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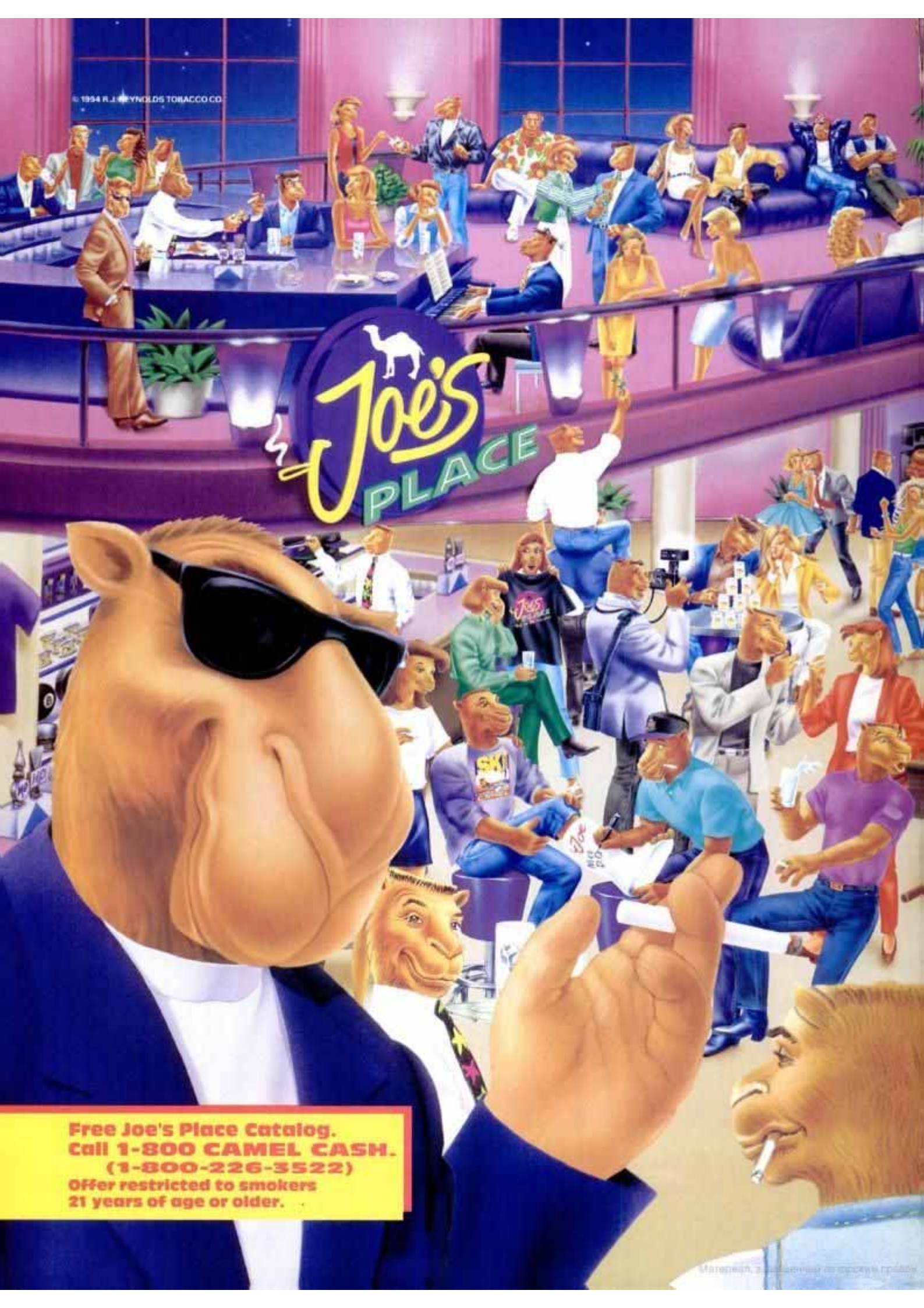
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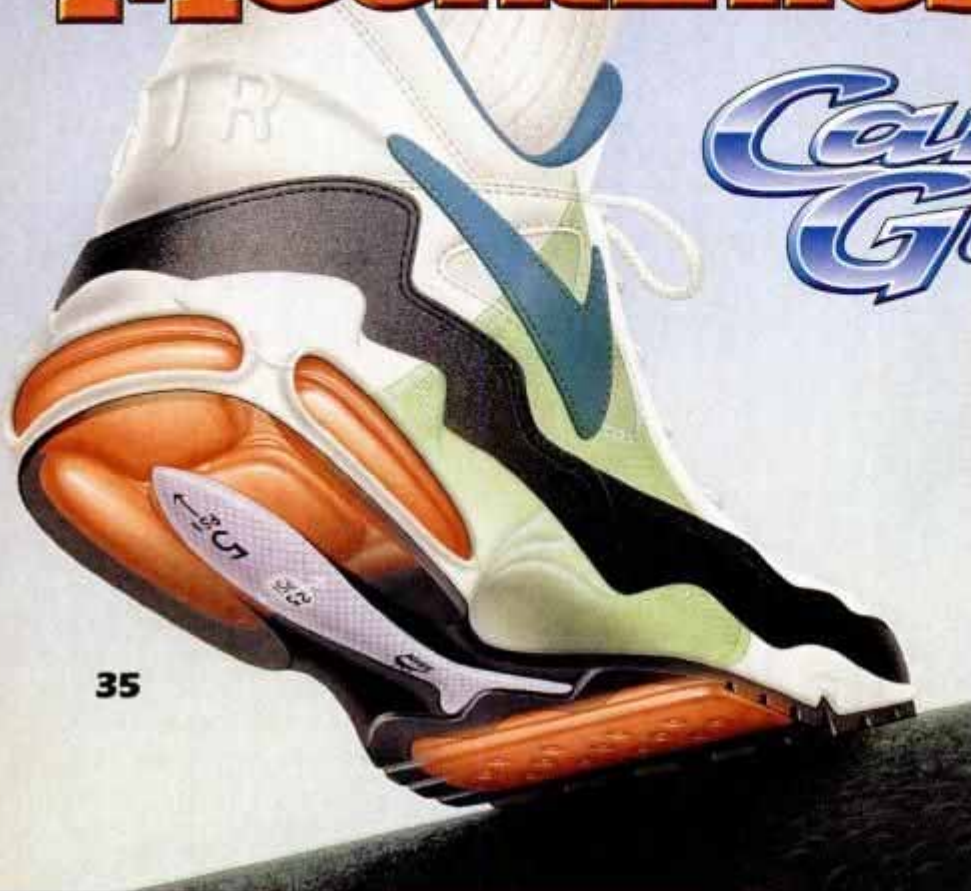


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Popular Mechanics®

Mechanics

MAY 1994
VOLUME 171
NO. 5



Car Care Guide

93



AUTOMOBILES

62 Owners Report: Pontiac Grand Am

It's a best seller with styling that wins the buyers.

93 SPECIAL SECTION: Car Care Guide

Every car needs periodic maintenance. Here's what your car needs—daily, weekly, monthly, yearly.

116 Detroit Spy Report The '96 Ford Taurus, '95

Dodge Avenger, '97 Dodge pickup, and more.

TELECOMMUNICATIONS

53 New Look For Cellular Phones

Digital technology carries data and a clearer signal.

120 Video Servers The heart of video-on-demand.

SPORTS SCIENCE

35 Shock Absorbers For Your Feet Latest athletic

footwear has cushions to let you literally walk on air.

BOATING/OUTDOORS

44 Best Of The SHOT Show

Nine great new products from the Shooting, Hunting, Outdoor Trade Show.

46 Comparison Test: Flats Boats

Fishing features and high performance converge in a 6-way shootout.

118 Rough Riders Jet-skiing the Windward Islands

on the hot new Kawasaki XIR.

AMERICAN CLASSICS

50 Winchester Model 94

On the 100th anniversary of the most famous rifle in history, it's still called the gun that won the West.

HOME IMPROVEMENT

66 Home And Shop Journal

- **How To:** Install an in-ground sprinkler system.
- **Smart Shopper:** Choosing lumber.
- **New Products:** Outdoor power equipment.
- **Home Improvement:** Basement insulation.

83 Homeowners Clinic Home maintenance Q&A

SCIENCE/TECHNOLOGY

17 Tech Update

- Fixed-up Hubble discovers the universe.
- Tomorrow's IndyCars today.
- Add-on armor for fighting vehicles, and more.

38 COVER STORY: America's Doomsday Plane

Our government's ultimate nuclear refuge.

56 Using Genes To Fight Disease

Medicine's direct assault on the genetic blueprints of cancer, AIDS and other horrific illnesses.

112 Horsepower, 2000 B.C. The chariots of the gods.

ELECTRONICS

59 Movies On CD A new Video CD format puts your favorite movies on compact disc.

110 Best Of The Consumer Electronics Show

Gonzo gadgets were everywhere at CES.

114 The Violence Chip Circuitry that blocks the bad stuff from your kids' TV.

DEPARTMENTS

4 Editor's Notes

10 Letters

12 Time Machine

140 Coming Next Month

EDITOR'S NOTES

● I've never met Ken Eberts. But I've been a big fan of his for years. In fact, I always wished I could own one of his fine paintings and have it in my home to enjoy. Ken Eberts is an automotive artist in the truest sense of the word. His entire life has been devoted to illustrating automobiles. In his own words, "As a young boy, I drew automobiles at the kitchen table in my parents' apartment in



Ken Eberts.

The Bronx. As a young man, I designed automobiles for the Ford Motor Co. For the last 22 years, I've painted automobiles in my paintings as an automotive fine artist." Fine indeed. I first became aware of Eberts's work in the pages of the weekly newspaper *Old Cars*, and other publications devoted to the old-car hobby. Later, I saw his work become the poster art for some of the most prestigious old-car shows such as Pebble Beach and Meadow Brook Hall. When the opportunity came up to commission an Eberts work for our annual Car Care Guide cover (page 93), I jumped at the chance. No one captures time and place like Ken Eberts. We're proud to have his art in the pages of POPULAR MECHANICS. ... Is the Boeing E-4B airborne war room a relic of the Cold War or something we still need, in light of the noise coming from the saber rattlers in Russia? Whatever your opinion, a look inside the huge plane (page 38) is a fascinating trip few have been able to take, what with the whole thing being one gigantic classified top secret. I, for one, am glad the aircraft is still around. ... Remember when you could walk into a shoe store and buy a pair of sneakers? Just buy them? You didn't have to be a biophysicist to make a choice. Have you walked into a Foot Locker store recently? There are literally walls full of sneakers—er, pardon, athletic shoes—to choose from. So how does one choose? Well, if you're after the very latest technology, you buy one of the shoes in our article, "Running On Air," which begins on page 35. The air cushion built into these shoes makes this the only way to fly these days. Too bad they cost about the same as a pair of Italian leather loafers at Gucci. ... One of the first things I did when I bought my present house was to have a sprinkler system professionally installed. Even then, it cost almost \$2000 for coverage of my paltry one-third acre lot, and we're talking 19 years ago. I hate to think what it would cost now. But our Home Improvement Department editors show you how to do it for a fraction of the cost beginning on page 66. This is one of the most cost-effective articles we've ever run. ... When it came time to pick the first candidate as the subject for our new American Classics series (page 50), the Winchester Model 94 was at the top of my list. If you have an idea for a future American Classics subject, drop me a note about it. Till next time.


Joe Oldham

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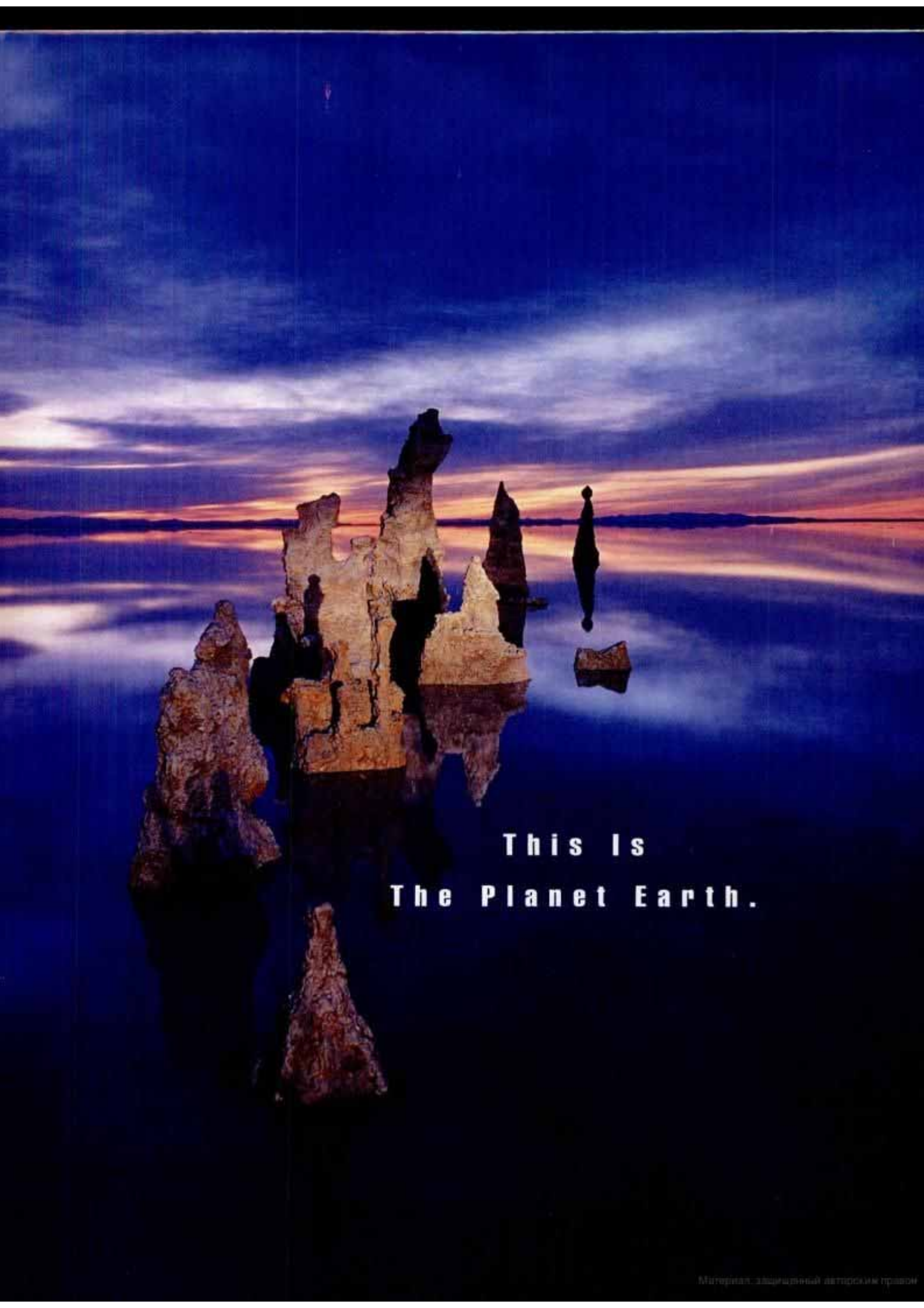
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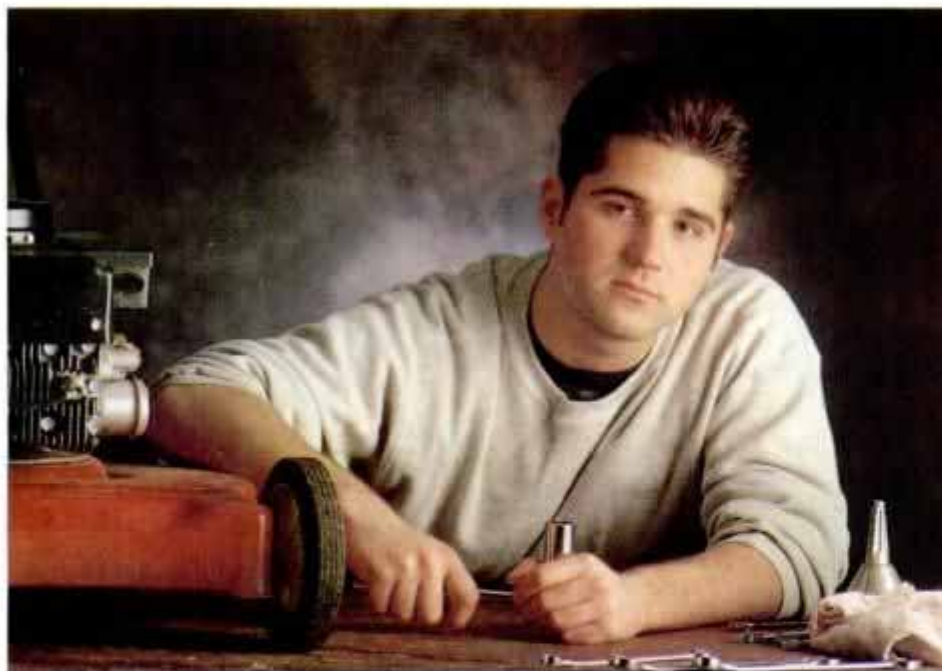


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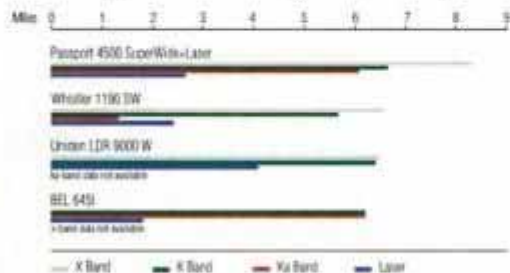
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Shocking, Simply Shocking



Apparently, everyone except for POPULAR MECHANICS knows General Motors built the Impact to demonstrate to government gurus and environmental nuts that electric cars are not practical for America. The road to a "more advanced (and affordable) battery" is blocked by the basic laws of physics and chemistry. Your cover story was informative, interesting and entertaining. But it did nothing for the technical credibility of POPULAR MECHANICS. Reminds me of the "airplane in every driveway" stories of the late 1940s.

WILLIAM K. SHARPE
KINGS PARK, NY

That was a helicopter in every driveway. —Ed.

With the rush to perfect an electric car, what are we accomplishing? We are only shifting the pollution problem from the automaker to the power company. Regardless of how we generate electricity—nuclear, fossil or hydro—we still have a pollution problem. Let's spend our time and money on some new method of generating power.

EDWARD A. SCHREIBER JR.
WAUSAU, WI

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

A marvelous article. But, where are we going to get the power to charge the batteries? With the obstacles in the way of building nuclear plants, we are going to encounter a most serious power-generation problem.

H. KENNETH ANDERSON
PORTLAND, OR

Your article would be more justified if sales of these cars were limited only to residents that have electricity provided by nuclear powerplants or hydroelectric plants. Only then will electric cars truly be zero-pollution vehicles. Electric cars charged up in cities like Los Angeles, where 35% of the air pollution originates from fossil fuel powerplants, will not solve any air-quality problems. Unfortunately, the do-gooder environmentalists who promote electric cars generally oppose nuclear power for generating electricity—a Catch-22 situation.

STEVEN A. ZIEG
YORBA LINDA, CA

Let's quit wasting time and energy on a stupid idea—the "magic" battery pipe dream—and get on with the development of something that will work. Ironically, the disposal of all these batteries from electric cars could pose its own serious environmental implications.

STEVE CORNELIUSSEN
CHICAGO, IL

In your discussion of the Impact, surely you err when you say, "we drag raced a '93 Acura up a steep incline and arrived in front." How can a 16.8 kw, which equals 22.52 hp, beat a real car? Something is wrong. Please explain.

JEFF DOUTHWAITE
SANTA BARBARA, CA

What's wrong is you. The 16.8 kw referred to in our story is the amount of power the battery pack can store at any given moment. The electric motor that powers the car is rated 102 kw, or the equivalent of 137 hp—more than a match for the 140-hp Acura Integra we raced up the hill. As for the outcome of the race, I was there. I drove the Impact. We started evenly from a dead stop. The Impact beat the Acura Integra up the hill. —Ed.

