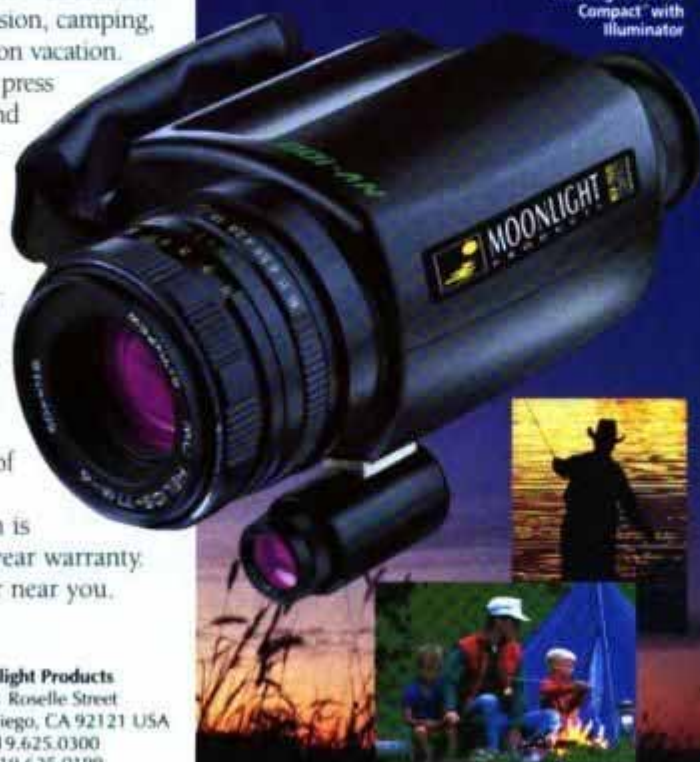
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The Mantis hedge trimmer is powered by a 300-watt motor and a helical gear-drive system, which ensures that four teeth of each gear are engaged at any point during the cut. According to the manufacturer, the result is maximum transfer of torque from the motor to the blades. The trimmer has blades that are made from hand-flattened high-carbon steel. The handle and switch are designed so that the trimmer can accommodate both right- and lefthanded users. The tool costs \$196 at Mantis dealers or from Mantis, 1028 Street Rd., Southampton, PA 18966, or call (800) 366-6268.

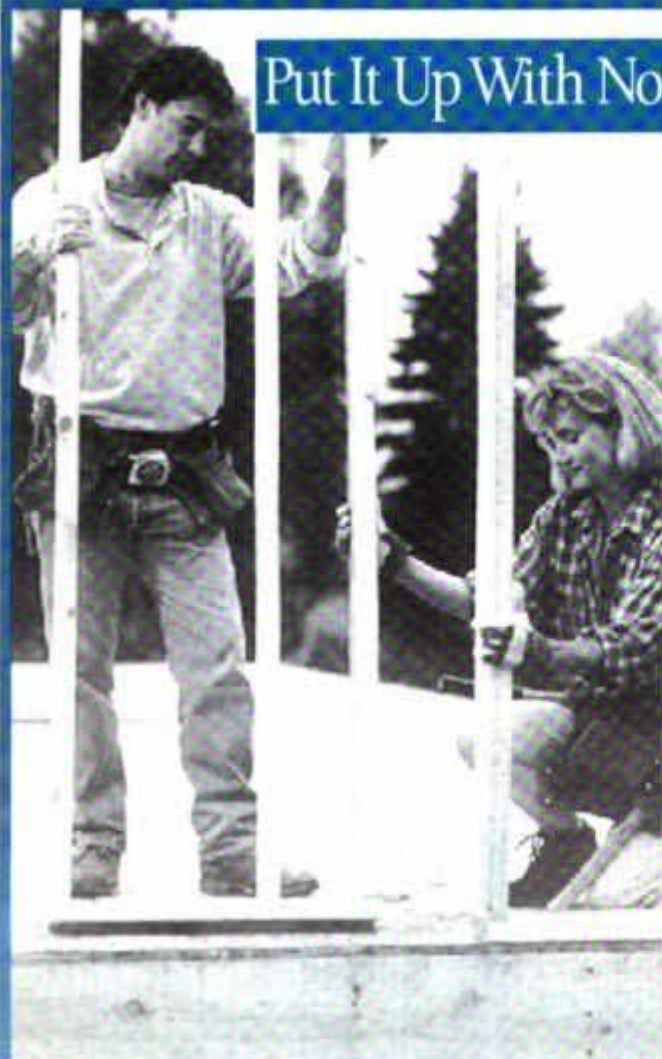


Lighten The Load

Clearing snow is tough work that often takes place at the beginning or end of the day—when you're tired. Ariens lightens the load with an optional 120-volt starter for its new snowthrower, the SS322. This 22-in. 3-hp single-stage machine is also offered in a 5-hp version, as the SS522. The starter is simple: One end of its cord goes into the machine and the other end goes to an outlet. Press the starter, remove the cord and you're off. The machine's gas cap and starter grip are oversize, making them easy to handle, even with gloves on. The 3-hp model costs about \$480, the 5-hp model about \$600, at Ariens dealers. The electric-start option is about \$100. Contact Ariens, 655 W. Ryan St., Brillion, WI 54110, or call (800) 678-5443. **PM**



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A BRUTAL MONTH

July proves to be tough for the Western Auto/PM race team.

BY AL PEARCE



Unfortunately for the Western Auto/PM team, Waltrip's No. 17 Monte Carlo spent much of July in the pits rather than on the racetrack.

● Poets have called April the cruelest month. But Darrell Waltrip and his Western Auto/POPULAR MECHANICS stock-car team will argue that one, since no month this season has been as cruel as July.

During the midsummer heat wave, the Charlotte, North Carolina-based team qualified ninth, 32nd, 12th and eighth in July's four races. Worse,

Waltrip and team PM finished 34th, 17th, 36th and 43rd. Waltrip dropped from 18th to 21st in the series standings and completed just 518 of the 848 possible laps.

Through it all, Darrell Waltrip, a 3-time series champion and 84-time feature winner, remained upbeat. "We're sitting here ready to win a race or two, maybe more than that,"

he said. "The cars are outstanding and the engines are great. The only thing we need now is a little good luck."

The Pepsi 400

The Daytona International Speedway in Daytona Beach, Florida, was the scene of Waltrip's greatest triumph: the 1989 Daytona 500. It was also the site of two of his worst accidents: a July '90 crash that cost him six races, and a spectacular flip entering Turn 3 two years later that destroyed one of his favorite cars. Even so, the famous 2.5-mile racetrack remains one of his favorite venues.