Under Sail

The arrival of my monthly issue of PM is always an exciting day for me. As an avid boating enthusiast for more than 25 years, I really perked up upon seeing the "Boating '94" headline on your February cover. Imagine my disappointment when your feature did not include a single item of interest to sailboating en-

thusiasts. We buy magazines, too, so how about giving us equal space?

STEVEN M. STOEHR
WESTERVILLE, OH

Sorry, Stoehr, we're power guys. —Ed.

Cooled Off Hotlines

Your "temporarily disconnected" Hotline Phone Service must be the longest "temporary" program since the federal income tax. The Hotlines are a great idea. When can we have them back? Please?

JOHN J. LIGHTER
BOWIE, MD

Like many businesses during this recession, we've had to cut back on some expenses. Unfortunately, the Hotlines had to go. If the economic climate improves, the Hotlines could be back as soon as this year. —Ed.

Reader Project Of The Month



Your article "Multipurpose Utility Shed" in the April 1985 issue provided the impetus for the construction of a similar structure. The overall geometry, features and ideas from your article were faithfully included in my project and make the shed functional and attractive. The construction afforded an opportunity to apply planning, organizational and mechanical skills and I derived lots of personal satisfaction from the completion of this project. The shed is a welcome addition to the property aesthetics. Thanks for the inspiration.

DAVID ALLISON
NEWTOWN SQUARE, PA



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TIME MACHINE

90 YEARS AGO: MAY 1904

Popular Mechanics

Rockefeller Will Pipe Oil Across America

Significant Scheme to Cross Millions that will make the Standard Oil Company Independent of Railroads, and will Revolutionize the Methods of Transportation

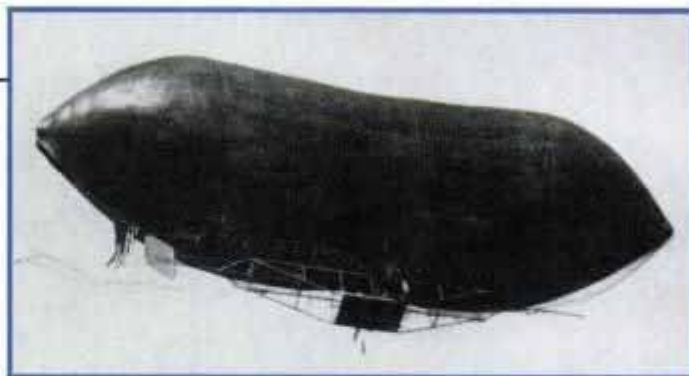
Standard Oil of New Jersey has announced a plan to build a pipeline from the oil fields of Kansas to the coast of New Jersey. The pipeline will be 2,000 miles long and will cost \$100,000,000. It will be the longest pipeline ever built and will revolutionize the methods of transportation of oil.



View of the Pipeline and Standard Oil of New Jersey's Latest Oil Refinery

Oil Veins

The tentacles of the Rockefeller empire were spreading, as a new pipeline would soon ferry crude from the fresh oilfields of Kansas to the monstrous Standard Oil refinery at Whiting, Indiana. Meanwhile, New Jersey refineries would be linked with their counterparts in Ohio. When the pipeline system ultimately stretched to the Gulf of Mexico, Rockefeller would be able to shuttle black gold across the country without kowtowing to the railroad barons.



Battle Blimp

Airships were already inflating expectations as war-birds. One West Coast inventor promised nothing short of destruction of the Russian fleet. Japanese agents were scheduled to

watch as the *California Eagle* bombed a barge off the Golden Gate. The 80-ft. airship caught the attention of Capt. Thomas Baldwin, who later sold the U.S. Army on the merits of the dirigible.

60 YEARS AGO: MAY 1934



Bee Plus

In aviation's golden age, engineers were abuzz with the notion that nature offered the best models for aircraft. Case in point: the effort by an Austrian researcher to imitate the flight of the bumblebee. Raymund Nimfuh designed a craft with two pairs of wings, each attached to the fuselage by rubber gaskets. Air pumps caused rubber cells under each wing to oscillate. In theory, the system would have provided lift, propulsion and steering.

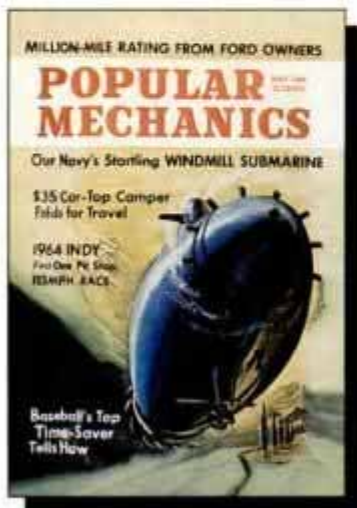
Post Flight

Meanwhile, other Austrians were launching a new era in postal delivery—the age of



rocket mail. Each vehicle carried between 200 and 300 letters across two districts in the city of Graz. The small rockets ascended at a 65° angle, then parachuted back to Earth. By all reports, the system did not lose a single letter.

30 YEARS AGO: MAY 1964



Aquabatics

At the Navy's David Taylor Model Basin, a new breed of submarine was cavorting through the water like a mechanical sea lion. The little model could stand on end, crab left and right, spin on its center, and rise and fall vertically. The key: hull-girdling propellers fore and aft, with blades of variable pitch. With such a system, engineers believed, a full-scale submarine could also dive deeper and run more quietly than its push-prop brethren.

Muscle Fish

An aquatic influence continued to wash through Detroit, as big fierce fish on wheels were hooking buyers. The original Barracuda came with the world's biggest rear glass, a 2077-sq.-in. arc that swooped from the roofline to a few inches above the tail

bumper. Early on, however, the fastback was simply a Valiant with window dressing. Only in 1967 did Plymouth begin putting teeth in the Barracuda, in the form of big-block engines. The killer 'Cudas—the 440s—arrived on the scene in 1969. **PM**



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10

76

2

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TECH UPDATE

News Of Tomorrow's Technology Today



Here's What The Universe Really Looks Like

BALTIMORE, MD—After a repair mission that went off like a dream (see "Hubble Rescue," page 42, Jan. '94), the nightmare of the Hubble Space Telescope is over.

Suddenly galaxies are popping into focus like science-fiction paintings, and fuzzy blobs of starlight snap into swarming pinpoints. Gone is the spherical aberration. Gone, the jittery solar panels. With beefed-up computer memory and a fresh set of backup components, Hubble is ready to lead astronomers on a tour through the universe.

First stop: Jupiter. Suspense is now building as a train of comets zeroes in on the big planet (see "When Worlds Collide," page 106, March '94). Already, Hubble has reimaged the comets and revealed that they are fragmenting further. Some of the

cometary chunks are also falling out of alignment with the main string. Hubble will revisit the comets before mid-July to track these developments.

Farther out in the cosmic sea, the telescope will begin sighting in on variable stars used as yardsticks in measuring the size of the universe. By gauging their brightness, Hubble will establish their distances from Earth. With enough such measurements, astronomers should be able to pin down

the distances between galaxies and hence the age of the universe—a long-standing issue that Hubble was built to resolve.

Already NASA is planning further upgrades to Hubble—second-generation instruments to be swapped during shuttle missions three and six years from now.

Before and after images of galaxy M100 (top) show results of Hubble repair, while new comet images reveal changes.

Highlights This Month

- **Cheap Shots**—NASA's new economy-class spacecraft.
- **Walk This Way**—Unique robot to swing across terrain.
- **Space-Age Frame**—The astonishing aluminum Audi.
- **Drain Brain**—Device rescues energy from bathwater.
- **Probe Probe**—Solving the *Mars Observer* mystery.
- **Racing News**—Tomorrow's IndyCars today.
- **Shot Blockers**—Add-on armor for fighting vehicles.

Editor/Writer: Gregory T. Pope
Reporters: Philip Chien, Mike Fillon, Scott Gourley,
Herb Shuldiner

Mars Observer Whirled Without End

PASADENA, CA—Missing in action since last August, the errant *Mars Observer* spacecraft probably threw itself into an eternal spin after bursting a pipe.

A probe led by Timothy Coffey, head of the Naval Research Laboratory, pinned blame on a faulty oxidizer check valve, although no one knows for sure.

In this scenario, the oxidizer—nitrogen tetroxide—accumulated in a pipe downstream of a leaky valve, all during the 11-month voyage to Mars. Then ground controllers commanded the spacecraft to pressurize its fuel tanks, in preparation for the boost into Mars orbit. Accordingly, hydrazine fuel rushed into the same pipe, where it met the oxidizer. The resulting



Faulty valve allowed fuel and oxidizer to rupture pipe, sending *Mars Observer* into a tizzy.

spontaneous reaction melted the titanium plumbing. And the combustion

—creating an off-center thrust that spun *Mars Observer* to death.

Titan Plus Centaur Equals Record Lift

CAPE CANAVERAL, FL—When the first Milstar (see "Switchboard In The Sky," page 40) went up on a Titan 4 rocket last February 7, Air Force officials breathed a sigh of relief. The last time the mighty Titan roared, an explosion seconds after liftoff deep-sixed a billion-dollar trio of spy satellites. And delay and expense have riddled the program.

The Titan that ferried Milstar was the first to carry a Centaur upper stage. This powerful motor, used on Atlas rockets, allows the vehicle to haul an extra 5000 pounds, doubling America's lift capability into geosynchronous orbit. Although the shuttle can hoist far heavier payloads, it can't send them to the geosynchronous altitude of 22,000 miles.

America's mightiest rocket, Titan-Centaur opens geosynchronous orbit to 5-ton payloads.



True Turf For Sports Domes

RINCON, GA—Although artificial turf is unforgiving on athletes, until recently it's been the only choice for indoor stadiums. But now a natural surface offers the convenience of the fake stuff.

RapidTurf grows in a thin layer of sand and organic waste on a microperforated sheet of polyethylene. Forced to grow laterally rather than straight down, the turf's roots form a natural fabric that allows harvesters to reap the grass intact.

RapidTurf Inc. also claims the grass will thrive in domes if the lights are brought up a few hours a day.



Although it's harvested intact and rolled like artificial turf, RapidTurf is the real thing.

Watts New Under The Sun

NEWNAN, GA—Sunlight is slowly creeping into power-utility operations. A solar-cell installation undergoing tests by Georgia Power Co. is converting solar energy at an efficiency of 15.5%.

The 1-kilowatt system builds on the high-concentration photovoltaic cell, which, smaller than a conventional solar cell, operates under a fresnel lens. The manufacturer, Amonix Inc. of Torrance, California, has demonstrated individual-cell conversion efficiencies of greater than 25%. Designed for volume production, such devices could bring utility solar-power costs down to about 8 cents per kilowatt.

High-concentration photovoltaics could put solar power within utilities' reach.



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IF IT WON'T COME CLEAN WITH SUPER CLEAN, IT WON'T COME CLEAN.



One Satellite Does It All

VANDENBERG AFB, CA—When the Air Force needs to conduct research in space, it either books room on the shuttle or piggybacks payloads on other spacecraft. Sometimes, however, the experiments are important enough to justify their own satellite.

ARGOS, the Advanced Research and Global Observation Satellite, is an example. On board, ultraviolet and X-ray sensors will map the ionosphere.

Meanwhile, a space-dust collector will grab samples and an arcjet will provide electrical propulsion. In addition, the X-ray sensor will lock on to bright X-ray stars to gauge the satellite's attitude and position—a unique



application of celestial navigation.

ARGOS will go up in September 1995 atop a Delta rocket.

The Air Force will combine a handful of experimental goals aboard one satellite, known as ARGOS.

AIR FORCE ILLUSTRATION

Indy 2000: The Future Of Auto Racing Is Now

PASADENA, CA—In May, man's thoughts turn to IndyCars. Nowhere are the wheels turning faster than in the minds of Honda executives, who are fielding two teams for this year's PPG IndyCar World Series. They've even gone to the extent of sponsoring a student project at Art Center College of Design, the nation's top training ground for auto design.

Paced by a 14-week deadline, the designers concocted a variety of vehicles. Among them: a hydrogen-powered 2-stroker from Joachim Anscheidt, a car with a breakaway safety capsule and a fifth wheel from Sergio Luna, a racer with variable front-tire air pressure from Robert Bauer, and an aerodynamic transporter from Kevin Cunningham.



ANTHONY POSTMA



ARTHUR LEE



SERGIO LUNA



GAIRY SMITH



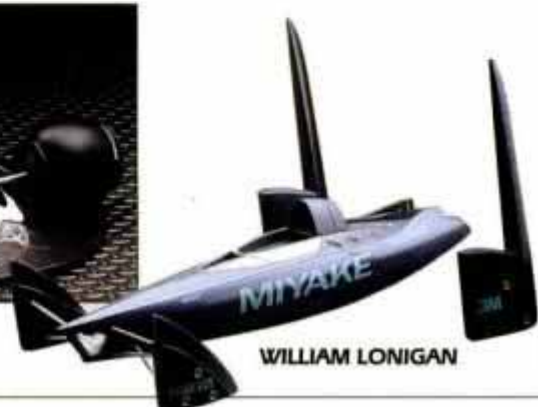
KEVIN CUNNINGHAM



JOACHIM ANSCHEIDT



ROBERT BAUER

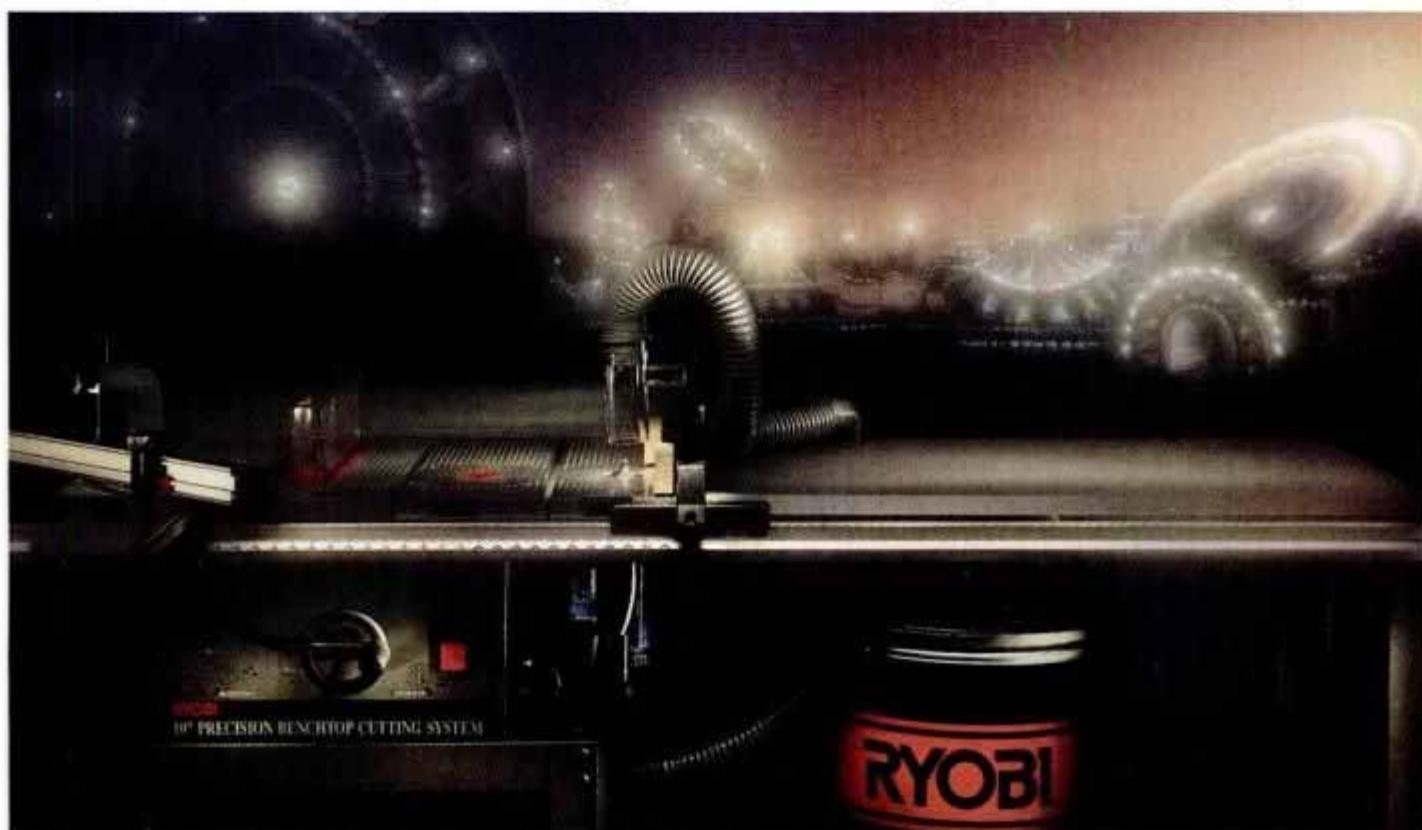


WILLIAM LONIGAN

ART CENTER COLLEGE OF DESIGN PHOTOS

The inverted router, adjustable rails, a sliding miter table, and the air floatation/vacuum clamp system. Is this a table saw, or a woodworker's theme park?

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mechanism that locks the rip fence parallel to the blade, front and back. Adjustable rails and tables to support up to 30" of ripping capacity, left or right of the blade. Ah, then there's the power! A whopping 15-amp, 3-horse motor with enough umph! to glide through your hardwoodiest 4x4's. And if the basic saw still doesn't have you panting, don't miss the options! The amazing Air Floatation/Vacuum Clamp Table. An inverted Router/Jig Saw Mounting Kit. The Quick Fold Outfeed Table. And a breathtaking Dust Collection System. There's even a Wide Table Kit for rip capacity up to 72". But wait, there's more! More features, patents, precision and options than any other saw in its price range. And that alone should be enough to get any serious woodworker's adrenalin flowing.

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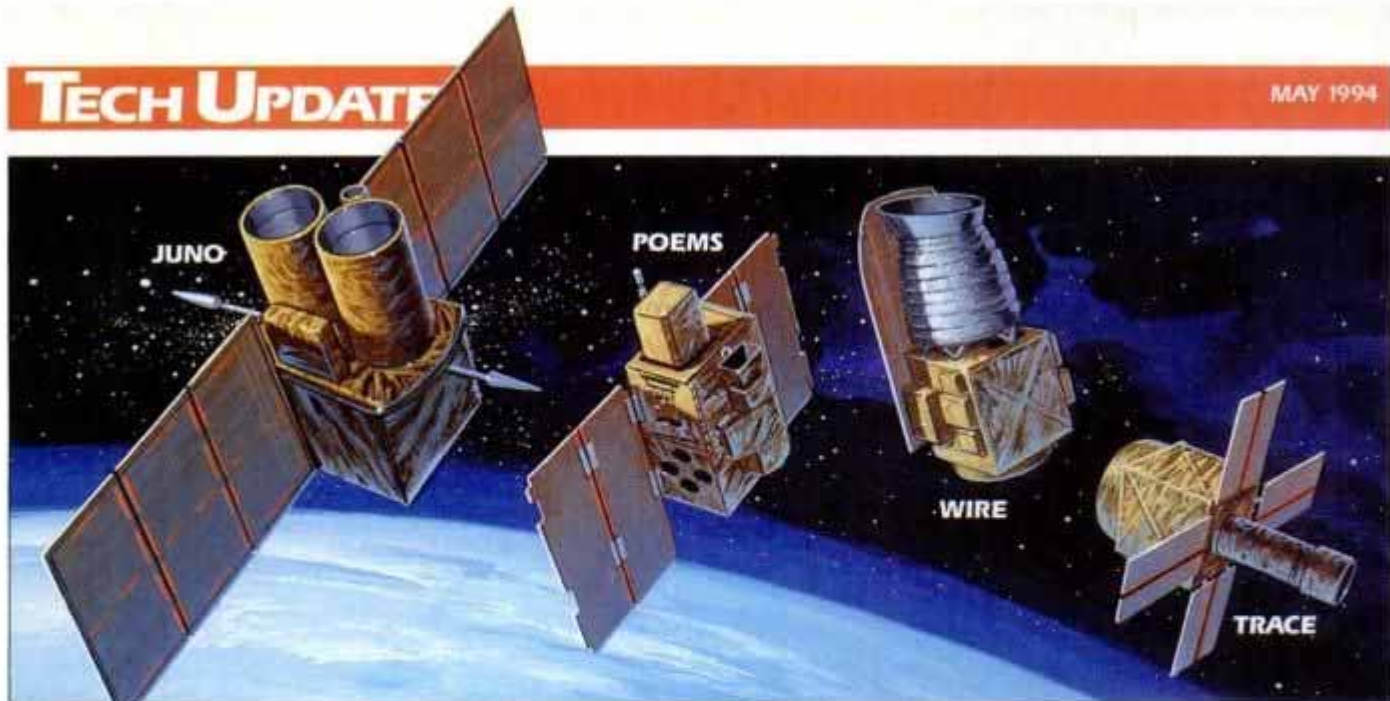
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*Based on 1993 CY manufacturer's reported retail deliveries.
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†3 years/36,000 miles. See dealer for details.