Waltrip qualified ninth on the 43-car grid and gained several spots in the early laps. But it soon became evident that his Monte Carlo's chassis wasn't as secure as it needed to be. "It got real loose and nothing we did during pitstops made it right," he said afterward. "It's the same car we had here in February [when it was a contender to win the Daytona 500], but it sure didn't handle like it."

Waltrip lost two laps to the leaders

(Please turn to page 108)



When the car was running right, Waltrip could race, such as here going around the Quaker State Ford Thunderbird at Pocono, in Long Pond, Pennsylvania.

PHOTOGRAPHS BY DON CARSON

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and finished 34th, well behind winner Jeff Gordon, runner-up Sterling Marlin, third-place Dale Earnhardt and the 16 other drivers who finished the race on the lead lap.

Slick 50 300

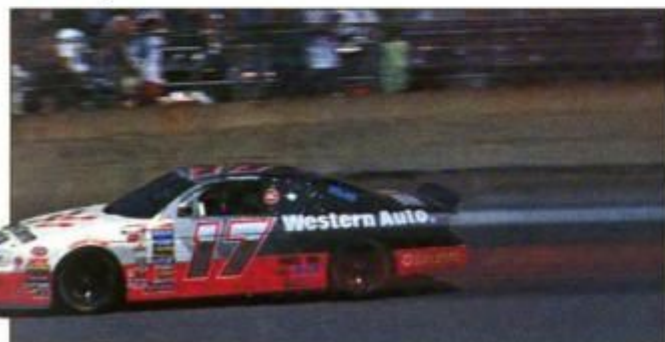
NASCAR's newest venue is also one of its finest. The New Hampshire International Speedway, in Loudon, also is one of only five current tracks where Waltrip hasn't won.

Always good on low-banked race-tracks that require guile and finesse, Waltrip expected the Western Auto/PM team to be a serious contender in the Slick 50 300. But after starting 32nd and finishing 17th, two laps behind winner Jeff Gordon, he was perplexed because the Chevy still wasn't handling as it should have been.

"This is the same basic car we raced here and at Indianapolis last year," Waltrip said, "but it hasn't been quite the same since we switched to the Monte Carlo body from a Lumina. It was good going into the corners here, it was good coming off and it was fast down the straightaways. But we just weren't able to get it to turn in the middle of the corners. That forced me to 'diamond' the corners, and that's not the fast way around here. Still, 17th is better than we have been doing."



Chevrolet versus Ford: Waltrip running with the RCA and the Smokin' Joe Camel Ford Thunderbirds.



For much of July, the Western Auto/PM No. 17 Monte Carlo was trying to make up time after pitting for adjustments.

Miller Genuine Draft 500

Some engine-related problems sidelined the Western Auto/PM team at Pennsylvania's 2.5-mile Pocono International Speedway for the second time this year.

Waltrip started 12th in the Western Auto/PM Chevy Monte Carlo, moved smartly into the top 10 in the early

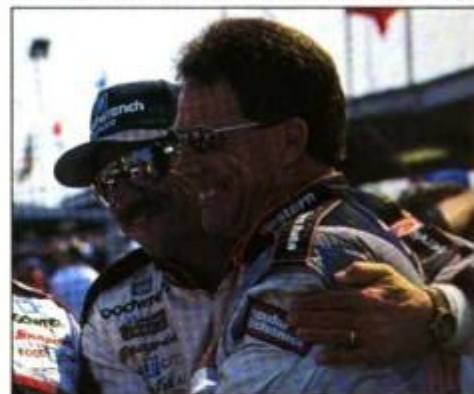
laps, then began backsliding as the race wore on. His crew made several major chassis adjustments during an early caution, which helped the No. 17 car return to ninth at the halfway point.

But a broken rocker arm sidelined Waltrip after 156 of the 200 laps. At the time, he was getting better fuel economy than almost everyone else after the final round of pitstops, and was looking at a top-5 finish. While Waltrip's race ended in the pits at 36th, Dale Jarrett snapped out of his season-long slump to beat Jeff Gordon and Ricky Rudd.

DieHard 500

A tough season got even tougher when the tour returned to Talladega, Alabama, for the DieHard 500. After finishing fourth in the spring race at Talladega Superspeedway, the Western Auto/PM team expected another strong run.

Waltrip moved from eighth on the grid to third in the early laps, drafting



Veteran champs Earnhardt and Waltrip wish each other luck at the Pepsi 400.

behind Dale Earnhardt to move up. But the near-100° F heat and high humidity took its toll, and Waltrip's engine began overheating. Finally, it gave up altogether with a burned piston, leaving Waltrip a dead-last 43rd after finishing just 45 of 188 laps.

"We have a great race team and we'll be back," Waltrip said, as fellow Chevy driver Sterling Marlin held off Dale Jarrett and Earnhardt for the victory. "Right now, we're just having some rotten luck. We're doing everything we know of to get better." **PM**

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wise, the division is still basking in the ever-growing glow of the Aurora, and Olds is busy building cars that compete with the imports.

After the flagship Aurora for this year comes the LSS, an upgraded and more powerful version of the Eighty Eight. (See our First Drive report back on page 57.)

For 1996, Oldsmobile continues to get its model lineup prepared. Achieva has a new instrument panel that looks like a baby brother to the Aurora design, with instruments and controls grouped for driver convenience. Under the IP brow is a passenger airbag. Base engine in the Achieva is the new dohc 2.4-liter Four that produces 150 hp, gobs of grunt at the low end and noticeably less noise and vibration than the motor it replaces. Still less noise and more power is available from the optional 155-hp 3.1-liter V6.

Eighty Eight and Ninety Eight models are slightly changed for 1996. Both cars offer sprightly performance from the 205 horsepower of their 3.8-liter V6 engines. Exterior styling changes in the Eighty Eight present a "purified" appearance. (That's Oldsmobile's word, not ours.)

The '96 Aurora gets some minor tweaks, including a slight softening of its ride and a flatter rear window to help eliminate distortion.

Oldsmobile finally has its version of GM's redone compact sport/utility, the Bravada, due at dealerships by the first of the year. Like the Blazer and Jimmy, the Bravada has all-new styling, more interior room and a 190-hp 4.3-liter V6 engine. Though similar to the others, the Bravada offers exclusive interior trim, seats and wood accents in the instrument panel.

Pontiac

Having launched the hot Sunfire last year, Pontiac's big news is much the same as the other General Motors divisions with which it shares platforms and drivetrains.

The Grand Am, like the Achieva and Skylark, has a new look and gets pulled around by the newly refined 150-hp dohc 2.4-liter 4-cylinder engine. The Bonneville benefits from Magnasteer and more power in both of its V6 engines. The Grand Prix, like other cars that have the dohc 3.4-liter V6, gets to spin its tires more readily, compliments of 215 hp at 5200 rpm and 215 ft.-lb. of torque at 4000 rpm.

Of course, if you want to really spin tires, get yourself a Firebird. Available for '96 with the WS6 Ram Air package, the Firebird launches at 305 hp—more than enough to smoke its P275/40ZR17 tires. See our First Drive report on page 57 to find out just how well it launches. **PM**

CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

Cutting Edge

Is there some way to change the strut inserts in my car without removing the strut altogether? I'd be happy to remove it, but that means opening a brake line—and the bleeder bolt is broken on one caliper. The brake line goes through a bracket welded onto the strut. I'm postponing that job for a month or two, because I'm going to do a complete brake job then anyway.

JOHN DINWIDDE
TUSCALOOSA, AL

Remove the clip or nut that secures the brake line to the bracket, and loosen up the line's fitting where it passes through the hole. Take your hacksaw and simply cut a kerf through the bracket. Carefully bend the bracket enough to sneak the brake line out. Remove the strut, and replace the insert. On re-assembly, simply replace the line, bend the bracket back into shape and reinstall the nut or clip. If you're really anal-retentive, you can wrap the line in a wet towel and have the clip tack-welded together.

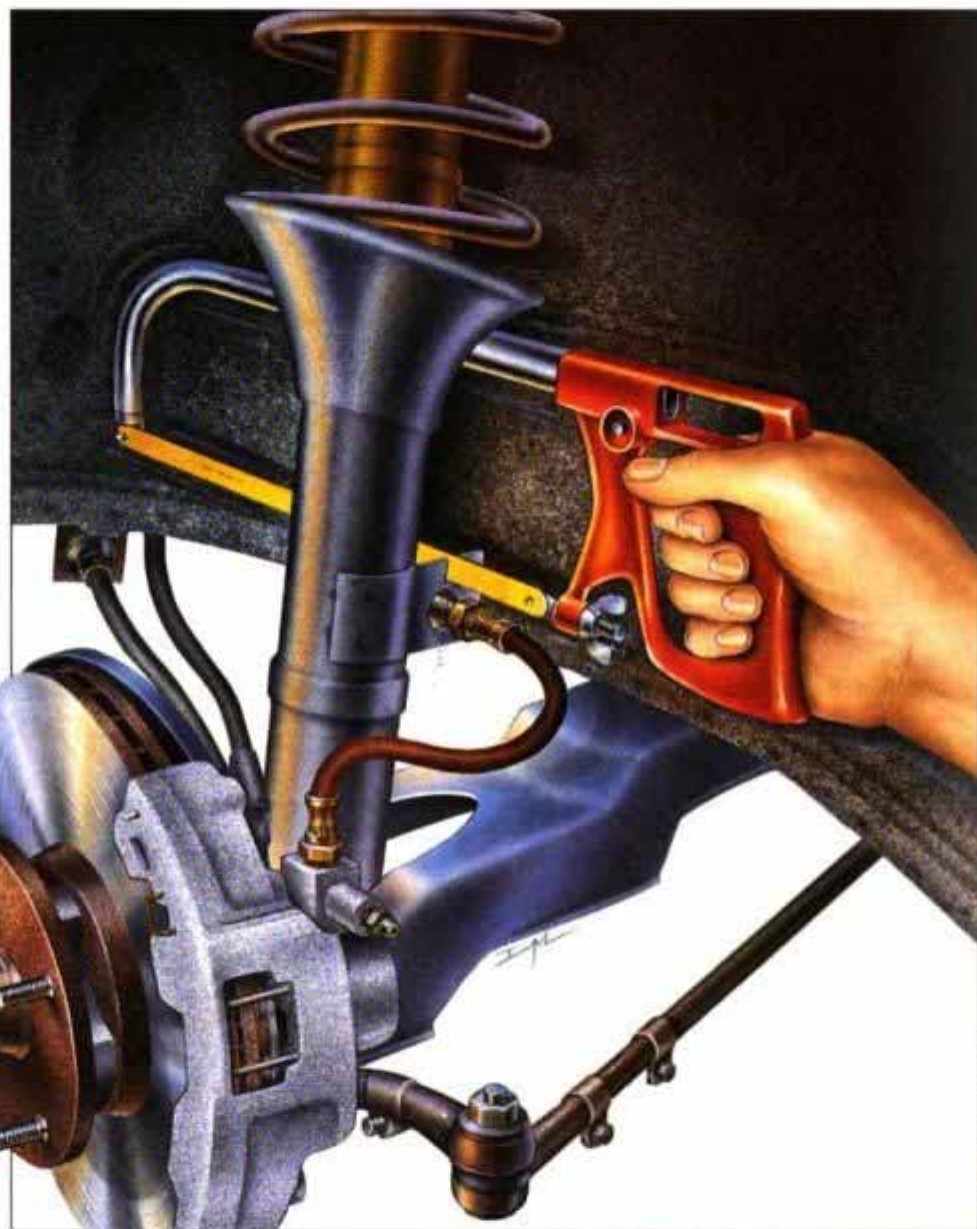
Goodbye, Mickey

My wife turned on the air conditioner in our Toyota yesterday and immediately heard a loud grinding, banging noise coming from under the dashboard. I pulled out the fan blower assembly and found a recently deceased mouse in the blower case.

How did it get in there? We always keep the windows rolled up when the car is parked. My wife is scared that another mouse will get in.

JOHN CONLON
NEW HAVEN, CT

Mice can get into any orifice just big enough to admit their skull—which means even a pretty small hole invites trouble. Rodents can be incredibly destructive to car interiors, chewing their way into all sorts of places. They're looking for some-



where to nest, materials for the nest and food. They will also chew on things just to wear down their constantly growing teeth. Feel good that you found your mouse before he set up house.

Where did he get in? Probably through the cowl vent area, since you surprised him inside the blower. To prevent more unwelcome visitors, put some plastic window screen between the cowl vent and the blower box. And in case Mickey's family is hiding somewhere else in your car, set some traps. Don't use poison, unless you like the smell of dead mouse on warm days.