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Better, Smaller, Faster, Cheaper

GREENBELT, MD—Call them the Small Explorers. They're the latest family of probes hoping for a lift into space. Seeking science on a shoe-string budget, NASA has been canvassing researchers for candidates.

A Small Explorer can't weigh more than 500 pounds or cost more than \$35 million. From 51 proposals, NASA has now whittled down the competition to four acronymic choices, two of which will fly before the year 2000.

JUNO, a Joint Ultraviolet Night-Sky Observer, would involve NASA and the Italian space agency. The Positron Electron Magnetic Spec-

trometer (POEMS) would measure antimatter in cosmic rays. WIRE, the Wide-Field Infrared Explorer, would focus on galaxies. And a Transitional Region and Coronal Explorer (TRACE) would watch the Sun's magnetic field and plasma structures.

Small Explorers would carry one or two instruments, allowing fast development and up-to-date hardware.

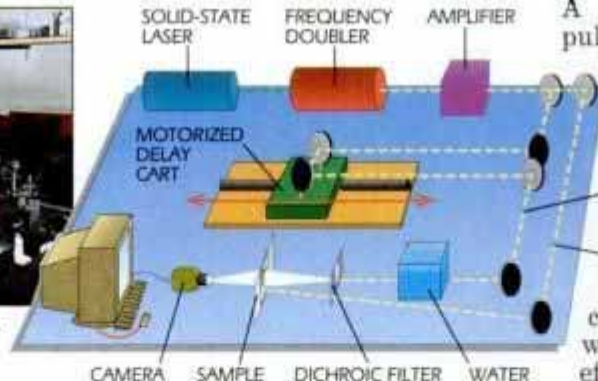
Shedding Light On Photosynthesis

ST. LOUIS, MO—Researchers are illuminating the mysteries of photosyn-

thesis, the process by which plants convert sunshine into chemical energy.



Laser pulses stimulate photosynthesis, then gauge speed of electron transfer in microbes.



At Washington University, chemists have assembled an ingenious laser apparatus to tickle photosynthesizing bacteria into giving up their secrets. A laser beam, delivered in pulses, is first split into two. One beam excites a sample of the microbes, triggering photosynthesis. The other, after an infinitesimal delay, then bathes the sample in white light. By seeing what colors are absorbed from the light during photosynthesis, the researchers can time the movement of electrons within the bacteria. The goal: more efficient solar-powered devices.

Washington University photo. PM illustration by Kurt Novak.

Air-Cushion Catamaran

MIAMI, FL—Somewhere between a catamaran and a hovercraft floats the SeaCoaster, a new hull design from Air Ride Craft Inc.

Now under analysis in the form of scale models, the SeaCoaster rides on twin sidehulls, each tipped with wave-slicing bows. Blowers create air cushions in hollows carved into each sidehull, which sink only slightly into the water. The combination adds up

to a smooth ride without the pitching motion commonly experienced in surface-effect ships.

Air Ride claims that a SeaCoaster slips through the waves with half the resistance of a monohull or

catamaran at cruise speed. Among three models being tested is a transatlantic racing hull.



As ferry or yacht, SeaCoaster offers air-blown twin-hull with wave-slicing bows.





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To get a feel for how a John Deere LX188 Lawn Tractor is built, just sit down. That way you can literally feel the strength of a frame that's welded, instead of bolted like some others. And the power that comes from the LX188's liquid-cooled, 17-horsepower V-Twin engine. (Other LX Series Tractors offer 14-horsepower overhead valve engines or a 15-horsepower V-Twin.)



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And to feel even better, you should know LX Tractors are available with 38-, 44-, and 48-inch mower decks and take a wide range of attachments, so you won't outgrow them. And they have the highest resale value, just in case you ever do.

Which makes this one seat-of-the-pants decision you'll never kick yourself for making.



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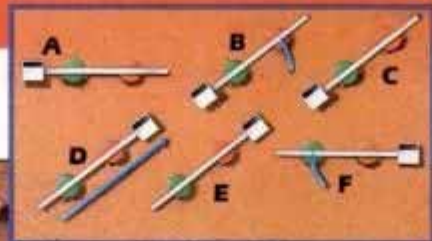
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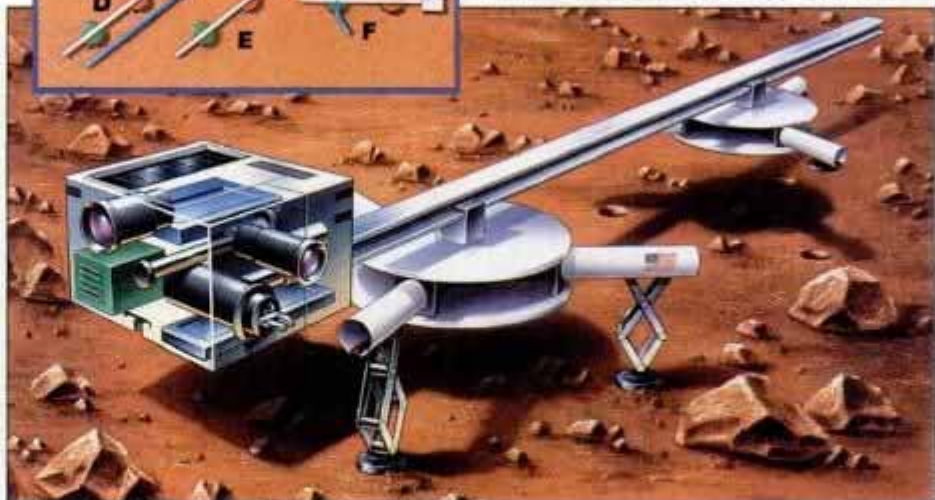
The Beast That Walks

STATE COLLEGE, MS—Brains, batteries, sample bins—all these burdens can weigh down a walking robot. But a unique design by Matt Michel and Robert Ferguson, two former Mississippi State University students, throws its weight around to good use.

The Beast (short for Best Economical All-Terrain Space Traveler) consists of two tripod legs and an equipment box that shuttles across an I-beam. The box serves as a counterweight while the Beast walks. First one tripod, counterbalanced by the box, raises its scissor-jack legs. Then a motor in the other tripod turns the I-beam to swing the lifted tripod forward. That tripod then replants its feet, and the box slides over to the op-



Beast slides its equipment box back and forth, using it as a counterbalance while it lifts and moves one tripod leg at a time.



posite end of the beam. The Beast then takes another step. In confined

spaces, the robot can also inchworm straight along the I-beam.

Chunnel On Track For Debut



DOVER, ENGLAND—As we go to press, the Channel Tunnel is still due to open this month, as British and French railroad authorities scramble to meet the deadline.

The shuttle trains that will ferry cars and trucks under the English Channel will debut first. Eventually a fleet of 38 trains will run between Folkestone, England, and Calais, France.

Later this summer, the 18-car Eurostar trains—based on France's TGVs—will inaugurate 3-hour London-Paris passenger service. British instructors are preparing engineers for the unfamiliar journey with a simulator that can reproduce fog, track obstacles and signal failure.



British instructors are preparing engineers for the unfamiliar journey with a simulator that can reproduce fog, track obstacles and signal failure.

Supersonic Periscope

EDWARDS, CA—When the Concorde swoops in for a landing, an articulation mechanism lowers its long pointed nose so that the pilot can see the runway. Although this system works fine, it's complex and heavy. Much simpler is a new solution—an upside-down periscope.

Mounted below the cockpit, the Research External Vision Display, or REVD, sends the pilot a view much crisper than a television image.



On needle-nose aircraft like this F104 Starfighter, periscope relays a runway view to pilot during take-off or landing.

The arrangement of mirrors and lenses also offers little that might break down.

NASA's Ames-Dryden Flight Research Facility developed the apparatus, intended for the now-defunct National Aero-Space Plane. But the periscope could benefit supersonic airliners or hypersonic warplanes.



Siberia's New Mud Puppy



NIZHNY NOVGOROD, RUSSIA—Australia's tough wild dogs may seem an odd inspiration for Russian aircraft. Nevertheless, Dingoes may soon roam the outback of Siberia.

The amphibious Dingo, blueprinted by AeroRIC Research and Production Enterprise, features a unique landing system—an air cushion contained by wing bladders and retractable flaps. This will allow the plane to touch down on unprepared surfaces that might scare off wheels, skis or pontoons. The system reportedly can overcome ground obstacles 1 ft. high and ditches 3 ft. wide.

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1. The driver involved in this wheelstand -- one of drag racing's most spectacular moments, is:



A) Darrell Alderman. B) Don Garlits. C) Joe Amato. D) Eddie Hill.

2. A voltage regulator limits the alternator voltage by controlling the:

A) Field current through the field winding. B) Induced voltage in the field winding. C) Rotor speed. D) Direct voltage in the armature winding.

3. An inoperative proportioning valve could result in:

A) Pulsating brake pedal. B) Dragging front brakes. C) Premature rear-wheel lockup. D) Low, spongy brake pedal.

4. The electric starter made its debut on the:

A) 1912 Cadillac. B) 1918 Chevrolet. C) 1908 Durant. D) 1924 Chrysler.

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5. The first hardtop convertible models produced for sale to the public were made by:

A) Chevrolet. B) Chrysler. C) Ford. D) Buick.

6. Chevrolet built their famous Cameo pickup in 1955. GMC also produced a similar pickup. What was it called?

A) Suburban. B) Sonoma. C) Caballero. D) None of the above.

7. When troubleshooting an engine with a vacuum gauge, a rapid fluttering of the gauge needle at normal idle, which becomes steady as engine speed increases, usually means:

A) Poorly adjusted carburetor. B) Worn valve guides. C) Blown head gasket. C) Burnt valves.

8. Which is true about the International Race of Champions (IROC) series that was started by Roger Penske in 1973?

A) All the cars are prepared as equally as possible. B) Camaros were used from 1973 through 1989. C) The race starts by drivers running to their cars. D) Both A and B.

9. What car line used the "Super" model designation in 1959?

A) Oldsmobile. B) Buick. C) Lincoln. D) Mercury.

10. What two car companies most recently formed a working partnership?

A) British-Leyland and Honda. B) Ford and Nissan. C) BMW and Rover. D) General Motors and Suzuki.

ANSWERS
1. B 2. A 3. C 4. A 5. D (The mid-1949 Riviera) 6. A 7. B 8. A (73-74 used Porsche 911 Carreras. Camaros started in the 74-75 season) 9. A (Buick last used the Super name in '58) 10. C.

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From the People at Penzoil.

Little Scramjet That Could

LIVERMORE, CA—Cross a miniature scramjet engine with the world's largest 2-stage gas gun, and you've got something clocking eight times the speed of sound. Rockwell International and Lawrence Livermore National Laboratory have done just that at Livermore's Super High Altitude Research Project, or SHARP, facility (see *Tech Update*, page 31, Dec. '92).

The 4-in.-dia. powerplant, built by Rockwell, is now the fastest air-breathing engine on record, eclipsing a Mach-5.5 mark set in 1992 by a rocket-boosted Russian scramjet. Although the model was built to burn hydrogen fuel, at press time researchers weren't certain that they had recorded any thrust from it.



Scale model of axisymmetric scramjet (inset), with built-in hydrogen propulsion system, roars out of 2-stage gas gun. Compressed hydrogen in gun boosted engine to Mach 8.

LIVERMORE PHOTOS

Hard Shells For The Hard-Pressed

ARCATA, CA—Military planners now know that peacekeeping missions are anything but peaceful. They're also hardened to the notion that lightly armored vehicles need an extra layer of protection.

In Somalia, accordingly, U.S. Marine amphibious vehicles and Italian M113 personnel carriers recently sported the Enhanced Applique Armor Kit, made by Israel's Rafael. The kit sandwiches a rubber-composite



Reactive-hybrid package shields vehicle from brunt of exploding armor panels.

material between two steel plates. The inner layer allows the plates to shift slightly on impact, deflecting such threats as shaped-charge jets or 14.5mm machine-gun rounds. Perforated carbon steel, which makes a traveling bullet tumble, lends similar protection.

Rafael has also tailored a reactive-

hybrid armor package for light vehicles. Unlike heavy tank steel, the aluminum hull of a vehicle like the M113 can crumple when reactive armor literally explodes to fend off a missile. But the hybrid armor has an inner shield to absorb the blast.

A technology still under development is flexible ceramic armor, a melange of ceramic balls and composite materials. Not only would such armor defeat large-caliber machine-gun rounds, but it can also be formed to any silhouette.



Perforated steel deflects bullets and blunts residual effect of shaped-charge weapons.

RAFAEL PHOTO
SCOTT GOUBLEY PHOTO



Enhanced Applique Armor Kit swaddles M113 in steel-composite sandwich.

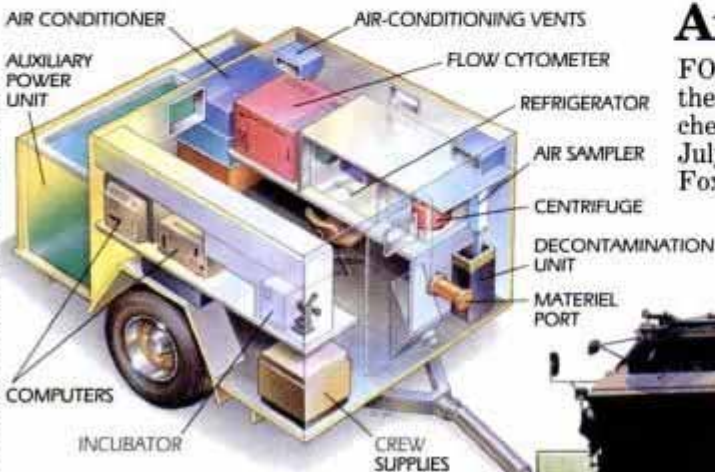
PAUL CORP. PHOTO

Army's 21st-Century Fox

FORT BLISS, TX—Fielded in haste during Desert Storm, the German-built Fox is the Army's nuclear, biological and chemical reconnaissance system (see *Tech Update*, page 10, July '91). Now General Dynamics is hard at work upgrading Fox vehicles to turn them into type-classified M91A1s.

One major retrofit will be the incorporation of an M1A2 tank's computer. In addition, new external sensors will help Fox sniff out chemical weapons as far as 3.8 miles away.

Meanwhile, German manufacturer Thyssen Henschel is developing a separate trailer called the Biological Identification Refinement Device (BIRD) to pinpoint germ-warfare microbes.



Upgraded Fox (right) features mast-mounted sensor and could pull BIRD trailer (above).



(More Tech Update on page 32)

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For Those Who've Already Set Themselves Apart From The Crowd.



For the many differences that distinguish Toyota T100 owners, like where they choose to make their home (or homes), there is one unifying similarity. Their appreciation for the integrity of Toyota products, presently owned and past, was key to their buying a T100.

Appreciation well-earned by Toyota's long-term commitment to producing products that stand and deliver. That commitment is the direct link to improvements like side-door impact beams and standard driver-side air bag* in every new 1994 Toyota T100.



T100's New Standard Driver-Side Air Bag and available 7-Speaker CD Audio System.*

Comforting features, no doubt, for the bread winner of the family. In fact, your comfort, well-enhanced by the T100's quiet car-like cabin, could make the difference between arriving for appointments relaxed and confident or not.

And because getting there is half the fun, you'll find the T100's unique size, big enough to provide for impressive payload and towing, is not so big as to impair performance and agility. Clearly, the Toyota T100 puts you in a whole new class of truck. But you already knew that.

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Call 1-800-GO-TOYOTA if you'd like a Toyota T100 brochure and the location of your nearest dealer. *Always use your seatbelt. Driver-side air bag is a Supplemental Restraint System (SRS). Buckle Up! Do it for those who love you. © 1994 Toyota Motor Sales, U.S.A., Inc.

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Canary In A Coal Mine

MINNEAPOLIS, MN—To a miner, fire can mean death, robbing underground air of oxygen and replacing it with toxic gases. Trouble is, present mine fire-alarm systems rely on slow or unreliable methods such as telephones, messengers or a permeating stench.

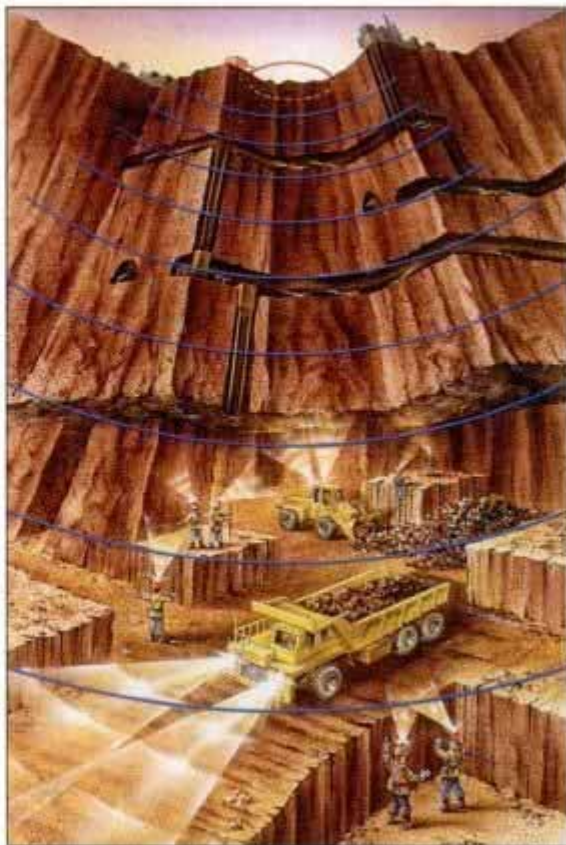
Taking a tip from submarine communications, however, the U.S. Bureau of Mines has successfully tested a system that can send a message throughout a mine instantaneously.

The hardware consists of an ultralow-frequency (ULF) loop transmitter at the surface, and small antennas in the caps and vehicles of each miner. When emitted, the ULF signal causes the miner's cap-lamps and vehicle headlights to blink rapidly, alerting personnel to an emergency.

Because the electromagnetic signal radiates in a spherical front, the loop could lie buried in the middle of a very extensive mine.

Two Canadian firms are already marketing a more advanced version that can relay messages to beeper-like devices worn by subterranean workers.

Rock-penetrating ultralow-frequency signal can alert entire mine to an emergency situation.



TM ILLUSTRATION BY DON MANNES

Robot Minds Manners



UNIVERSITY OF ROCHESTER PHOTO

If you set the table, then forget why, this robot can tell you, thanks to artificial intelligence.