Oil's Not Well

My Dodge dealer uses nothing but 30-weight oil in my minivan, and I have it changed every 3000 miles. Will the straight-grade oil damage my engine if I leave it in as I drive north this winter? Also, is there any harm in changing from straight-grade to multiviscosity oil? CLARENCE HUSTED
ELLENTON, FL

Multiviscosity oil is an industry standard, because it provides the lubrication your engine needs at startup and at low temperatures without becoming unacceptably thin at high temps. While straight-grade oil is technically acceptable to meet

CAR CARE

Chrysler's warranty requirements, it's not the best. Your dealer may well be the only one left in the country still using nonmultiviscosity oil. Maybe he bought a huge amount of it awhile back and needs to use it up. Maybe he remembers when MV oils first came on the market 30 years ago and weren't very good.

Switch to a 10W-30 oil at your next oil change. Bring your own oil to the dealer, and watch while the mechanic pours it in. Or have your oil changed somewhere else.

Clutching At Straws

I have two vehicles with hydraulic clutches. My 1984 Fiero requires pushing the pedal very firmly to the floor to change gears, while my '87 GMC S-15 pickup engages the clutch very near the top of the pedal travel. We used to be able to adjust mechanical clutches easily—is there any way to adjust these hydraulic ones?

RUSS APRE
VIA INTERNET

Start by bleeding the clutch in exactly the same fashion as bleeding your brakes. Top off the reservoir with brake fluid, and have a helper stand

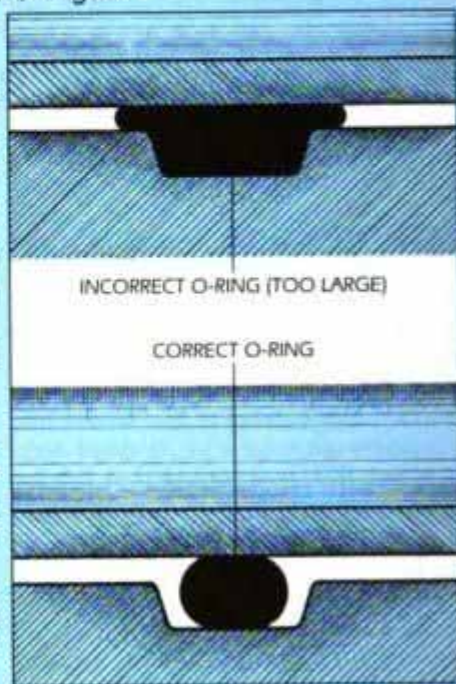
Ring My Chimes

● I took apart an engine the other day, one that someone had tried mightily to keep the oil inside of for more than a year. Obviously with little success, as the entire bottom of the vehicle was coated with oil. The leak came from an O-ringed access plug set into the bottom of the aluminum-alloy engine block.

First evidence of the leak was three different kinds of gasket sealer smeared everywhere. Rule: O-rings are meant to seal without the benefit of any other type of sealer. They rely on the seal created as the O-ring squishes between the surfaces. And because of the inevitable contraction and expansion of metal with the heat, gummy sealers will prevent the O-ring from rolling slightly with the change.

The next culprit was too thick an O-ring, installed in a misguided attempt to close the gap. Seals that are too thick will eventually cut themselves on the corners of the sealing groove—and leak.

I cleaned up all of the sealer, carefully polished the sealing surfaces and lightly oiled the correct O-ring so it would seat properly, and all is well.



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CAR CARE

on the clutch. Loosen the bleeder bolt at the slave cylinder until the flow stops. Then tighten the bleeder, ask your helper to lift his foot slowly and start again. Don't let the reservoir run dry, or you'll have to start over. Do this until the fluid runs clear. If you get any air, that's probably the source of the problem in your Fiero. It's a good idea to flush the system this way every year or two anyway.

The pedal has a self-adjusting mechanism at the linkage to the master cylinder. Try lifting up the pedal with your foot a few times—this should adjust the linkage. You may need to check the service manual for the correct procedures for servicing the adjuster if this doesn't help. If it does, just remember to lift up the clutch pedal every couple of weeks.

An Arresting Development

My '93 Chevy Blazer (15,000 miles) just needed a brake job, specifically new front pads. I was shocked, as I don't abuse the brakes at all. This truck is used for occasional commuting, about 30 miles on a freeway, and errand-running on weekends.

The service manager at my local dealership says this is normal.

MARK HILGENBRINK
CHICAGO, IL

You're doing most of your driving on short urban trips—which is the hardest on brake-pad life. Modern vehicles have low rolling-resistance tires, better aerodynamics and tall gearing, all to improve your fuel economy—at the expense of using more brake to slow down. Another factor is the removal of asbestos, a powerful carcinogen, from brake-pad materials in favor of safer but more rapidly wearing substitutes. Car manufacturers also are very sensitive to the cosmetic issue of squealing brakes, and sometimes specify pad materials that are quiet at the expense of longevity.

Bottom line: shorter pad life. The only suggestion I can make is to be sure you're not being sold a complete brake job when all you really need is just a set of pads. **PM**

DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

- Humidity causes squealing/grabbing rear brakes on some 1990-94 Ford Explorers and Rangers. Seal the backing plates and install updated shoes (PN F3TZ-2200-A).
- GM recommends degunking your cup-holder slide tracks with warm water and mild soap to restore free movement.
- The fuel-injector wires can get trapped when reinstalling the air cleaner on 1988-93 GM light trucks. Twist the wires once to remove the slack.
- Dodge/Plymouth Neons with tight window cranks may need new regulators. But first lube the slides, adjust the glass and cut the lower lip off the inner weatherstrip.
- A fresh taillight gasket, applied with sealant, on 1988-92 Mazda 626/MX-6 models should keep the lights from burning out. A new lens isn't necessary.
- There's a new engine computer available from Toyota for 1993 V6 Camrys that will improve hot-soak restarts and driveability on mild downhill grades.

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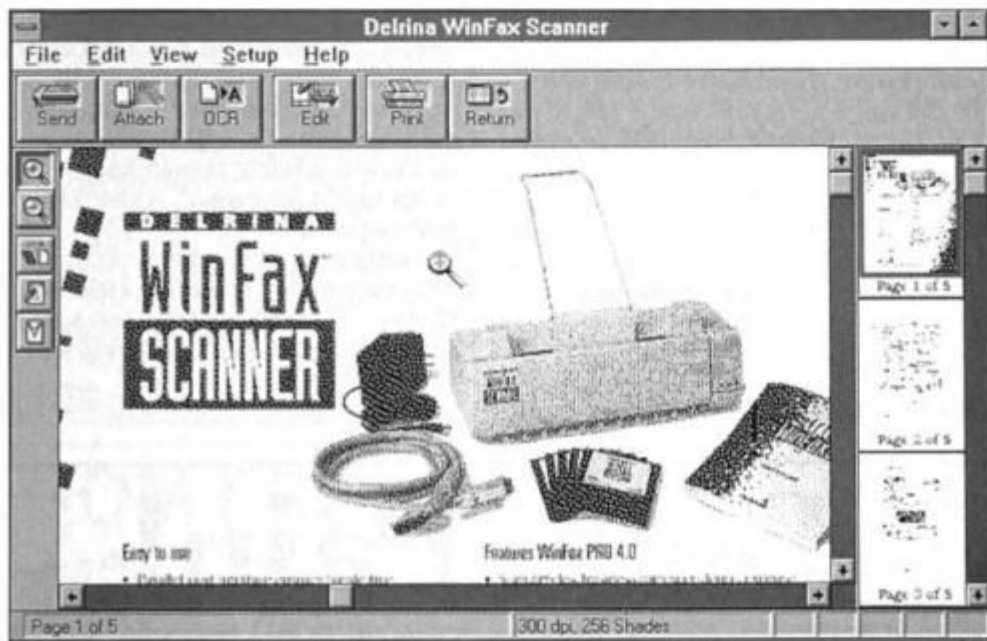
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Metal coil mattresses can create pressure points and provide uneven support.

SCANNING THE GLOBE

Scanners capture images and text for display on your computer. New models do even more.

BY STEPHEN A. BOOTH, Contributing Editor



● Remember how computers were going to create a paperless society? This will come as news to trees. The personal computer has proved prolific at churning out printed documents, and, for all its electronic storage, the PC hasn't put a dent in the filing-cabinet business.

But visionaries who saw the PC's magnetic memory as a repository for printed matter haven't given up yet. What's been needed is a cheap and easy way to feed documents to a PC.

Now the missing link is about to come home in the form of image scanners designed and priced for the mass market. What's more, these scanners promise to make the personal computer a truly multifunctional marvel—for example, a convenience photocopier, a fax machine, even an electronic darkroom for transferring the family snapshot album to magnetic diskettes, or a custom print shop

Delrina's WinFax scanner lets you feed paper documents to a PC for storage, faxing or making photocopies with your printer.

for your artsy newsletters or T-shirts.

Scanners are optoelectronic devices that read 2-dimensional images and convert them to computer files for storage or manipulation. The machines and their related PC software have been around for years, but high cost basically confined scanning

Plustek



Page Reader 800 is a compact, hand-fed single-sheet scanner.

to well-heeled publishing operations.

Handheld scanners first brought the technology to small businesses and home offices, but they were hard to use and mostly limited to black-and-white imaging. Now, you can buy desktop scanners that read full pages in B&W for \$200 to \$300, while color scanners have inched down from the \$1000 level to about \$600.

In computer jargon, a scanner is called an input device, as is a keyboard. Scanners come in different styles, with different operating systems and performance capabilities. Their common function, though, is to resolve graphics (text or pictures) from a flat surface (e.g., a sheet of paper or a photograph) into a data file that a PC can digest.

Once the physical 2D image becomes a string of digital code, computer software makes possible other tasks, such as editing documents or cropping, resizing and retouching images. The input may remain in PC storage—or be output in other forms. For example, the newspaper clipping of Junior's touchdown rush can become part of an electronic scrapbook. Or, you use your printer to make photocopies—or even incorporate the scanned story and photo into a family newsletter you'll print up and mail to the relatives. You might even fax the scan to a few dozen college football recruiters.

There are two types of scanners now coming to the home market: the sheet-fed scanner and the flatbed scanner.

Sheet-fed scanners are exclusively for black-and-white conversions—called "grayscale" in scanner lingo. Even if the original is in color, the output to the computer will be monochromatic. Flatbed scanners, however, come in color and grayscale versions.

Mechanically, sheet-fed scan-

(Please turn to page 117)

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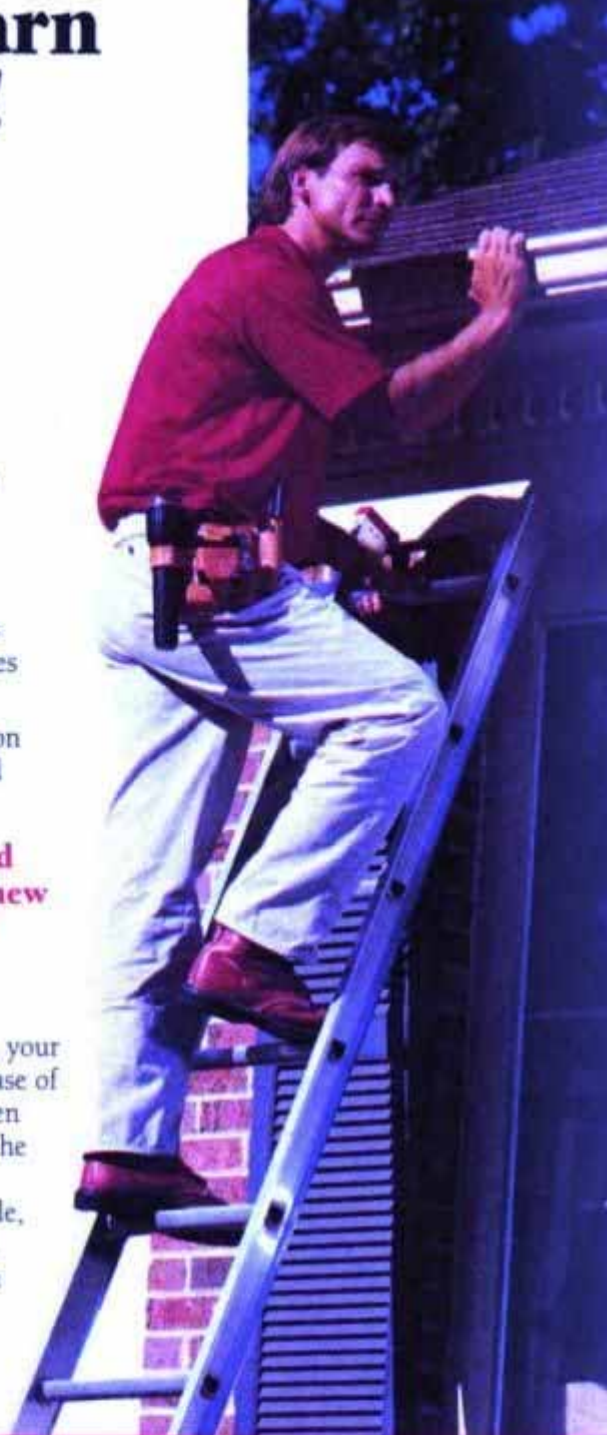
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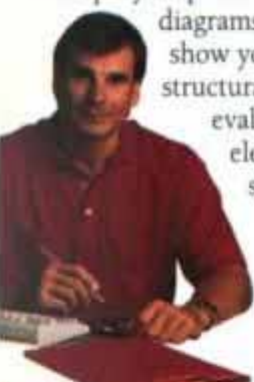
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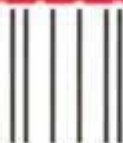
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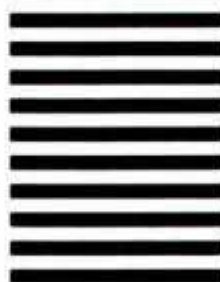
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You don't need a PC with Mustek's MFS-6000 MP. The flatbed color scanner is a fax and copier when linked to a phone and printer.