ROCHESTER, NY—How nicely do you set a table? A robot programmed at the University of Rochester might be the best judge. The machine casts a stern eye over a place setting and renders a quick verdict. It'll also tell you whether you intended breakfast, lunch or dinner, if you didn't already know.

The robot is demonstrating artificial-intelligence constructs that quickly extract the most important information from a scene—techniques useful for analyzing medical images, for example.

The Incredible Tin-Can Audi

SOEST, GERMANY—Big steel, move over. The aluminum automobile has finally arrived in the form of the Audi A8.

The sedan, under production for 1995, will feature an aluminum space frame that weighs about 40% less than an equivalent steel version. The weight savings emerge even though the aluminum components are bulkier to ensure crash-worthiness.

Audi and Pittsburgh-based Alcoa have joined forces to design a unique factory around aluminum. In Audi A8 will build on a stiff, lightweight extruded-aluminum space frame engineered for crash safety.

stead of the extensive tooling required to form steel parts, the plant will feature a handful of extrusion dies to squeeze out frame beams. In addition, vacuum-cast aluminum nodes will provide strong joints between beams, while punch rivets will minimize welding.



ALFA PHOTOS



TM ILLUSTRATION BY JOE RODRIGUEZ

Radar Saves Children

KOKOMO, IN—Harried and distracted by their rambunctious cargo, school-bus drivers often feel they need an extra set of eyes to prevent accidents. Now radar apparatus from Delco Electronics and Hughes Aircraft will help a driver keep track of children as they swarm on and off the bus.

Called Forewarn, the system mounts microwave sensors below the front bumper and at the side of the bus. The units engage when the bus comes to a halt and the stop-arm extends. The radar monitors the driver's blind spots, triggering visual and audible warnings if a child moves into these zones.

Forewarn microwave radar alerts school-bus driver if children wander into blind spots.



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Basic

It Tastes Good. It Costs Less.

SURGEON GENERAL'S WARNING: Smoking By Pregnant Women May Result in Fetal Injury, Premature Birth, And Low Birth Weight.

© Philip Morris Inc. 1994

Kings: 16 mg "tar," 1.1 mg nicotine—av. per cigarette by FTC method.

Материал: дизайнерский авторский проект

It's operated by your foot, but doesn't cost an arm and a leg.



Introducing Murray's New Automatic Drive Riders.

Henry Ford made history by manufacturing a luxury everyone could afford. Now it's Murray's turn. With Murray's Automatic Drive Mower, everyone can enjoy the ease of 100% foot-operated automatic drive at about half the price of most dealer brands. There's no hard shifting, no jerking motion. And

when you consider that just one touch of the pedal controls both direction and speed, well, let's just say that for the money, it's definitely the easiest and quickest way to mow your lawn. Automatic drive is featured on both Murray and "Ultra by Murray" riders and can be found at fine retailers across the U.S.A.

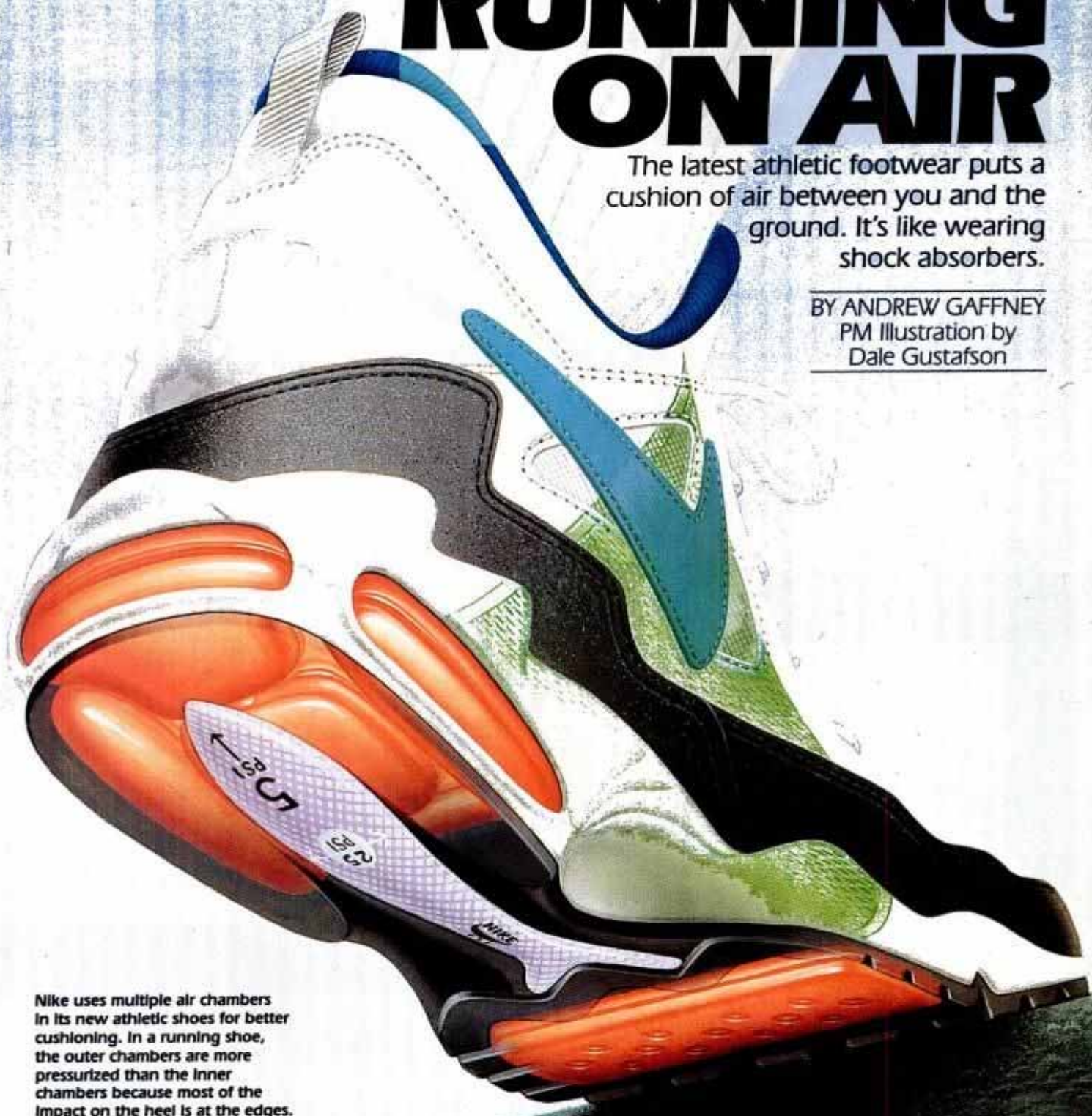


MURRAY.
Tough as they come™

RUNNING ON AIR

The latest athletic footwear puts a cushion of air between you and the ground. It's like wearing shock absorbers.

BY ANDREW GAFFNEY
PM Illustration by
Dale Gustafson



Nike uses multiple air chambers in its new athletic shoes for better cushioning. In a running shoe, the outer chambers are more pressurized than the inner chambers because most of the impact on the heel is at the edges.

• If you are one of the many weekend warriors still digging a pair of canvas Converse All-Stars out of the closet for occasional athletic outings, the next pair of sneakers you buy will likely be an experience comparable to trading in your old Chevy for a new Mercedes.

While the old Chuck Taylors were dependable enough to get the job done, the latest athletic footwear features lots of gadgetry under the hood to make your ride not only faster, but also more comfortable and safer.

Terms typically associated with cars, such as aerodynamics and shock absorption, are now important criteria in what is worn on the

RUNNING ON AIR

body's wheels. The most significant advancements have come in the areas of shock absorption and cushioning for your feet.

Where older sneakers traditionally consisted of a simple outsole stitched to a canvas or leather upper and a midsole with foam for some cushioning, the majority of today's higher-end models feature some type of cushioning or shock-absorption system. The first major breakthrough in this area was Nike's Air technology. Offered for the first time back in 1979, the Air system initially featured gas-filled bags inserted in the sole of the shoe to help cushion and return energy to the foot.

While the shape of the old Air bags limited the technology to linear uses, the new manufacturing process allows Nike to use multiple chambers to conform to different shapes and levels of air pressure for different parts of the foot. The idea is to diminish the



**BROOKS
THE TRUTH**



Brooks uses a rollbar (left) to give The Truth stability and durability.

500 pounds of impact a 150-pound runner feels 1000 times per mile, says Nike. For example, in a running shoe a higher pressure of 25 pounds per square inch (psi) is placed in the outer chambers of the heel where added cushioning is needed, as op-

posed to 5 psi in the inner chambers.

Almost every other athletic footwear manufacturer offers high-tech cushioning technology, designed to achieve similar goals. For example, Converse's React Juice is a combination of liquid and gas that adjusts to movements of the foot within the shoe. Converse uses the React Juice in the heel and the ankle of several of its high-end sneakers to provide cushioning, stability and support.

Rather than using a gas or liquid, Reebok's primary cushioning technology, Hexalite, is a honeycomb structure used primarily in the heel and the forefoot of the sole.

Although Reebok plans to continue using Hexalite as a shock absorber, the company is also working on translating its Pump technology into the area of cushioning. The Pump concept, which has been used as a custom-fit device in the uppers of shoes, now would allow you to adjust the level of cushioning you receive at different parts of the foot.

Similarly, Adidas' Tubular technology acts like a bicycle tire around the perimeter of the shoe for the ultimate in shock absorption. The Tubular shoes offer separate chambers with an integrated digital pressure gauge in the rear of the shoe to set varying degrees of pressure in the heel and forefoot area.

A more conventional cushioning system was unveiled earlier this year by L.A. Gear. Donzís Flak,

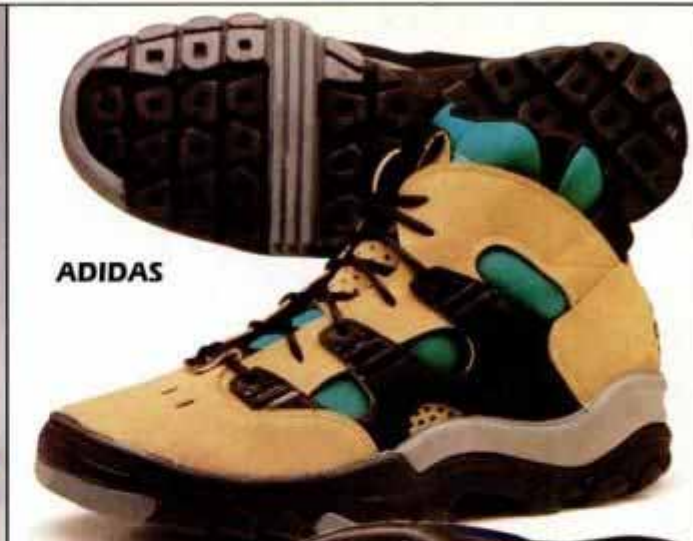
a technology originally developed to protect Army helicopter pilots in Viet-

Inside The Converse Backjam





TANEL 360



ADIDAS

nam, is being used by L.A. Gear as a cushioning system in several new sneakers. Rather than using a gas or liquid formula, Flak is a compressed foam-like material, resembling shaving cream, designed to provide cushioning while maintaining stability. L.A. Gear plans to use the material in the sole, midsole and sidewall of several of its new models.

Manufacturers are also careful not to make materials that are so bouncy that they forsake the foot's stability. Running shoe supplier Brooks has zeroed in on this issue with the recent introduction of The Truth. The shoe's midsole features a composite rollbar constructed of graphite, carbon-fiber plates and a urethane core to provide enhanced stability and durability. Brooks cites research indicating that its midsole "may last twice as long as its foam predecessors."

Athletic footwear suppliers also are making their interiors more comfortable for a smooth ride. In fact, some leading-edge shoes even include air-conditioning systems to keep your feet from overheating. Tanel, a leading supplier of cleated foot-

wear for sports, recently introduced its first basketball shoe, called the 360. The shoe provides an air-conditioning system—basically a one-way scuba-type valve designed to force the airflow outside of the shoe. The shoe also features the company's 3-D rebound system in the heel and midsole. In this system, two opposing dome units sandwich a set of compression/expansion rings for shock absorption.

Sneaker designers may aspire to emulate the temperature control of automobiles, but they don't share the vision of roomy interiors. Companies like Adidas are now using stretchy materials like neoprene as booties that conform to the shape of the foot. The liners are available in an assortment of colors and can be purchased separately.

Stretch materials are also being used to hold the foot snugly in place during athletic activities. Spalding, for



Tanel features a unique sole configuration (above left). Interchangeable booties from Adidas offer a tight fit and varied colors.

instance, will offer a men's shoe this fall that has a spandex inner lining.

Perhaps the most well-known gadget in providing a custom-fit sneaker is Reebok's Pump technology. Reebok introduced a new generation of the technology this year called Instapump. While the original Pump featured a manual device used to adjust the fit of the upper, the Instapump uses a separate CO₂ cartridge to inflate three separate chambers in the upper. By using the stretchable, inflatable chambers in place of heavier materials, the shoe's weight is reduced while still providing a custom fit.

A good fit is also an issue addressed in sneaker exteriors. Conventional shoe laces and tongues may eventually be rendered obsolete by one-piece spandex uppers and new closure systems. For example, Nike's Air Carnivore cross-trainer features an anti-inversion strap above the ankle to prevent sprains. Converse's Backjam takes a radical approach, featuring a deep V-cut in the rear and a back-strap closure system for alternative entry and added ankle support.

While all of these technologies will make sneakers more comfortable, and may even make you play a little better, they won't come cheap. Most of these high-tech models will sell for between \$100 and \$200. Yes, sneakers are becoming more carlike—the more add-ons that are built in, the higher the sticker price.

PM



REEBOK INSTAPUMP FURY

A CO₂ cartridge is used to inflate three separate chambers inside this very colorful Reebok athletic shoe. The inflatable chambers replace heavier materials, so the shoe is lighter while still offering a good fit.

AMERICA'S TOP-SECRET DOOMSDAY PLANE

Conceived to weather a Cold War apocalypse, the E-4B remains our government's ultimate refuge if nuclear-power relations turn stormy again.

BY KENNETH J. STEIN

PM Illustration by John Batchelor



• You are the president, and the unthinkable has happened. Neofascist extremists have seized control of the Kremlin and ordered a sweeping blitz into the Persian Gulf. To show they mean business, they've volleyed a dozen ICBMs at the United States. Washington, New York and Omaha, Nebraska, now lie in smoky rubble. But you were spirited away before the devastation and, flanked by top generals, now lead a tense meeting in a top-secret conference room—somewhere between Minneapolis and St. Louis, 35,000 ft. above a shattered nation. While the Pentagon and other strategic military bases are dust, a perfectly functional command center gives you every option you need.

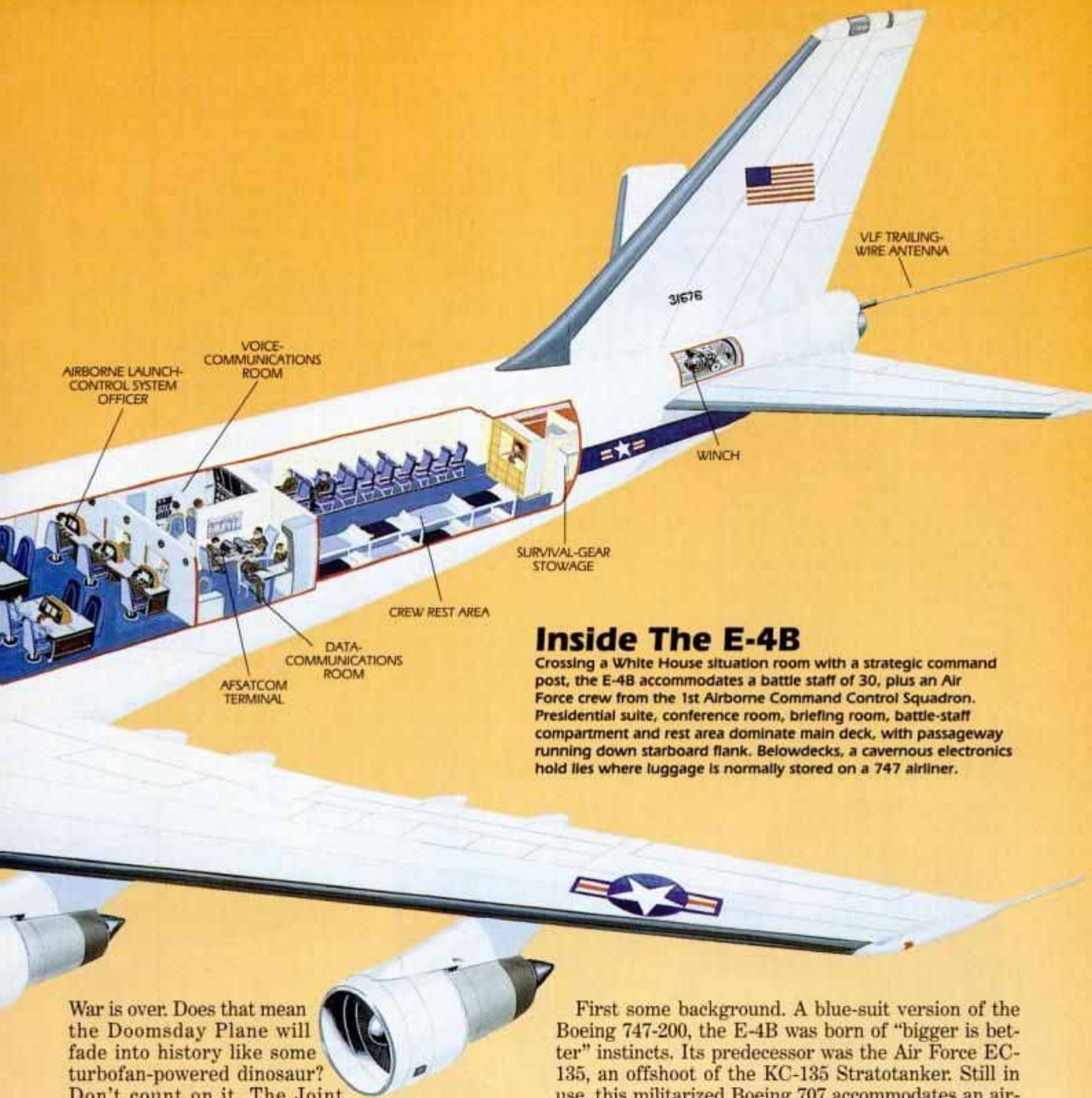
Welcome to the doomsday scenario. For this nightmare, the Pentagon hatched plans for the E-4B National Emergency Airborne Command Post, the

best of planes for the worst of times. No American military program symbolizes nuclear preparedness quite like NEACP (pronounced "kneecap" by the initiated). A White House with wings, NEACP exists solely to whisk the president and his underlying chain of command out of harm's way when nuclear hostilities loom.

As a constantly moving headquarters-in-the-sky, the E-4B would elude nuclear attack far better than ground-based or even subterranean facilities. Inside, a web of sophisticated communications and command-and-control technology would keep the finger of authority on the strategic button. While the Joint Chiefs of Staff have code-named the E-4B "Night Watch," the rest of the world knows it as the "Doomsday Plane."

True, the specter of nuclear doomsday no longer haunts international relations as it once did. The Cold





Inside The E-4B

Crossing a White House situation room with a strategic command post, the E-4B accommodates a battle staff of 30, plus an Air Force crew from the 1st Airborne Command Control Squadron. Presidential suite, conference room, briefing room, battle-staff compartment and rest area dominate main deck, with passageway running down starboard flank. Belowdecks, a cavernous electronics hold lies where luggage is normally stored on a 747 airliner.

War is over. Does that mean the Doomsday Plane will fade into history like some turbofan-powered dinosaur? Don't count on it. The Joint Chiefs will only say they are currently "reassessing" the role of the E-4B. But the Pentagon still keeps a stranglehold on information about this cherished asset. In 1987, in fact, the Joint Chiefs slapped the aircraft with a Sensitive Compartmentalized Information Facility certification—a tag that eclipses "top secret"—effectively sealing off the E-4B from the media. Still, enough is known publicly about the E-4B to reveal the extent to which our military will plan for a worst-case scenario.