ners operate like the business end of a fax machine. Rollers transport the document past a light source and a row of image sensors. These compact machines, usually about 1 ft. wide \times 4 in. square, weigh only about 3 pounds. Some, such as Delrina's WinFax scanner (\$299) or Brother's ImageCenter 100 and 150 (\$200 and \$250), have an automatic document feeder (ADF) to send five to 20 pages through the scanner, one at a time. Others, such as the tiny Page Reader 800 (\$199) from Plustek, require you to feed each page by hand.

A flatbed scanner more closely resembles a photocopier machine. You place your document on a glass surface and close a lid to secure it. A stepper-type motor drives the light source and image sensor down the length of the document. The image sensor is a charge-coupled device (CCD), similar in operation to those used in video camcorders and a necessity for color pickup. Some grayscale sheet-fed scanners use CCDs (such as the Umax PageOffice, \$499), though most employ the contact-sensing LEDs (light-emitting diodes) found in most fax machines.

Sheet-fed or flatbed scanners will usually handle documents as small as a business card and as large as legal-size ($8\frac{1}{2} \times 14$ in.) stationery. Letter size ($8\frac{1}{2} \times 11$ in.) is the max for some flatbeds, such as Epson's ES-1000C (\$799) and Canon's IX-4025 (\$599), but they'll scan legal-size paper with the proper accessory. To scan transparency films (such as

35mm slides), you'll also need an optional adapter that costs about \$700.

Two scanner specifications you're certain to encounter are dpi (dots per inch) and ppm (pages per minute)—and they're somewhat related. Then there's TWAIN.

The term dpi refers to image resolution, or sharpness—in general, the more dots per linear inch, the better. Specs of 300 to 600 dpi are typical, and some scanners use sophisticated software to interpolate greater resolution—up to four times greater. Just keep in mind that your printer will be the limiting factor here: Whatever the resolution of the scan, a 720×720 -dpi printer can't make it any finer.

Actual scanning speed depends on the complexity of the document. Most scanners will state a rate of "up to [X]" pages per minute—the scanner's top speed. A photograph will take longer than a simple sheet of type. Some scanners "scan" at a fixed dpi, but others automatically adjust their pickup resolution to suit the subject matter—in other words, they don't waste time over-scanning a low-resolution original.

As for TWAIN (literally, Technology Without An Interesting Name), it's just an industry protocol that ensures your scans can be incorporated into other software applications, such as word processors, spreadsheets or graphics programs.

To make this easier, virtually every scanner sold today comes with software that lets you manipulate the input to the PC. You'll certainly get a so-called OCR (optical character recognition) program. This reads the scanned "picture" of print on a page—

still just a graphics file to your PC—and translates it into an alphanumeric text file so you can edit the document, change typefaces and whatnot.

Many sheet-fed scanners also come bundled with software that allows you to automatically transmit the scanned image as a fax, as well as to perform document-filing functions. Most PCs already have a modem built-in, but these can only send faxes generated within the PC. A scanner with faxing software (such as Delrina's WinFax 4.0) will process external documents just like a stand-alone fax.

With color scanners, you can expect to receive programming for such image manipulation functions as sizing and color adjustment. You could buy this software separately, but scanner manufacturers increasingly are providing a one-box solution.

Another feature of this increased simplicity in scanning is how the devices hook up to your



Canon's all-in-one solution, the MultiPASS 1000: combo scanner, printer, phone, fax and copier.

PC. Installing a circuit board under the hood is seldom required anymore. Most scanners, especially the compact sheet-feds, connect to your PC's parallel printer port and provide a pass-through port to reconnect your printer. Color flatbeds do require connection to a SCSI (small computer system interface) port and provide the necessary board.

Besides stand-alone add-on scanners, you'll find a whole new category of multifunction machines that combine scanner, printer (usually laser), copier, fax, modem and telephone under one hood. These include Canon's MultiPASS 1000 (\$1480) and Brother's MFC 4500ML (\$1000). There's even one color-scanning device that doesn't need a PC. Just connect Mustek's MFS-6000 MP (\$895) to a phone line and a printer and you've got a fax machine and a photocopier—a color photocopier if your printer can handle it. Of course, that means you're generating more paper. Perhaps it's an endless loop after all. **FM**



Epson's ES-1000C color flatbed scanner uses CCD image-sensors like those in camcorders.

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the Tacoma over a 4-day span, Cliff and I came to appreciate the roominess of the optional extended cab. While I packed lightly, Cliff brought along several cases of bulky camera equipment. Fortunately, everything—luggage, camera gear, fishing tackle and food/beverage supplies—fit easily into the generous space behind the bucket seats. This freed up the main part of the cab for maps, binoculars, GPS unit, cassette tapes, soda cans, guidebooks (notably *The Milepost*, from Vernon Publications, 3000 Northrup Way, Bellevue, WA 98004) and other long-distance driving necessities.

The Tacoma's interior helps fend off road fever by being equipped with a sliding rear window (optional) for excellent ventilation and by making clever use of tasteful, durable materials, such as molded door panels that include integrated speakers and map pockets. On the driver's side, which comes with a standard airbag, the dash is logically designed for easy access to all controls and instruments. On the floor, the 4wd shifter is just a short reach away.

A separate cruise-control lever is also within easy reach, but it's embedded in the steering wheel in an awkward position. After reaching the minilever, which is somewhat reminiscent of a computer trackpoint or mouse, the cruise control was relatively difficult to engage. Apparently, it's unwilling to activate until average speed is established for 4 to 5 seconds and during that time deviation is no more than a tenth of an mph (an estimate). Once engaged, however, operation was exceptional.