In from the Cold War

Let's return to our doomsday scenario, with you in the president's shoes. Right now you'd probably be getting the rundown on your temporary new home.

First some background. A blue-suit version of the Boeing 747-200, the E-4B was born of "bigger is better" instincts. Its predecessor was the Air Force EC-135, an offshoot of the KC-135 Stratotanker. Still in use, this militarized Boeing 707 accommodates an airborne battle staff of 11, plus communications technicians and the airplane's flight crew.

In the communications network that makes up the National Military Command System, the EC-135 could—and still can—play many parts. The E-4B inherited one critical role from the EC-135: the Strategic Air Command (SAC) mission known as Looking Glass.

Looking Glass aircraft began flying on February 3, 1961, and continued for more than 30 years, ending only with the cessation of the Cold War. For all those years, an aircraft was always aloft, flying three shifts per day, around the clock. Each Looking Glass, with additional EC-135s supplying communications relays, was poised to take over direct control of bombers and ICBMs should SAC's well-publicized underground

DOOMSDAY PLANE

command post at Offutt Air Force Base in Omaha be rendered inoperative.

As it evolved, the EC-135 added new capabilities, including on-board plasma-display computers and direct hard-copy reception via Afsatcom satellite links. But eventually officials decided they just needed a bigger plane.

So in 1973, the Air Force awarded a contract under its 481B Airborne Command Post program, calling for acquisition of two new Boeing 747-200B jumbo jets, to be gut-renovated as command posts and designated E-4A. The new craft would open up floor space of 4620 sq. ft., compared with 873 sq. ft. for an EC-135. Initially, however, the command-and-control electronics for these original E-4As included only equipment transferred from EC-135s.

By 1975, with an additional contract award, three E-4A airplanes were equipped to assume NEACP duties, accommodating a battle staff of up to 30 personnel. Not until 1980 was a fourth airplane, designated E-4B, added to the fleet, able to perform as either NEACP or Looking Glass. As of 1985, all four airplanes were modi-

fied to E-4B standards, to be flown exclusively by the 1st Airborne Command Control Squadron from Offutt AFB. New wiring supported the SAC mission that enabled a Looking Glass—with proper authorization—to unleash the ICBMs if their ground control centers became inoperative.

Launch-control officers would bring their ominous black boxes with them if the E-4B was to fly Looking Glass.

High and low

So much for history. Next on your briefing is a rundown of the big bird's distinctive suite of electronics. Two systems—at the top and bottom of the radio spectrum—stand out as the calling cards of the doomsday scenario.

One is the 33-in. satellite antenna dish housed in a dome that protrudes behind the plane's trademark 747 hump. Built by RCA, the 11-kw antenna benefits from the dense data rate of superhigh-frequency (SHF) communications. The dish's pointing system derives aircraft-position data from navigation systems and zeros in on a Defense Satellite Communications System (DSCS) spacecraft high overhead in geosynchronous orbit. Spread-

spectrum technology disguises message content as noise on radio sidebands, providing anti-jam protection. Through this system the president can maintain tamper-proof voice and data communications with American strategic forces worldwide.

The other distinction is the 200-kw, state-of-the-art very-low-frequency (VLF) transmitter housed at the tail end of the fuselage. Through a 5000-ft. trailing-wire antenna, the president can issue commands to ballistic-missile submarines. Although VLF offers a very low data rate, the radio waves can penetrate the ocean. Sub commanders can thus receive terse orders without surfacing and compromising their locations.

Inner sanctum

Now we'll take you on a tour of the E-4B, starting with the stateroom suite. These deluxe facilities are furnished with a desk, conference area, double-deck bunks, private toilet facilities and other touches to accommodate the National Command Authority—the president, a member of the Joint Chiefs or a duly designated representative.

Let's walk fore to aft through the four other major compartments that make up the main deck space.

First is the high-level conference room, dominated by a 9-person table.



Switchboard In The Sky

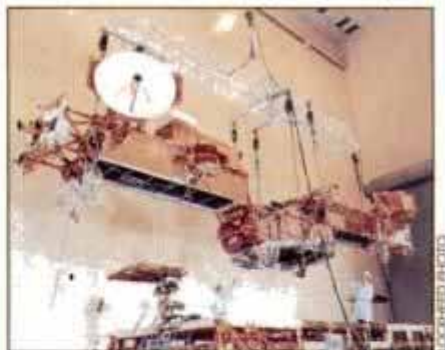


● How might the Pentagon harness a nuclear warhorse like the E-4B for today's conventional, regional-conflict scenarios? A brand-new satellite system—Milstar—may offer an analogy. Developed to relay communications during a protracted nuclear war, Milstar could do just that, says the Air Force. But as a follow-on to the DSCS III satellite, it's more likely to serve as the ultimate switchboard between stateside tactical commanders and overseas field units.

The first of six Milstar spacecraft went up on February 7. At 10,000 pounds, Milstar is the biggest satellite ever put into geosynchronous orbit. With that weight

comes heavy responsibility. As a strategic satellite, Milstar would transmit orders from the E-4B NEACP during an all-out nuclear war. It's radiation-hardened to withstand electromagnetic pulse, and intelligent enough to recover from system failures that wipe out other satellites.

But where Milstar excels is in evading enemy attempts to neutralize it. "Milstar is the F-117 of satellite communications," says Brig. Gen. Leonard Kwiatkowski, the Pentagon's program director for military satellite communications. Its unparalleled anti-jam capabilities include frequency-hopping, by which a transmission's frequency changes in random jumps. In ad-



Developed for nuclear scenarios, huge Milstar takes jam-proofing a step further.

dition, the satellite needs no tracking-and-control center, always an inviting target during wartime. Ultimately, Milstars will bounce signals via direct satellite-to-satellite crosslinks, without using vulnerable ground stations.

All this power comes at a price, however. Officials will have spent at least \$17 billion by the time the sixth Milstar is in place, and the final four satellites will have scaled-back capabilities suited for tactical, rather than strategic, communications. Ironically, the first Milstar went up while President Clinton was speaking with a Russian cosmonaut aboard the shuttle. Still, if the world situation does change, the president can always rely on Milstar for secure communications.

—Philip Chien



AIR FORCE PHOTO

Just aft of the conference room is a projection room that can illuminate screens in both the conference room and the adjacent briefing room.

The briefing room itself houses a table and three high-backed chairs that face forward. During a Looking Glass mission, they'd be occupied by the Airborne Emergency Actions Officer—required to be an Air Force general—and his staff members.

The next room back—the largest on the airplane—is the battle-staff compartment, which provides about 30 desks for intelligence, logistics and operations planners, various controllers for force status, emergency actions, operations and communications, plus weather, reconnaissance and other officers. Airborne Launch Control System officers would also sit here. To activate airborne launch, these officers would each turn a key inserted in their black boxes, while the aircraft's pilot would concur with a third key.

Next aft is the communications area, which divides voice and data links longitudinally. A staff of 15—more than double that aboard an EC-135—operates and monitors all communications facilities. A stairway from this compartment leads down to the aft lower-lobe equipment areas, which include an electronics maintenance shop and a control station for the hydraulic winch that reels and stores the trailing-wire VLF antenna.

To move fore and aft, personnel can follow a passageway on the starboard side. Near its front end, a stairway descends to the forward lower lobe, filled with equipment bays that house extensive communications and cryptographic systems.

Nothing but the best

Although the Pentagon won't break its code of silence about the E-4B, it's clear that the planes have enjoyed continuous improvement. For example, a 1990 report recommended installation of aircraft-wide fiberoptics to ease integration of new elements

E-4B COMMUNICATIONS

Although the E-4B can broadcast across the full radio spectrum, very low frequencies can penetrate water to reach submerged subs while jam-resistant superhigh frequencies carry commands to ICBM silos.



PM ILLUSTRATION BY KURT FOWAR

into the command-and-control system. Also in 1990, earlier funding was increased for computer upgrades in both E-4B and EC-135 aircraft.

Mechanically, the E-4Bs boast top-flight equipment. All four airplanes have been retrofitted with high-bypass-ratio General Electric CF6-50E2s to replace the original Pratt & Whitney JT9D engines. In addition, an engine oil-transfer system supports very long flights. The fleet is equipped for in-flight refueling, and tests of aircraft and crew endurance have extended to 30 hours.

Meanwhile, special attention was given to meeting the electrical-power demands of the communications systems. Each of the four main engines is equipped with two 150-kilovolt-amp (kVA) generators, providing a total of 1200 kVA. In addition, two auxiliary power units, operable up to about 20,000 ft., put out 90 kVA each. The airplanes also carry extra air-conditioning capacity to cool the electronics installations.

Role player

While it bristles with unique technology, the E-4B faces an uncertain future.

When the Soviet Union disintegrated, Looking Glass flights were officially terminated and NEACP became moot. The mission of the E-4B is reportedly now undergoing an extensive reassessment by the Joint Chiefs of Staff.

Future military planning may well address limited encounters, more like Desert Storm than *Red Storm Rising*. In such localized conflicts, effective battle direction and coordination may come closer to the scene from such systems as the Air Force E-3A AWACS or the new E-8A Joint-STARS. What role a distant command-control platform like the E-4B could play is a question mark in a world that has suddenly changed.

At the same time, the world could easily change again, throwing the United States back into tension with a newly hostile Russia. It is undoubtedly for this possibility, personified in hard-liner Vladimir Zhirinovskiy, that the Pentagon continues to keep a close wrap on the E-4B's capabilities. Ironically, those capabilities might only reveal themselves under the grim scenario in which the Doomsday Plane lives up to its nickname.

PM



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ON TARGET

The best new products hit a bull's-eye at the SHOT (Shooting, Hunting, Outdoor Trade) Show in Dallas.

BY JOE SKORUPA, Boating/Outdoors Editor

● You walk into the Dallas Convention Center and look around. Over there, James Bond's Walther PPK. Down the aisle, Dirty Harry's Smith & Wesson .357 Magnum. Scattered around the room are Colt .45s, Glock 17s, Winchester lever-action rifles, Weatherby shotguns, Remington pump rifles and just about every other celebrated firearm you can think of. No, this isn't the firearms hall of fame. This is the annual SHOT (Shooting, Hunting, Outdoor Trade) Show, the world's largest marksman's and outdoorsman's emporium.

Guns are very much in the news these days associated with violent crime, but the firearms at the SHOT Show are intended for hunting, target shooting and collecting. And they are state of the art, featuring laser sights, recoil reduction weights and vents, and cantilevered scopes mounted on indestructible barrels with synthetic stocks.

Beyond firearms, hot products include locking systems and optical sights (as opposed to scopes). And speaking of hot products, a new all-weather fire-starter kit is a real scorcher. Here are the nine top products of the SHOT Show. Kit Carson would be green with envy.



Splat, You're Red

For serious paintball shooters, the EXC-68 (\$350), by Benjamin Sheridan of East Bloomfield, New York, features a new expansion chamber that provides the power to shoot twice as many balls per CO₂ tank while maintaining consistent velocities. This 6-pound open-bolt semiautomatic pistol with a 10-in. barrel offers an edge to shooters hunting after targets that can actually shoot back.



Locked-On Laser

Laser sights have been slow to catch on because they're add-on units that often don't precisely mesh with frames. Now the Laseralm Series I pistol (\$795), by Emerging Technologies of Little Rock, Arkansas, eliminates this problem by designing a frame that comfortably accepts a laser sight. The Series I pistol, which is available in .45-caliber or 10mm models and 6-in. or 4 $\frac{3}{8}$ -in. barrels, also features a dual-port compensated barrel and a vented slide.

In Like Flint

The job of igniting kindling in wet, windy conditions can be a major headache. In some cases, it can mean survival. To get the job done quickly, Gerber, of Portland, Oregon, has come out with the Strike Force Fire Starter System (\$20).



It features a self-contained flint rod, striker bar and two tinder cubes that

ignite easily, even when wet. The entire Strike Force Fire Starter System loads into a high-impact case.



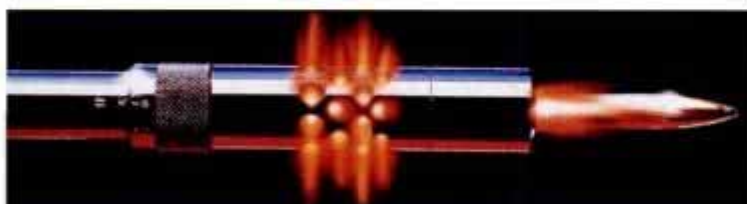
Line Of Fire

Mossberg, of North Haven, Connecticut, shows its innovative capabilities by adapting its all-weather Model 590 shotgun for emergency use. The new single-shot unit, called the Mariner Line Launcher (\$999), has a special chamber for firing line-launching blanks and an under-barrel canister that holds up to 700 ft. of line. The line shaft has a screw-off canister tip that holds a chemical light stick.



Wide-Angle Vision

Although originally designed for military use, the Elcan Optical Sight (\$845), by Hughes Lertz Optical Technologies, will appeal to hunters because of its good and wide apparent field of view (27.2"). The outer casing is made of a resilient thermoplastic. For those looking for easier scope-sight acquisition, contact the Ontario, Canada-based company for further information.



The New BOSS

Browning's done it again. The Morgan, Utah-based innovator rocked the firearms industry this year with the introduction of the Ballistic Optimizing Shooting System (BOSS), which eliminates barrel vibration and recoil. The result is significantly improved accuracy. Browning BOSS-equipped centerfire rifles include the A-Bolt bolt-action and BAR Mark II semiauto. The BOSS is an \$80 option that's fitted at the factory and can't be purchased alone.



Locked And Uncocked

When a semiautomatic pistol is put away, you want it secured against unauthorized tampering. The semiautomatic pistol lock (\$15.95) by Safegun, of Forestville, Maryland, accomplishes this by fitting into the firing chamber and expanding outward to lock into place. This tough unit is difficult to defeat and fits most semiautos. The Saferev Lock performs the same function for .38 Specials.



Rare Air

The semiautomatic 1077 RepeatAir CO₂ rifle (\$65), by Crossman of East Bloomfield, New York, debuted with a bang. Actually, it debuted with 12 bangs or rounds of .177-caliber pellets that were fired from a rotary clip in just a couple of seconds. Semiauto air rifles are new to marksmen, and the Crossman 1077 RepeatAir leads the way into a rapid-fire new era.



Rugged As All Outdoors

Some hunters have to work a little harder for their game. To help out, Remington has designed a Special Purpose series of shotguns with synthetic stocks and cantilevered scope-mount

barrels. The Remington 11-87 SPS (\$699), an autoloader with a fully rifled 21-in. barrel, comes with a nonreflective matte-black finish and a black stock. A Cordura sling is also standard.



FLATS

Dedicated fishing features and shallow-water performance converge in a 6-way flats boat shootout.

BY MARK WEINTZ; PM Photos by Skip Gandy

● Top anglers flock to the waters around Florida's Captiva Island because of its passes to the Gulf of Mexico, mangrove-encrusted islands and tidal flats, all teeming with game fish. To fish these unique waters effectively, you need a boat that can run in a foot of water, and then be poled silently to stalk wary snook, redfish and channel bass.

For many years, the allure of fishing on flats boats was

confined to places like this in Florida, but in recent years its popularity has exploded from Maine to Texas. Currently, flats boats are the hottest-selling saltwater rigs in the country. For anglers who embrace them, the ultimate thrill is to land a feisty fish on light spinning or fly tackle.

Their ultimate weapon is a dedicated flats boat with specialized fishing and performance features. To find out which models are the best of this breed, we brought together six top rigs for three days of fishing with guides and performance testing by the PM test team. Here are the results.

Hewes Light Tackle 20

Renowned for making the first production flats boat more than a quarter century ago, Hewes' most recent model is



MAKO 181 FLATS



SILVER KING
GRANDE MASTER 18

OUT

the Light Tackle 20, which adds a couple of new twists, such as a flip-up bench seat and a deeper freeboard for a better rough-water ride. In addition to leading the fleet in overall length, cockpit depth and deck area, the Hewes also boasts the most rod storage area (16 rod holders) and the largest fuel capacity.

Being the largest boat, the Hewes is able to create an open, uncramped cockpit despite incorporating a big center console. It also has enormous storage spaces.

The solid feel of the boat comes from Klegecell coring. The excellent rough-water ride is produced by a variable-V hull with running strakes that converge at a transom notch. The Light Tackle 20's performance figures are in the middle of the pack, but this is respectable considering

the boat could handle an additional 50 horsepower.

The tilt wheel is a nice touch, as is the 750-gph livewell pump. Overall, the 2-year-old Light Tackle 20 keeps Hewes in the forefront of an increasingly competitive class.

Hydra-Sports 1900 Key Largo Flats

While everything about the Hewes addresses tradition, everything about the Hydra-Sports 1900 Key Largo addresses a new era in flats boats. It starts with sleek fiberglass work and designer good looks, and, beneath the skin, it continues by providing the fleet's most impressive ride.

The saltwater expertise of Hydra-Sports shines through in a boat that bears a resemblance to a bass boat. Like a bass boat, the variable-V hull has a recessed transom pad

FLAT OUT

and a stepped bottom. Not surprisingly, it blasted to the fastest top speed of the bigger boats. Where the Hydra Sports differs from a bass boat is in its handling. The rock-solid ride was outstanding, especially in wind-blown chop.

The Hydra Sports is a cornucopia of fishing and performance features: cast-net storage locker, anchor locker, trim tabs and full dash instrumentation, to name a few. Throw in an Evinrude 150-horsepower out-



HYDRA-SPORTS 1900 KEY LARGO FLATS



RANGER 184 FLATS

board plus a trailer, and the package price for the Key Largo makes it a well-loaded value leader.

Ranger 184 Flats

Known as king of freshwater bass boats, Ranger has ventured offshore in recent years. Its most recent venture is the 184 Flats, which, like the Hydra-Sports Key Largo, helps usher in a new era for flats fishing.

Want to grab a rod from a storage locker? Just flip open the gunwale.

The padded interior of this unique rod locker safely cradles expensive fishing outfits, which drip-dry through an open bottom. Hatches silently flutter closed, thanks to gas shocks. A posh bench seat is concealed beneath the rear deck.

Despite being the heaviest boat, the 184 Flats led the fleet in hole shot. Other top marks were in storage volume and side-deck width. Outstanding standard features are an anchor locker, trim tabs, hydraulic

steering, poling platform and 1000-gph livewell pump, although the 25-gallon well is somewhat small.

Although relatively new to salt-water, the 184 Flats rounds out the top tier of our fleet and upholds Ranger's freshwater reputation.

Silver King Grande Master 18

Designed to pursue the mighty tarpon, the Silver King Grande Master 18 is a versatile fishing machine.

The nearly flat-bottomed hull and straight-up sides help give this boat a shallow draft, but also create hydrodynamic drag, hence the back-of-pack performance marks. While the Ranger trades off cockpit space for fishfighting deck area, the Silver King does the opposite. Which is best? We prefer deck area.

Splatter-coated inside hatch surfaces and lack of an anchor locker are minor glitches easily overcome by such outstanding standard features as: hydraulic steering, poling platform, pole and trim tabs. One feature



HEWES LIGHT TACKLE 20



HYDRA-SPORTS 1900 KEY LARGO FLATS



KEY WEST 1760 STEALTH

SPECIFICATIONS AND DIMENSIONS

MANUFACTURER/ MODEL	BASE PRICE/ PRICE AS TESTED	ENGINE/ HORSEPOWER	PROP/ FUEL CAPACITY	LENGTH/ BEAM	WEIGHT (LESS MOTOR)/ DRAFT	TOTAL DECK AREA/SIDE-DECK WIDTH	CASTING PLATFORM/ REAR DECK	COCKPIT AREA/ DEPTH	STORAGE VOLUME/ LIVEWELLS
Hewes Light Tackle 20	\$12,000/ \$21,000	Yamaha Pro-V/ 150 hp	14 1/4 x 21 1/2" 56 gal.	19' 10 1/2" 7' 10"	1100 lb./ 11"	100.3 sq. ft./ 13 1/2"	47 sq. ft./ 38.5 sq. ft.	27 sq. ft./ 16 1/4"	29 cu. ft./ 1 bait well
Hydra-Sports 1900 Key Largo Flats	\$18,995/ \$21,200	Evinrude EL/ 150 hp	13 1/2 x 25 1/2" 50 gal.	19' 1 1/2" 7' 5"	1145 lb./ 11"	97.4 sq. ft./ 11"	51 sq. ft./ 33 sq. ft.	24 sq. ft./ 14"	29 cu. ft./ 1 bait well
Key West 1760 Stealth	\$10,000/ \$19,200	Suzuki EFV/ 150 hp	14 1/4 x 25 1/2" 40 gal.	17' 6 1/2" 7' 8"	1000 lb./ 10"	86.6 sq. ft./ 13 1/2"	43 sq. ft./ 29.3 sq. ft.	30 sq. ft./ 13"	17 cu. ft./ 2 bait wells
Mako 181 Flats	\$11,999/ \$22,525	Suzuki EFV/ 150 hp	14 1/4 x 24 1/2" 50 gal.	17' 10 1/2" 8' 0"	995 lb./ 10"	92 sq. ft./ 14 1/2"	46.5 sq. ft./ 30.2 sq. ft.	30.4 sq. ft./ 11 1/2"	23 cu. ft./ 1 bait well
Ranger 184 Flats	\$14,660/ \$22,500	Mercury/ 150 hp	14 1/4 x 21 1/2" 48 gal.	18' 11 1/2" 7' 9"	1350 lb./ 13"	95 sq. ft./ 14 1/2"	50 sq. ft./ 31 sq. ft.	33 sq. ft./ 14"	44 cu. ft./ 1 bait well
Silver King Grande Master 18	\$14,800/ \$29,600	Yamaha/ 150 hp	14 1/4 x 20 1/2" 44 gal.	18' 8 1/2" 7' 7"	1150 lb./ 10"	93.4 sq. ft./ 11 1/2"	43 sq. ft./ 37 sq. ft.	38 sq. ft./ 14 1/2"	25 cu. ft./ 1 bait well

*Boat, motor and trailer package.



KEY WEST 1760 STEALTH



HEWES LIGHT TACKLE 20

we especially liked is the carpeting behind the horizontal rod holders, which nicely protects tackle.

Key West 1760 Stealth

Although the smallest boat tested, the Key West 1760 Stealth held its own and performed remarkably well while offering exceptional value.

A solidly built fishing machine, the Stealth is a speed lover's favorite. With its light bow high out of the water, it ran as fast as a bass boat,

which seems to have been part of its inspiration. A relatively flat hull has a notched transom and comes with standard trim tabs.

Top features include: two plugs for 12/24-volt accessories, twin livewells, 12 rod holders, anchor locker and standard pole and platform.

If value attracts you to this punchy performer, then consider powering down to a 115-hp outboard. You'll improve economy and lose none of the Stealth's exceptional fishability.

Mako 181 Flats

Best known for bluewater fishing boats, Mako now offers four flats models, including the 181. Small in some ways—such as weight, freeboard, cockpit depth, deck area and storage volume—the Mako is big in others, such as side-deck width, cockpit area and beam.

The 181 Flats didn't easily assume a balanced running attitude, and its back-of-pack performance marks showed it. We were also surprised by the boat's fit and finish, which was clearly not up to Mako's bluewater standards. One glitch: horizontal rod racks that wouldn't accept standard 7-ft. rods.

With a low base price, the 181 can be viewed as a work in progress, which is typical for fishermen who often customize their rigs.

Our flats fleet was divided into big boats and small. Overall, the Hewes, Hydra-Sports and Ranger (all big) comprise the top-quality tier, while the Key West easily wins in the small-boat category. **PM**



MAKO 181 FLATS

RANGER 184 FLATS

SILVER KING GRANDE MASTER 18

TEST RESULTS

POLING PLATFORM AREA/HEIGHT	MAX. RATED HORSEPOWER/LIVWELL PUMP	SPECIAL FEATURES	ACCELERATION (0-25 MPH)/TOP-END SPEED	FISHABILITY RANKING	OVERALL RIDE RANKING	FIT & FINISH RANKING
6.77 sq. ft./37½"	200 hp/750 gph	Hydraulic steering, flip-up bench seat	7.38 sec./54 mph	1. (tied) 16 rod holders, big decks, great range	3. fine ride but 200-hp outboard would add zip	3. solid overall but outshone by top tier
4.54 sq. ft./31½"	175 hp/700 gph	Full instrumentation, trim tabs, anchor locker	7.20 sec./55 mph	1. (tied) only cast-net locker, huge casting platform	1. peerless at speed and in rough water	1. (tied) sets a new standard for others to meet
6.50 sq. ft./38"	150 hp/twin 500 gph	Pole, platform, trim tabs, anchor locker	5.98 sec./61 mph	2. (tied) 12 rod holders, twin wells, wide side decks	4. (tied) light bow airs out at speed like a bass boat	2. (tied) sound and solid inside and out
6.83 sq. ft./35"	150 hp/360 gph	Hydraulic steering, trim tabs	7.49 sec./51 mph	3. problems with rod storage, weak bait-well pump	4. (tied) sluggish for a reportedly light hull	4. not up to Mako bluewater standards
8.93 sq. ft./35"	175 hp/1000 gph	Poling platform, trim tabs, anchor locker	5.98 sec./53.5 mph	1. (tied) great tackle storage, wide side decks	2. (tied) top-tier performance in all conditions	1. (tied) second to none, sets a new standard
7.85 sq. ft./38½"	175 hp/700 gph	Hydraulic steering, pole, poling platform, trim tabs	7.42 sec./49.5 mph	2. (tied) shallow draft a plus, good overall design	2. (tied) sound but sluggish ride, change of prop might help	2. (tied) fine workmanship overall, no glitches

AMERICAN CLASSICS

WINCHESTER MODEL 94

Celebrating 100 years and 6 million units made, Model 94 sets a standard that makes it the most popular lever-action deer rifle ever.

BY ALEX ZIDOCK JR.

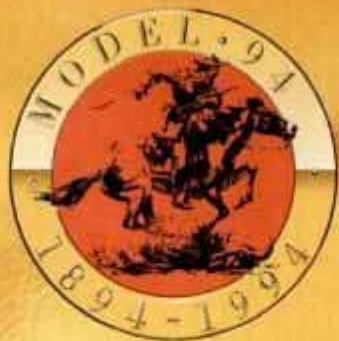


If any firearm can lay claim to the title "America's Rifle," it is Winchester's celebrated Model 94. After the slim, light, beautifully balanced rifle was introduced in 1894 by the U.S. Repeating Arms Co. (USRA), of New Haven, Connecticut, it went on to become the firearm of choice for homesteaders, hunters, outlaws and lawmen of the Wild West.

As a testament to the practicality of its design, the Model 94 has maintained its popularity throughout the decades with few mechanical changes. Now in its centennial year, more than 6 million Model 94 rifles and car-

tridges have found their way into the homes and hearts of hunters across America. And few would quibble with the assertion that the Model 94, with its equally celebrated .30-caliber Winchester Center Fire cartridge (.30 WCF), is the most popular, widely used big-game hunting combination in the history of sporting arms.

When the Model 1894 came along, there was no doubt about its purpose: It was a hunting rifle. But it wasn't just another hunting rifle. Its design revolutionized the firearm industry and set a standard by which all other hunting rifles were to be measured.



The legacies of founder Oliver Winchester (above) and the Texas Rangers (right) are found in an original Model 94 (top firearm) and a commemorative (bottom firearm).



Model 1894 appeared during a key transitional phase when black powder was on its way to being supplanted by the high-pressure loads of fast-burning smokeless powder. At the time of the 94's introduction, smokeless powder was already being used in the .30-40 Krag military round, but it wasn't available as a sporting choice.

Built according to a patent purchased from pioneering firearm designer John Browning, the Model 1894 was originally developed to shoot two popular metallic black-powder cartridges: the .32-40 and the .38-55. However, one year later in August 1895, the Model 94

became the first American-made repeating sporting rifle to handle a smokeless-powder cartridge. To accomplish this, Winchester strengthened the action by using a new steel alloy and by adding a nickel-steel barrel. The rifle was then married to the new .30-caliber Winchester Smokeless cartridge, and a new era in sporting firearms was born.

One of the first advertisements for the new rifle/smokeless-powder cartridge combination claimed the bullet would have a velocity of more than 1800 ft. per second and give "a penetration of 33½ pine boards of

WINCHESTER MODEL 94



$\frac{3}{8}$ -in. thickness." Although it sounded impressive, the new sporting arms combination was a hard sell.

The problem was that it had to compete with the most popular deer rifle/cartridge combination of the era—the Winchester Model 1873/black powder. Many hunters felt the smaller

.30-caliber bullet would be too slight to cleanly take mule deer, elk and moose. They looked at the little hole at the end of the Model 94 barrel and the big hole at the end of black powder 73 and judged the 94 to be too light for big game.

However, by 1910, Winchester listed the .30 WCF at a muzzle velocity of just over 2000 ft. per second, which meant it could send a 170-grain, metal-jacketed lead-core bullet 200 yards with a midrange trajectory of just $5\frac{1}{4}$ in. above a straight line. By contrast, using the same 200-yard distance, a .44-40 all-lead bullet pushed by black powder had to be elevated 16 in. at midpoint to hit the target. Since game was getting harder to find at the turn of the century and longer shots were becoming the norm, the Winchester combination soon became the sporting arm of choice.

From the beginning, Winchester offered the 1894 in two versions: the 20-in. round barrel, for saddle-ring carbines, and the 26-in. round or half-octagon barrels, for the solid take-down rifles. However, other variations of the 94 appeared in the first decades of production.

For example, Model 94s exist with half-round, half-octagon barrels in lengths from 14 in. to 36 in. Magazines can be found that hold from three to eight cartridges. And since the slab sides of the firing mechanism were perfect for engraving, 94s exist with varying degrees of ornate designs and overlays.

By the time the century ended, there were approximately 200,000 Model 94s being used. By 1902, when the .32 Winchester Special cartridge was introduced, more than 250,000 of the 94s had been built. In 1927, the millionth 94 was presented to President Coolidge. In 1948, No. 1.5 million was presented to President Truman. And in 1956, President Eisenhower accepted No. 2 million. Today the mark is well beyond 6 million.

Besides regular yearly productions of five rifle and carbine models, dozens of Model 94 commemoratives

have been produced over the years, and many fetch hefty prices from collectors. While the value of an original Model 94 built between 1894 and

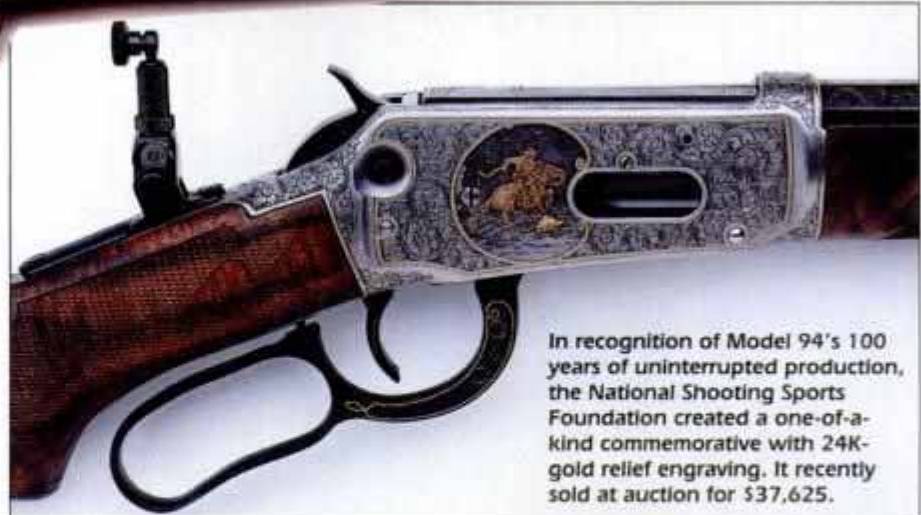
1937 is about \$800, the Alaska Purchase Centennial Commemorative Carbine, which was produced in 1967, is now worth about \$1800. Other sought-after commemoratives are the Theodore Roosevelt Rifle, the Texas Ranger Carbine, the Wells Fargo Carbine and the one-of-a-kind 24K gold relief model built for the National Shooting Sports Foundation.

For the Model 94 centennial year, three limited-edition reproductions will be offered, beginning with the New Model 94 Custom Limited Edition Centennial rifles (\$4684). Only 94 of these will be made, featuring 26-in. half-octagon barrels, rear tang-mounted sights, hand engraving and gold inlays.

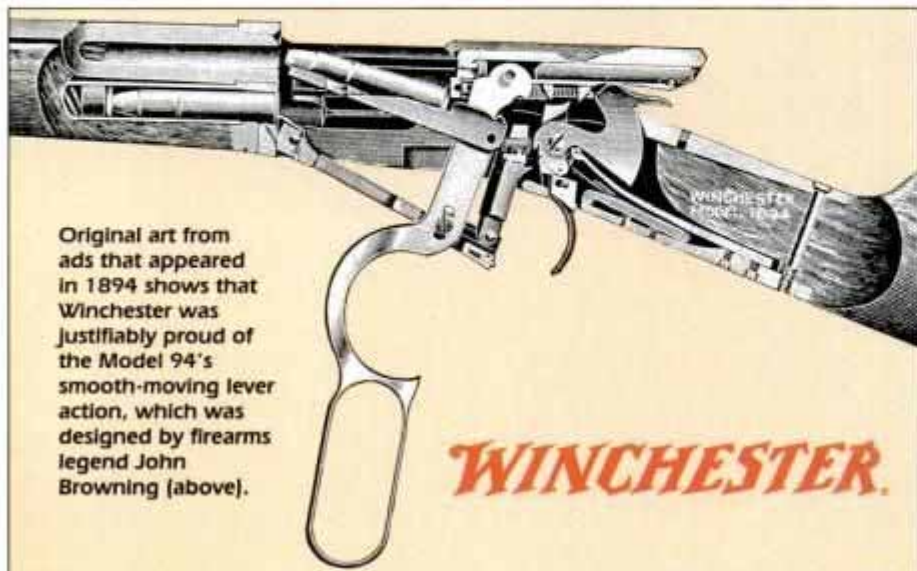
USRA will also produce 3000 New Model 94 Limited Edition High Grade rifles (\$1272), which are engraved and checkered in classic styles. A third commemorative will be the New Model 94 Limited Edition Grade 1 rifle (\$811), of which 12,000 will be produced.

In the early days, Model 94's appeal might have been because of its near-perfect action and highly accurate .30-caliber smokeless cartridge. And while these attributes are as popular today, there's an added benefit to owning a Model 94. You join a large number of owners from presidents to paupers and from the famous to the forgotten who have made the Winchester Model 94 the sporting arm of choice. When you carry a Model 94 into the field, you carry a true piece of Americana, and the Wild West comes alive in your hands.

PM



In recognition of Model 94's 100 years of uninterrupted production, the National Shooting Sports Foundation created a one-of-a-kind commemorative with 24K-gold relief engraving. It recently sold at auction for \$37,625.



Original art from ads that appeared in 1894 shows that Winchester was justifiably proud of the Model 94's smooth-moving lever action, which was designed by firearms legend John Browning (above).

WINCHESTER.

The Changing Face Of Cellular Phones

A clear signal that also carries data is the hallmark of a new digital system.

BY GEORGE MANNES

• Cellular telephones are entering a new age. More than a decade after cellular telephones debuted in the United States, wireless phone service blankets the country and serves more than 13 million customers. New customers are signing on at the rate of 11,000 per day. Now, in the midst of all this, new products and new transmission schemes are expanding cellular's availability and making it easier to transmit not just voices but all sorts of useful data.

One new device that promises to revolutionize cellular telephony is the Simon telephone, scheduled to go on sale this year from BellSouth Cellular Corp. A handheld cellular phone with a 1.4 x 4.5-in. LCD touchscreen instead of a traditional keypad, the Simon is an all-in-one gadget for wireless communication. You can use the Simon not only to phone somebody, but also to send and receive faxes and electronic mail. Moreover, the



Simon functions as a pager, a pen-based electronic scratch pad and an organizer with an appointment calendar, address book and calculator.

Familiar-looking to anyone who has operated a Macintosh or Windows-based computer, the Simon's icon-based control/display screen changes for different applications. It can display the telephone's keypad, a fax that's been received, a list of phone numbers of people who have been trying to reach you or a message you've received through the Simon's alphanumeric paging option. You can use a small stylus to make on-screen selections or scribble out an outgoing fax.

While Personal Digital Assistants (PDAs) from such companies as Apple and Tandy have gotten a lot of attention, the less-publicized Simon, designed by IBM, has certain advantages. Unlike the Apple Newton and the Tandy Zoomer, the Simon is a phone: You can use it to call Dad in Boise. The Simon can also easily send people data, not just receive it.

One feature these other devices have that the Simon lacks—but which few may miss—is handwriting recognition, the theoretically cool (but in reality imperfect) software that converts your on-screen handwriting into a computer's characters. You can write or draw on Simon's sketch pad or on a received fax, but the machine can't convert your script to type. For situations where you need to type—say, preparing outgoing E-mail—Simon includes what's called a predictive keyboard. Instead of displaying all the letters of the alphabet for you to choose from, the Simon displays only the six letters that its software deems most likely to follow the preceding letter. If these six don't include your choice, you can push a button to access the next likeliest set of letters.

Simon is a little short on memory, however. Under normal usage, Simon can hold only about a 3-page fax. An optional plug-in flash memory adds another 10 to 12 pages.

Simon is expected to go on sale nationwide (except in Alaska, where cold weather limits the usability of the device's screen, according to a BellSouth executive) this spring. The Simon



NOKIA
The 2120 features a 30-character display and a continuous diagnostic readout.

doesn't rely on any special cellular network hardware or software, so it works on any system.

As cellular phones grow in popular-



ity but the wireless spectrum allotted to cellular service stays the same, system owners are revamping their networks to expand their capacity and provide other services to consumers.

Ever since cellular telephones were introduced in the United States,

they've all used the same standard to govern the over-the-air signals transmitted to and from each phone. This universal air-interface standard is called Advanced Mobile Phone Service, or AMPS. In an attempt to squeeze more voice channels into its networks, cellular supplier Motorola developed an air-interface standard called Narrow-band Advanced Mobile Phone Service (NAMPS), which splits up conventional voice channels into three smaller ones.

Like AMPS, NAMPS is an analog system, meaning that the shapes of radio waves physically correspond to the voices they transmit. But unlike AMPS, the newer system can be used with a control channel that handles functions beyond the usual billing and security. One of the benefits of this control channel is that it lets the cellular company offer paging services through people's phones. Let's say someone is trying to reach your NAMPS phone but you've turned it off. Instead of having to call again, the caller can page you by keying in a phone number, a short text message or a voice-mail message. When you turn your phone back on, you're alerted that you have a message waiting.

Other new air-interface standards are digital, meaning that voice is converted into the 0s and 1s of computerized bits before it is transmitted over the air. Like NAMPS, these systems have a control channel that can be used to provide paging and voice mail.

These digital systems promise two additional consumer benefits. One is greater privacy, because digitization encrypts phone calls, thereby preventing strangers with scanners from eavesdropping.

A second advantage is battery conservation. Currently, portable cellular phones are commonly rated for 12 hours of standby time—the amount a user can leave the phone turned on to receive incoming calls. But a digital system

could extend standby times in phones by a factor of 10 to 100, depending on how the cellular network is set up. Digital systems also promise to double the time batteries can power actual conversations to 2 hours.