In addition to being spirited, the good-looking Tacoma, which features a stylishly beefed-up chrome grille, delivers a level of ride comfort that sets a new standard for compact pickups, and it does so without sacrificing workhorse strength or front-end precision. The new rack-and-pinion steering felt crisp and smooth from wheel lock to wheel lock, and maneuvering was quick, thanks to a reduced turning radius.

Clearly, the new Tacoma is a milestone in the long history of the Toyota compact pickup. The showroom sticker price may be slightly higher than that of comparable domestics (base price for our model was \$19,068, and \$22,663 as tested), but for those who appreciate Toyota's proven philosophy—ruggedness, reliability, quality and operating economy—Tacoma value will more than compensate.

True Alaska story: Arriving too late to see much of Deadhorse, I ask the manager of the Arctic Caribou Inn a string of questions about the town and surrounding area. She

doesn't know any of the answers. Finally, she explains, "Look, I never go outside. It doesn't pay."

You'd have to see Deadhorse to understand her point of view. Thick clouds and heavy industry are the town's main attributes. In fact, there's nothing to do there except visit the pipeline terminal and the Arctic Ocean, which is called the Beaufort Sea in this region. Unfortunately, the entire shoreline at Prudhoe Bay is restricted, and the only way to see it is by taking a commercial bus tour. Many people who make the long drive each year are extremely disappointed

to learn they have to stop and turn around 10 miles from the top of the continent. (Fortunately, ARCO officials gave us a private tour.)

In the end, I guess the only reason to make the run is to drive the infamous Haul Road, and become a member of a very exclusive club. During our week's stay in Alaska, Cliff and I couldn't find anyone who had driven the road's entire length. So, if you want to impress your friends, go to Valdez, Alaska, and drive to the top of the world on the Haul Road. If you want to impress yourself, do it in a Toyota Tacoma. **FM**