The only commercially available

How Digital Signal Packets Work



Cellular Digital Packet Data (CDPD) technology breaks data into chunks that are transmitted as space between conversations allows.

digital system is called Time Division Multiple Access (TDMA), in which the same cellular channel is time-shared by several phone conversations. TDMA squeezes three conversations, at least, into the space required by one AMPS phone call.

Several new phones for use on TDMA systems are due on the market soon. Motorola will introduce the 7-ounce Micro Digital Lite this spring. Employing Motorola's now-familiar "flip phone" design, the Micro Digital Lite can be set to

In 1993, McCaw installed TDMA in its Florida, Pacific Northwest and Los Angeles systems. The company plans to start TDMA service in nearly all of its markets by the end of this year.

The other major digital air-interface standard, Code Division Multiple Access (CDMA), promises to provide 10 times the capacity of current cellular systems—though competing cellular carriers argue over the merits of TDMA and CDMA the way VCR manufacturers used to debate Betamax versus VHS.

In CDMA, voices are split into small pieces, tagged with an identification code and transmitted across a broad swath of spectrum shared by fragments of numerous other calls. At the receiving end, the building blocks are reassembled into a recognizable voice.

The CDMA transmission system also promises to extend battery life by requiring about one-tenth the power needed for conventional cellular phones, according to CDMA supplier Qualcomm. This is because the CDMA system allows each phone to use only the power needed to complete or receive the call. US West plans to introduce CDMA in Seattle in early 1995.

PacTel Cellular expects to intro-

duce CDMA in its Los Angeles system in 1995, and subsequently in San Diego, Atlanta and Sacramento.

The conversion to digital technology hasn't been all smooth sailing, however. Digital phones have sometimes mistakenly encoded background noise, giving the transmission a birdcall sound called warbling. Errors in speech compression also can be heard as echoes of the speaker's voice. These

(Please turn to page 117)



BLAUPUNKT

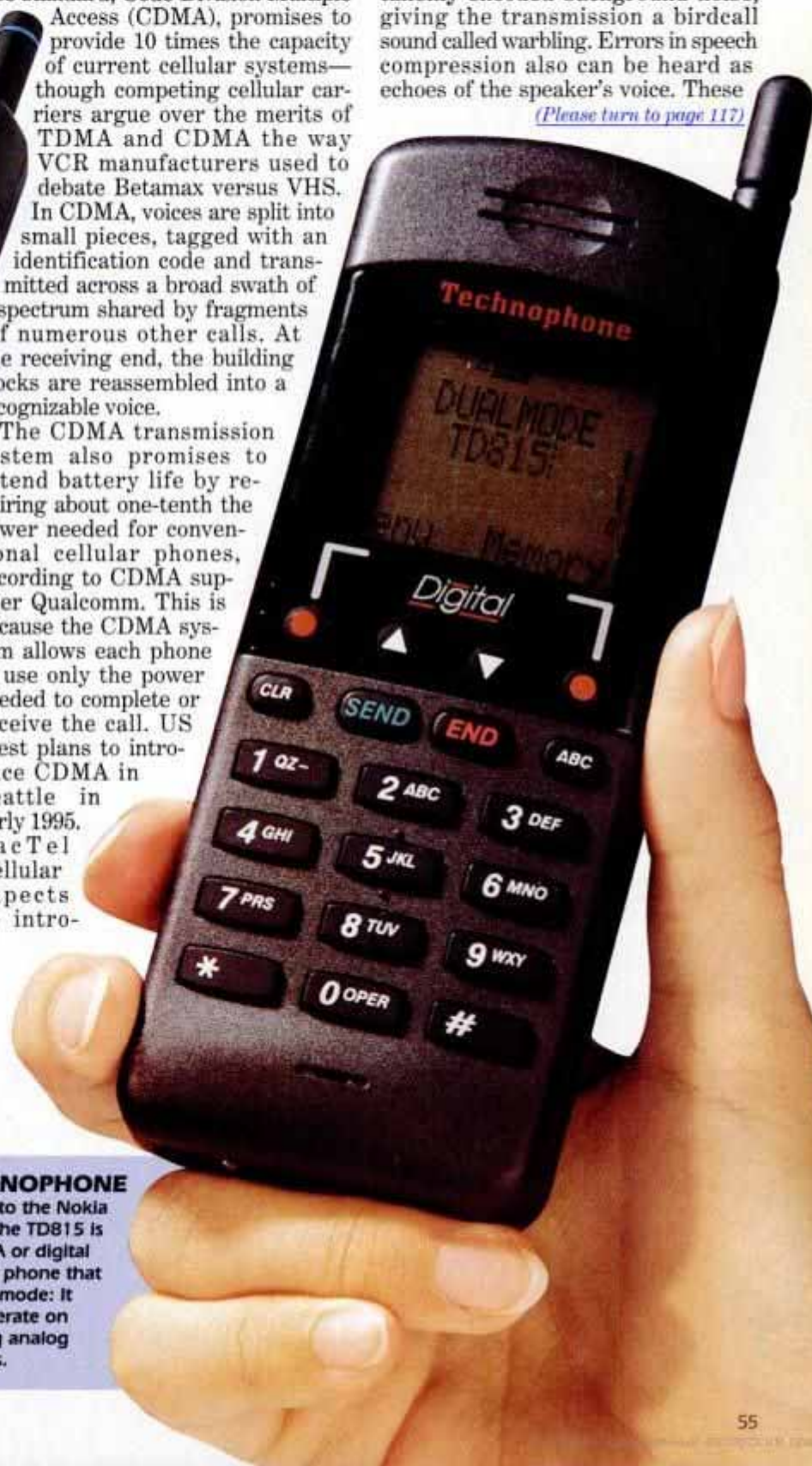
The TC-242 uses an innovative 4-way rocker switch to control functions.

vibrate, rather than ring, to alert the user to an incoming call. Nokia's model 2120, a TDMA phone also due this spring, weighs only another 0.4 ounces more than the Motorola Micro Digital Lite. Expected to sell for about \$500, the Nokia 2120 has a 30-character display and continuous readouts regarding battery power and signal strength. Also due is a similar model, the TD815, marketed by Nokia under the Technophone brand. Another handheld model is the 10.5-ounce Blaupunkt TC-242, listing for \$1295, which features an innovative 4-way rocker switch for controlling functions.

One of the proponents of TDMA is McCaw Cellular (commonly operating under the name Cellular One) which, with more than 2.68 million customers, is the nation's biggest cellular carrier.

TECHNOPHONE

Similar to the Nokia 2120, the TD815 is a TDMA or digital cellular phone that is dual-mode: it can operate on existing analog systems.





GENE WARS

To vanquish cancer, AIDS and other killers, medicine is mounting a direct assault on the genetic blueprints of disease.

BY GREGORY T. POPE, Contributing Editor; PM Illustration by Alexander and Turner

● Ruthless, machine-like, alive only when inflicting mayhem, viruses are commandos in a microscopic battleground. They infiltrate cells, commandeer genetic machinery for their own use and wreak havoc from within. They bring ills as minor as warts, as major as AIDS. No wonder so much medical research has targeted these tiny agents of destruction.

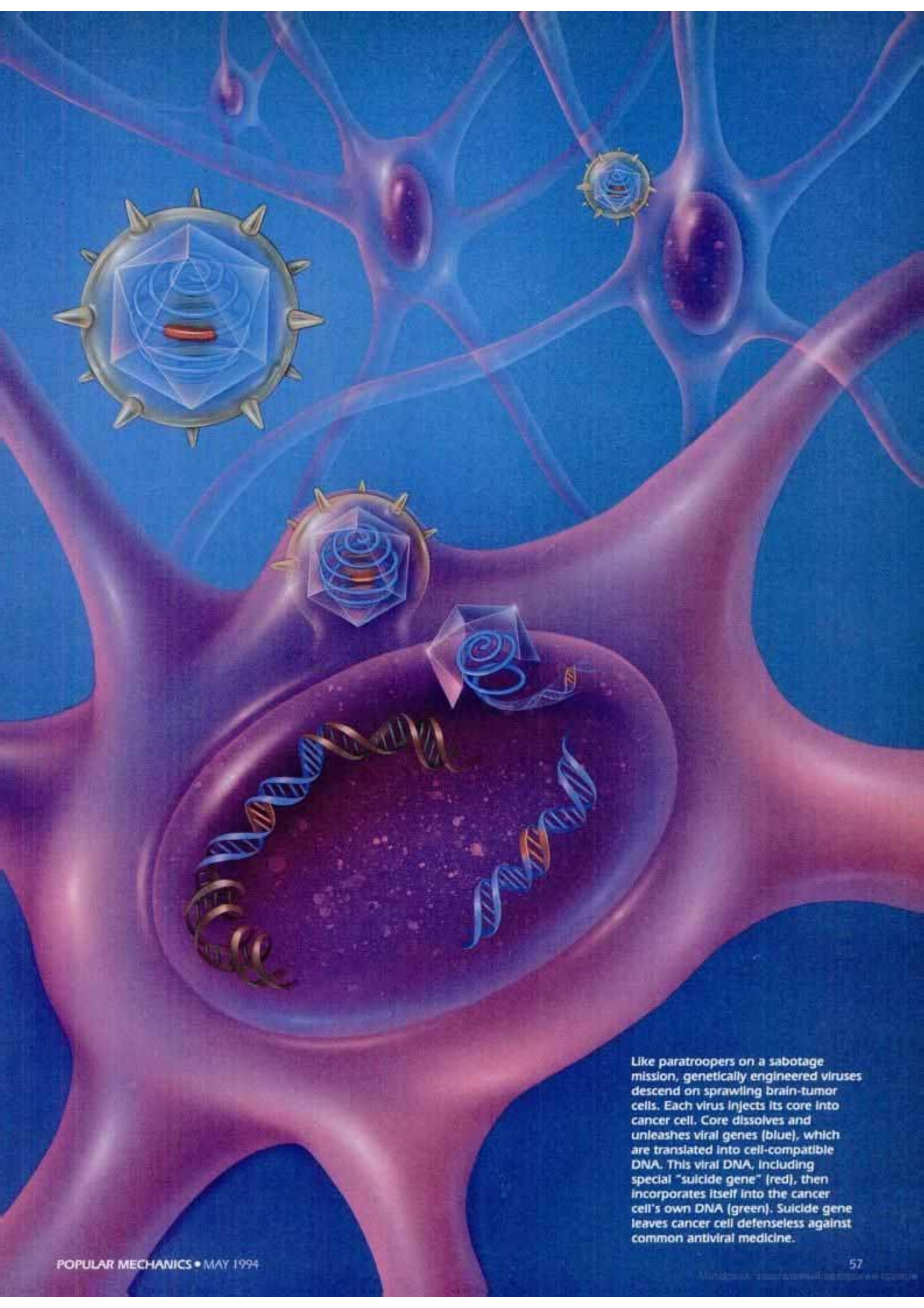
Now, in an ironic twist, medicine is recruiting the virus, and its special-forces lifestyle, to fight the good fight against our worst diseases. Cancer, AIDS, inherited ailments such as cystic fibrosis—full-frontal attacks with drug treatment have done little to stop these killers. So a new strategy is emerging: Viruses are being enlisted to slip behind enemy lines and deploy new weapons against disease. Because the weapons are genes, the strategy is known as gene therapy.

Once wishful thinking, gene therapy is now real—although still experimental—thanks to decades of basic research. Like the code-breakers of World War

II, biologists are in the midst of an all-out effort to decipher the molecule known as DNA. Packaged in twisted double strands, DNA inhabits every cell and contains the information needed to run a cell's life. This information is parceled into discrete segments of DNA known as genes.

Through an elaborate biochemical translation process, genes direct the construction of proteins that keep things running smoothly in a cell. When disease strikes, and things stop running smoothly, it's often because one or more genes have become faulty in some way. Researchers have made headway in identifying the faults responsible for many genetic diseases, such as cystic fibrosis and hemophilia, as well as acquired diseases such as cancer.

Much of this progress stems from the new recombinant-DNA technology, with which biologists can pick apart and rearrange genes. Now the same technology is allowing genetic engineers to assemble made-to-



Like paratroopers on a sabotage mission, genetically engineered viruses descend on sprawling brain-tumor cells. Each virus injects its core into cancer cell. Core dissolves and unleashes viral genes (blue), which are translated into cell-compatible DNA. This viral DNA, including special "suicide gene" (red), then incorporates itself into the cancer cell's own DNA (green). Suicide gene leaves cancer cell defenseless against common antiviral medicine.

GENE WARS

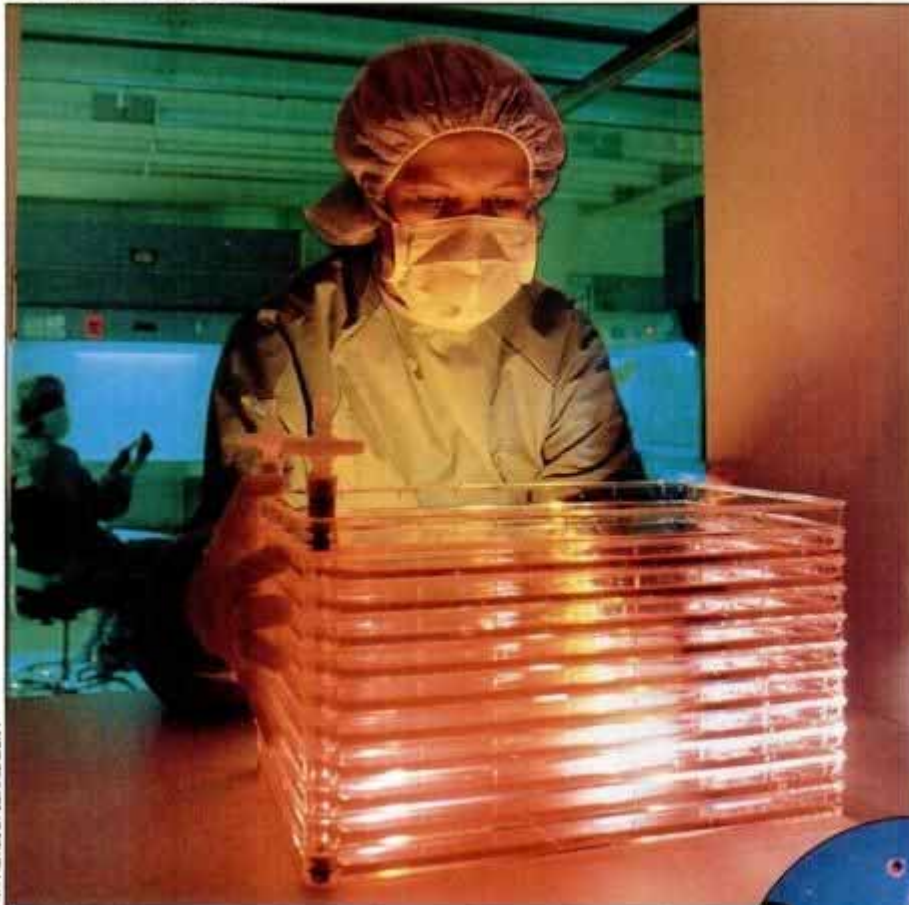


PHOTO BY LORNE DUKA

Somatix cultivates genetically altered tumor cells as a cancer vaccine.

order viruses, which are essentially genes wrapped in a shell. Normally, viruses replicate and cause damage by forcing their own genes into a cell's DNA. By replacing these rogue viral genes, researchers can use the virus to introduce genes of their own choosing into diseased cells. Gene therapists thus correct the mistakes produced by a faulty gene, treating illness at its root cause.

Out-of-body experience

Gene therapy made a dramatic debut in 1990. Three doctors at the National Institutes of Health (NIH) in Bethesda, Maryland, began treating two girls suffering from ADA deficiency: the "boy-in-the-bubble" syndrome that cripples the immune system. The virus that carried out the mission—a variety known as a retrovirus—planted a working ADA gene in blood cells drawn from the girls' veins. The cells were then injected back into the patients' bloodstreams.

The girls' health rebounded. Today they attend school and play sports. "The result has been so positive," says Kenneth Culver, one of the NIH pioneers, "that it's continued to fuel a rapidly growing enthusiasm. Also, ours was the first protocol to get through the regulations, and it's created a trail for others to follow." Today, the NIH has okayed at least 68 gene-therapy experiments, and the Food and Drug Administration has

signed off on roughly half of these so far.

The ADA procedure, known as *ex vivo* gene therapy, has proven readily adaptable to other illnesses. For example, inherited blood disorders such as hemophilia and Gaucher disease arise from missing or misfiring genes that viruses can replace. Preclinical tests are under way on these ailments.

In a variation on the *ex vivo* theme, clinical trials have begun at Johns Hopkins University Medical Center in Baltimore and other institutions of a long-sought approach to cancer treatment.

First, physicians extract tumor cells from the patient and expose them to an engineered retrovirus. The virus transfers a gene that produces an immune-stimulating protein called GM-CSF. The cancer cells are irradiated to keep them from replicating, then returned to the patient. Like a vaccine, the cells rouse a host of immune-system cells that had previously been ignoring the patient's cancer. Ideally, this army will blitz through the body, exterminating cancer everywhere.

Although this so-called immunotherapy has been a Holy Grail for cancer researchers, until gene therapy arrived it had been an unfulfilled quest. "The expectation is that it should work with any type of tumor,"

says Anton Berns, research director of Somatix Therapy Corp. in Alameda, California, which manufactures the engineered virus.

A similar tactic harnesses another retrovirus—the notorious HIV, which triggers AIDS. HIV might turn out to be the perfect weapon against the very disease it causes. Because HIV targets specific immune-system cells, which it renders useless in combating infections, researchers believe they could use an engineered version to introduce AIDS-fighting genes. These genes could either revitalize the immune system or just block HIV replication. Research is ongoing at several institutions.

Inside track

But while *ex vivo* gene therapy is promising, it also demands much labor and requires repeat treatments. Researchers are now refining gene therapy to make it both more convenient and more curative. Instead of extracting cells, doctoring them with viruses and returning them to their owners, testers are working on methods that work directly on cells within the human body—*in vivo* gene therapy.

For example, Culver—now at the Human Gene Therapy Research Institute in Des Moines, Iowa—is collaborating with Genetic Therapy Inc. in Gaithersburg, Maryland, on its novel assault against brain cancer.

The technique is ingenious and insidious. Genetic engineers first infect mouse skin cells with a retrovirus fitted with a "suicide gene." The mouse cells are then injected directly into the brain and serve as factories, cranking out hordes of viruses.

Retroviruses have a built-in safety mechanism: They only attack dividing cells. For that reason, they key in on proliferating cancer cells and leave normal brain cells alone. Once the viruses have integrated the suicide gene into a good percentage of cancer cells, doctors treat the patient with a common anti-herpes drug. The suicide gene produces a protein that leaves the infected cancer cells defenseless against the drug. As it turns out, other cancer cells not altered by the virus die off as well, because of a still-mysterious "bystander effect."

The treatment is nearing completion of a second trial in which doctors begin to test for efficacy as well as possible side effects. Five out of eight patients have shown an anti-tumor response. In one patient, the tumor vanished. But Culver is already super-

(Please turn to page 113)





PICTURE DISCS

Video joins audio on compact disc.

BY STEPHEN A. BOOTH, Contributing Editor
PM Illustration by Jeffrey Lynch

● If movies on tape are part of your diet at home, then get ready to expand the menu to include movies on compact discs. If you thought CDs were just for music, then it's time to open your eyes. Get ready for Video CDs.

The new Video CD format puts full-length movies on a little disc—two discs, in most cases, since the digital technology used for Video CD squeezes about 70 minutes of motion picture and stereo sound onto each. Most movies run longer than 70 minutes, of course.