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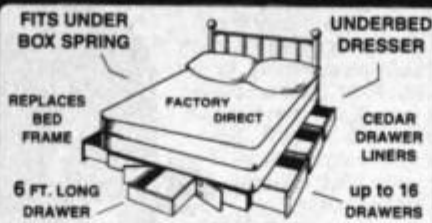
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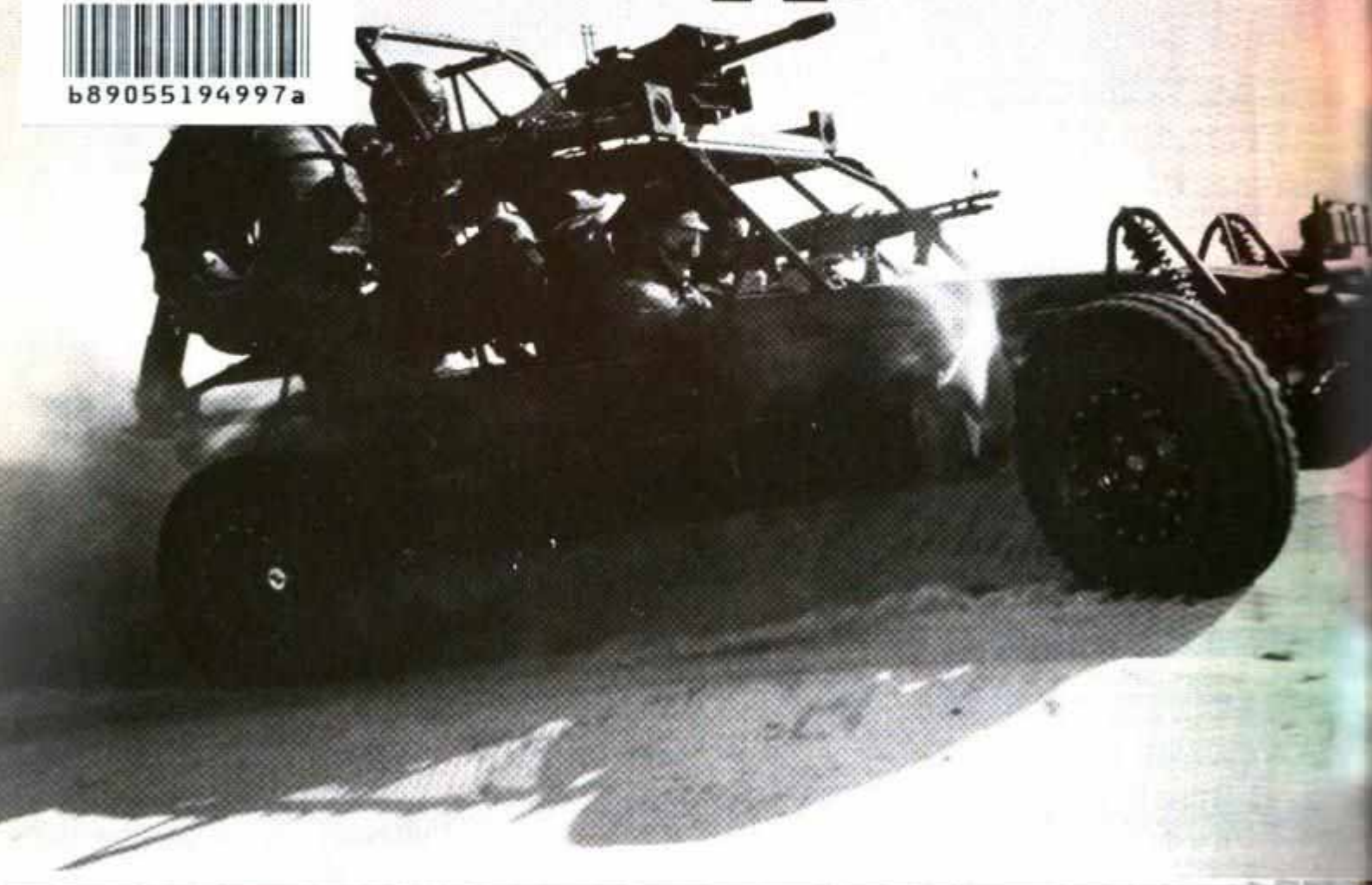
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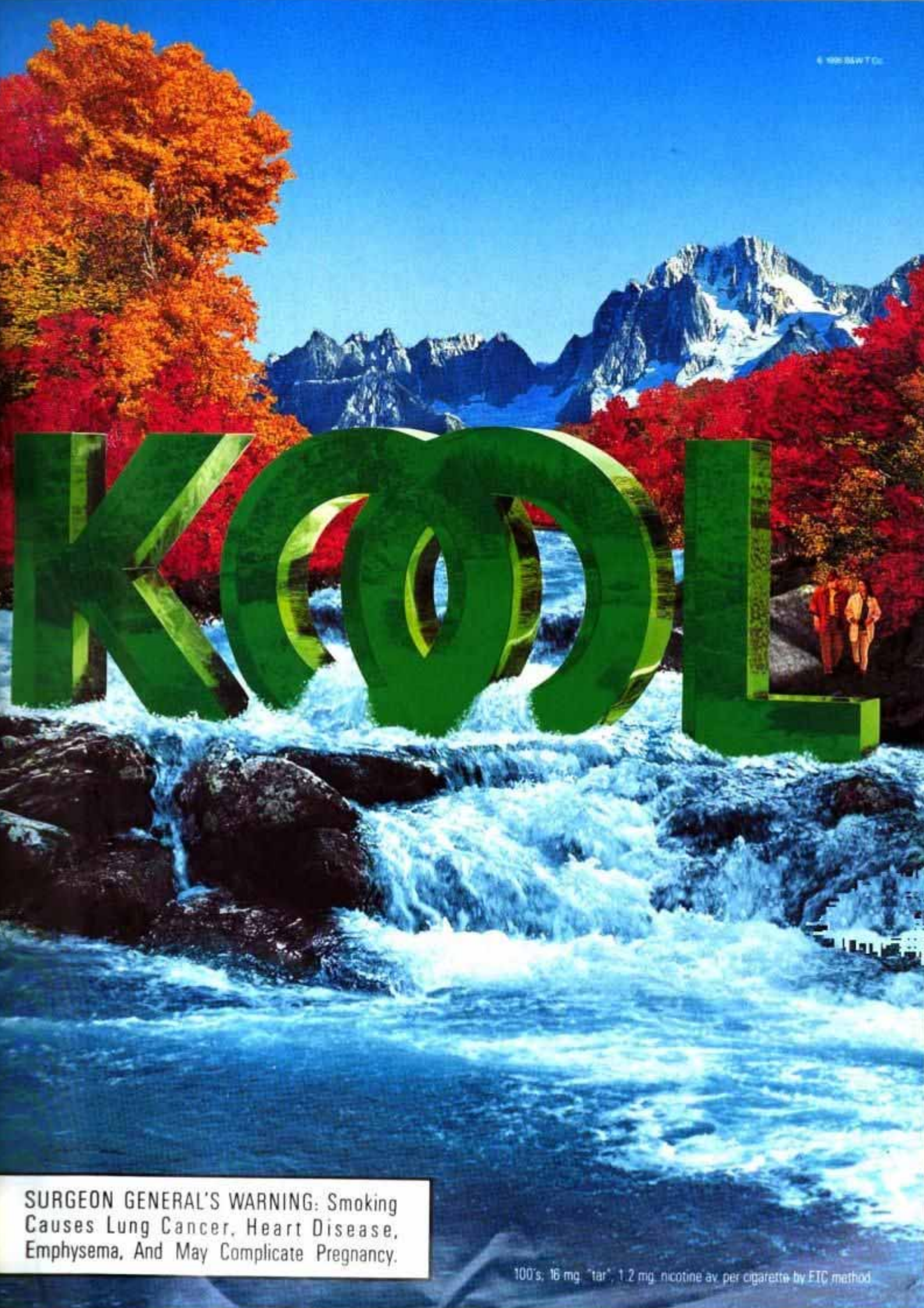
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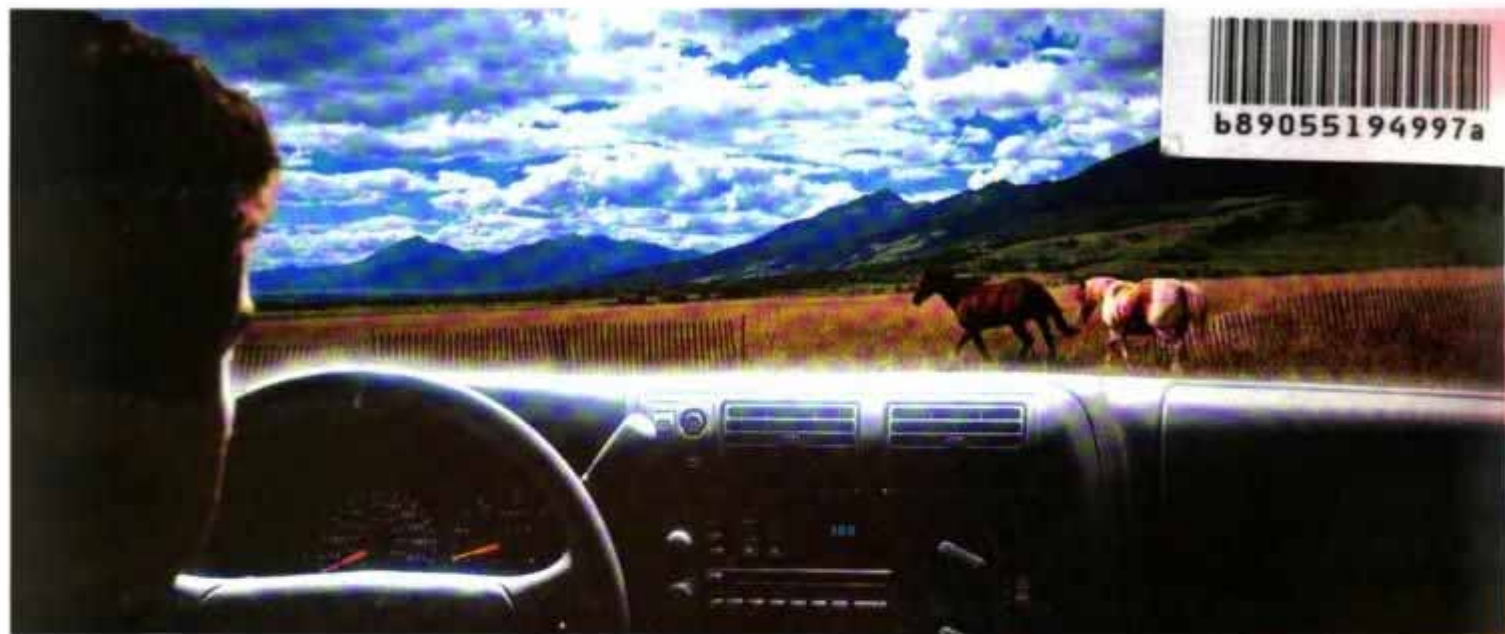
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