Squeeze is the operative word here. The picture that appears on a Video CD uses a digital compression process that has more in common with computers than with cinema. This technology gets used for two mediums. For the family room, playback will be on a new breed of Video CD players coming to market.

For computers, a CD-ROM drive and an accessory board will get the job done.

Already, more than half a dozen companies have demonstrated Video CD players in prototype form. Most take into account the need to store multiple discs in order to show a movie with minimal interruption. Sanyo, for example, is modifying its Studio 24 CD changer, which stores up to 24 CDs, for Video CD. One machine, therefore, could have 12 or more videos ready for play.

Similarly, Panasonic has shown a 3-disc changer model. JVC's version uses a 6-disc magazine in conjunction with a single-disc tray. Samsung plans a 5-disc carousel changer, as well as a combination unit that will play 12-in. video laserdiscs as well as movie and music CDs.

PICTURE DISCS

According to its proponents, Video CD will have an image quality on par with VHS tape. This claim usually is qualified with the term "subjectively." This means that while electrical measurements might differ between Video CD and videotapes, you shouldn't see any difference.

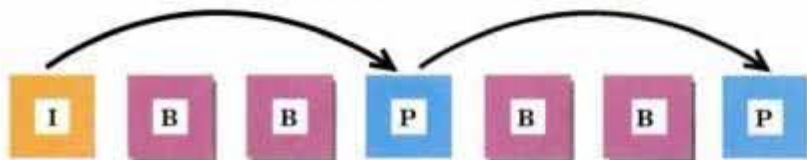
The compression method that squeezes the contents of a VHS cassette onto two thin discs is called MPEG Level 1. The initials mean Motion Picture Experts Group, a worldwide standards-making committee, and Level 1 is the first step in audio/video digitization that eventually will evolve toward high-definition video products for the home. Why compression at all?

Despite the immense data-storage capacity of optical compact discs—some 600 megabytes, depending on

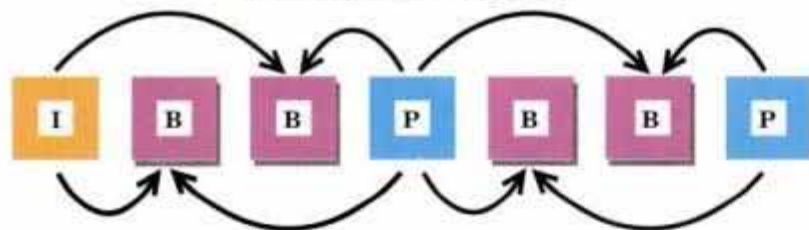


How Video Compression Works

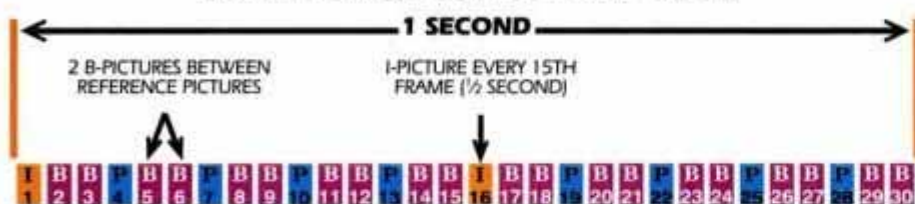
Forward Prediction



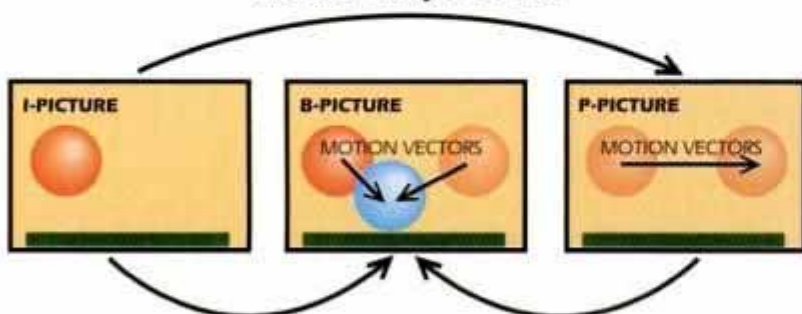
Bidirectional Prediction



Typical Display Order Of Picture Types



Motion Compensation



Thirty still frames equal 1 second of motion video. To compress data, MPEG doesn't repeat information that's the same in future frames. Data in Intra (I) picture comes from the actual frame and is a reference for Predictive (P) and Bidirectional (B) pictures. To prevent P-pictures from creating motion errors, they're separated by B-pictures, which are never used for future reference. Motion compensation estimates the bouncing ball's position in the P-picture from its direction and speed in the I-picture. Combining this before and after data positions the ball in the B-picture.

who's counting—a CD can hardly hold half a minute of uncompressed, full-motion, full-screen video with sound.

To get data off the disc at the rates needed to create smooth motion pictures with synchronized sound, that raw video and audio has to be condensed to about 1/200th of its content. In fact, the compression ratio of MPEG-1 is 180:1. You wouldn't recognize this boiled-down production as a movie any more than a cow would make sense of powdered milk, but decompression by the MPEG circuitry in a Video CD player reconstitutes the product to full strength.

You might surmise that to achieve this degree of compression something's gotta go. Actually, MPEG doesn't discard information. But in condensing video, it doesn't repeat information that hasn't changed from one frame to the next.

If you look at the 30 still frames that make up a single second of a motion picture, probably very little has changed within a given scene. Take backgrounds: In a Western, for example, the sky and the mountains in the distance most likely haven't moved much. Maybe the only portion of the picture that changes is Clint Eastwood's Adam's apple—if he happens to be talking. In an MPEG-compressed movie, precious bits would be allocated only to the motion that conveys his deathless dialogue. The data that makes up the background would be carried over from previous frames.

All of this is more complex than it seems. When a movie is compressed, three different kinds of "pictures" are created to maintain faithfulness to the original.

One is called the Intra or I-picture. The digital coding here consists solely of the information contained in that actual movie frame. I-pictures are used as a reference point for other frames in each second of MPEG

video. Typically, there are two I-pictures in every second, usually spaced 15 frames apart.

P-pictures or predictive are created from the nearest previous I-picture, or from a preceding P-picture. Because their content is estimated from what happened in earlier frames, they eat up little data space. But because the information in a P-picture can be derived from other P-pictures, they're prone to error—especially where motion is present.

For this reason, P-pictures never run adjacent to one another in MPEG coding. They're separated by B-pictures—as in bidirectional—which use both a preceding frame and a subsequent frame as references for what they should contain.

To prevent any error in a P-picture from compounding like bankbook interest, MPEG encoding employs motion-compensation circuitry.

Motion here means change of position and, secondarily, shape. In the example of the bouncing ball, the rate and direction of movement in the I-picture are used to estimate the position of the ball in the P-picture. Then, this before-and-after information is combined to place the ball where it should be in the B-picture. In baseball, this would be called the dreaded intermediate bounce—neither the long hop nor the short one—and that intermediate bounce is the one even the best shortstops handle on an instinct no one has yet digitized. This probably explains why P-pictures don't run side by side and B-pictures aren't used to predict frames.

As elegant as MPEG-1 sounds, it's neither the only chapter nor the final one in the flicks-on-a-disc story.

While nobody's actually shipped a machine or pressed a Video CD yet,



On-screen prompts let you play movies, cartoons or other videos on a Philips CD-I player as easily as you would on a VCR.

companies like Goldstar are promising spring delivery. The closest thing you can look at is the Digital Video movies from Paramount produced exclusively for Philips CD-I players (interactive CD) with their \$250 add-on FMV (full-motion video) cartridges.

CD-I/FMV and Video CD are close relatives. For example, a Video CD will play on a CD-I/FMV machine. But the movies that are now available on CD-I/FMV discs (about \$25 each) won't play on Video CD machines. The difference mostly has to do with coding for special effects.

Now that there's a Video CD standard, it's likely that Paramount and other movie studios will press their movie discs in this fashion. But if you don't



feel like waiting for dedicated Video CD players, you can enjoy MPEG-encoded movies on your home computer.

The ReelMagic card (\$449), from Sigma Designs of Fremont, California, lets you play Video CDs and CD-I/FMVs on any PC with a 386 or better microprocessor and a CD-ROM drive. If you don't have a ROM drive, you can get it along with the ReelMagic board, stereo speakers and all the necessary connectors in Sigma's multimedia upgrade kit (\$849).

Sigma's CD-ROM drive is a double-speed model, meaning it transfers data at 300 kilobytes per second. Right now, this drive is only relevant for CD-ROM software—namely, accessing that digital encyclopedia entry faster than you could flip pages in a book. Video CD's future, though, entails higher-density discs, faster drives and advanced levels of compression.

Higher-density discs will come when short-wavelength blue lasers enable the pits and bumps of CDs to be etched more tightly than today's red lasers permit. This means movies will come on a single disc instead of Video CD's equivalent of the old 2-reeler movie. Faster drives would feed the data to your TV more smoothly. And more advanced compression should pre-empt any aesthetic objections of the film-versus-tape type. All this probably will happen PDQ—so don't blink. **FM**



Existing Philips CD-I players can be upgraded to play full-motion video simply by inserting a special cartridge into an existing slot in the machine.



PONTIAC GRAND AM

What you see is what you get.

BY MICHAEL LAMM, Contributing Editor; PM Photos by Scott Dahlquist

● During the glory days of the classic GTO, Pontiac's product strategy was to deliver the top image car in every market segment it entered. Pontiac's planners developed this approach because their division was always forced to share body shells and major components with other GM divisions, especially Chevrolet.

It's been a long time since the GTO, but those requirements really haven't changed much. And the Grand Am is the proof.

Although the Grand Am name dates to 1973, Pontiac introduced the current series in 1985, and it's been Pontiac's best seller for four of the past five years. The present body bowed as a 1992 model. What sets it apart from GM's other N-body cars (Chevy Corsica/Beretta, Oldsmobile Achieva, Buick Skylark) is styling. So it came as no surprise that styling convinced 70.4% of the Grand Am owners in our survey to sign up.

But most buyers also agreed that

the Grand Am's beauty extended beneath the surface. They shopped the competition and concluded that price and value won out as their next strongest reasons for purchase.

Pontiac's 1994 Grand Am lineup consists of two trim levels—SE and GT—for both its coupes and sedans. The SE's standard engine is the Quad OHC, a 115-horsepower sohc 2-valve version of the 2.3-liter Quad 4. The GT powerplant, called the Quad 4 H.O. (for high output), puts out 175 hp.



Spiffy dash reinforces sporty theme.



Firm seats bothered some owners.



The V6 dominated powertrain orders.

Both the SE and GT offer an optional 155-hp version of the Quad 4 or a 3.1-liter 155-hp pushrod V6. Both these optional engines are available only with a 4-speed automatic. Most of the Grand Am owners we surveyed chose the V6. The V6 added \$460 to the price of an SE, but gave the GT purchaser a \$90 credit.

GM decided to upgrade all versions of the Quad engine in 1993, mostly by borrowing structural refinements from the H.O. version. Extra ribbing on the block and bulkheads now add stiffness and cut noise. The cylinder-bore bottom deck extends lower, and gussets strengthen the rear wall of the block. There's a stronger head gasket, of course, with greater torque capacity in the head bolts. Parts of the induction system have been made huskier to mute intake roar during hard acceleration. The timing-chain cover is thicker, there's an oscillating vibration damper on the right-side engine mount and the exhaust system has been redesigned. Most of these en-

gine refinements came in response to owner comments about the earlier Quad engines.

Our survey shows that all three iterations of the Quad powerplant delivered better fuel mileage than the V6. And the 5-speed beat the automatic by a significant 3 to 4 mpg. So it's apparent that economy wasn't uppermost in the minds of most Grand Am buyers, even though 18.8% listed operating economy as a virtue. Gas mileage ranged from 21.1 in town to 32.5 on long trips and varied widely by engine and transmission choice.

Power was judged excellent by 54.2% of our respondents and good by 37.3% more. What this means is that acceleration and passing speeds were deemed ample, though perhaps not quite blinding. Owners thought more highly of handling and braking than of the acceleration delivered by any of the four engine options.

The SE's extensive standard equipment list includes antilock disc/drum power brakes, automatic electric door locks, an AM/FM ETR

SUMMARY OF PONTIAC GRAND AM OWNERS REPORTS*

Total miles driven	1,173,861	Styling	75.2%	Average	2.6	Leaky windshield washer	19.0%
Average miles driven	4974	Handling	29.8	Poor	0.7	Electrical system	12.7
Purchase price:		Comfort	25.7	Control layout:		Noisy heater blower	7.6
Average	\$15,072	Ride quality	19.3	Excellent	54.2%	Front-end alignment	6.3
Range	\$12,000-\$18,800	Performance	19.3	Good	39.4	Automatic door locks	6.3
Why did you choose the Grand Am?		Engine power	18.8	Average	5.8	Gearshift mechanism	6.3
Styling	70.4%	Operating economy	18.8	Poor	0.6	Repair it yourself?	
Price/value	29.2	Specific dislikes:		Instrumentation:		No	97.5%
Previous Pontiac ownership	23.5	No complaints	19.1%	Excellent	52.6%	Yes	2.5
Pontiac reputation	10.2	Automatic door locks	8.1	Good	40.9	Dealer repairs satisfactory?	
Performance	7.5	Seats too firm	6.9	Average	5.8	Yes	79.1%
Handling	7.5	Ride too firm	6.4	Poor	0.6	No	20.9
Body style choices:		Shoulder harness chafes	5.8	Driver sightlines:		Dealer service opinion:	
2-door	53.1%	No standard airbag	4.6	Excellent	43.4%	Excellent	57.3%
4-door	46.9	Not enough space in rear	4.6	Good	44.1	Good	33.1
Model choices:		Suggested changes:		Average	10.5	Average	6.2
Grand Am SE	81.2%	Standard airbags	14.7%	Poor	2.0	Poor	3.4
Grand Am GT	18.8	Softer seats	8.8	Overall convenience:		Dealer sales policy:	
Options/Accessories:		Improve shoulder harnesses	7.4	Excellent	48.0%	Excellent	53.4%
Air conditioning	99.2%	No changes	6.6	Good	48.0	Good	38.1
Var. ratio power steering	91.7	Reduce noises, rattles	5.9	Average	3.9	Average	6.8
Rally gauge cluster	78.1	Revise instrument layout	5.9	Poor	0.0	Poor	1.7
Power windows	61.1	Softer suspension	5.9	Workmanship opinion:		Number of vehicles owned:	
Split/folding rear seat	48.5	Engine power:		Excellent	64.7%	This vehicle only	28.2%
Power driver's seat	14.8	Excellent	54.2%	Good	34.5	Two vehicles	32.9
Avg. mpg, city/hwy:		Good	37.3	Average	0.4	Three vehicles	21.4
115-hp Quad OHC	24.8/31.7	Average	6.5	Poor	0.4	Four or more	17.4
155-hp Quad 4	25.5/31.3	Poor	2.0	Comfort opinion, front seats:		Principal driver:	
175-hp Quad 4 H.O.	21.4/27.6	Handling:		Excellent	64.8%	Female	73.0%
155-hp V6	21.1/27.0	Excellent	62.6%	Good	30.5	Male	24.3
5-speed manual	25.6/32.5	Good	35.5	Average	3.8	Equal	2.7
3-speed automatic	22.2/27.9	Average	1.9	Poor	0.8	Age distribution of owners:	
Engine choices:		Poor	0.0	Comfort opinion, rear seats:		Under 29	29.8%
155-hp V6	71.7%	Braking:		Excellent	45.9%	30-49	46.7
115-hp Quad OHC	14.1	Excellent	67.7%	Good	45.5	50-plus	23.5
155-hp Quad 4	10.7	Good	29.7	Average	8.6	Based on your experiences, would you buy a Pontiac Grand Am if you had it to do over again?	
175-hp Quad 4 H.O.	3.4	Average	2.6	Poor	0.0	Yes	60.6%
Transmission choices:		Poor	0.0	Mechanical trouble?		Maybe	34.7
3-speed automatic	92.1%	Overall performance:		No	66.9%	No	4.7
5-speed manual	7.9	Excellent	59.5%	Yes	33.1	What type of trouble?	
Specific likes:		Good	37.3				

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

PONTIAC GRAND AM



Although Pontiac brand loyalty was an impressive sub-theme in survey group's Grand Am purchase decisions, sexy styling won more hearts than any other two factors combined.

EDITORS REPORT

Elements Of Style

● Pontiac characterizes itself as GM's Excitement Division, with considerable justification. The division's design teams regularly make sales winners out of cars that seem to produce yawns and cobwebs for other GM divisions—even though all the cars are virtually identical in their mechanical particulars.

As noted in the main body of this Owners Report, the Grand Am is an excellent example of this phenomenon. Introduced at the same time as its stablemates from Oldsmobile (the Achieva) and Buick (the Skylark), it succeeds while the others languish. Although Pontiac's chassis engineers can single out some minute differences in suspension tuning—as well as the broadest array of powertrain choices among the N-bodies—the truth is that Grand Am, Achieva and Skylark are clones. While there are distinctions in appearance, obviously, and interiors, dynamic observations that apply to one apply to all.

For example, consider the Quad 4 engine family, which was a key part in the N-car product planning. The Quad OHC—GM's 2-valve version of the Quad 4—was specified as the base engine for the various N-cars. As our survey shows, Grand Am buyers rejected the Quad OHC—as well as the two Quad 4 variants—in favor of the V6.

There's a good reason for this. The Quad OHC is not only anemic, it's noisy—although '94 editions are quieter. Mated to an automatic transmission, which is the overwhelming transmission choice among Grand Am buyers, the Quad OHC engine still gives a thoroughly indifferent account of itself.

Although the standard (155 hp) and H.O. (175 hp) versions of the Quad 4 still draw criticism for noisy operation, they're

both spirited performers. The H.O. version in particular hustles the Grand Am to true sport coupe (or sedan) status. The V6 engine option for 1994 is GM's 3.1-liter 3100, which replaces the previous 3.3-liter and is definitely an improvement on its predecessor. The same can be said for the 4-speed automatic that goes with the new V6. In our view, GM made a mistake by providing 3-speed automatics—rather than 4-speeds—for its N-car fleet. The 3-speed is still in the lineup—it's the automatic option with the Quad OHC—but the more desirable 4-speed is now available with the V6 and with the standard Quad 4.

One other initial N-car mistake that's been corrected for 1994 is the lack of a driver's airbag. GM consumer clinics indicated that buyers considered antilock brakes to be more important than airbags, so the N-cars were launched with ABS as standard equipment and automatic seatbelts instead of airbags.

Well, whatever deficiencies there may have been, it seems clear that the Pontiac Grand Am is making most of its owners happy. It does this with performance that's fairly ordinary throughout most of the model range. Handling is competent, but a good way from cutting-edge for front-drive cars. Front-seat headroom and legroom are competitive, but rear-seat space is a bit cramped. Ride quality is adequate, tending toward taut, which—in our opinion—plays well with Pontiac's youthful image.

And that, of course, is what the Grand Am is all about. It's bold and sassy, inside and out, a rolling style statement on behalf of its owner. It's one of those rare cars that seem to make owners happy just by looking good in the driveway.

—Tony Swan

sound system, power steering, a remote decklid release and a 5-speed manual transmission. The Grand Am GT package adds a dual exhaust, Level II suspension with front and rear stabilizer bars, rally gauges, a tachometer and color-keyed alloy wheels. Only 7.9% of our owners opted for the 5-speed manual transmission, mostly because it's not available with the popular V6 option.

And nearly 25% had owned Pontiacs before, which made brand loyalty the third key factor in Grand Am purchases.

Roughly one-third of the owners we surveyed reported mechanical troubles of some sort. That's a relatively high figure. However, generally speaking, most of these problems weren't serious. The most common concerned a split hose in the wet-arm windshield-washer system. Noisy heater blowers were also cited, as were too-quick upshifts of the automatic transmissions. Dealers correctly repaired these and other problems in 80% of all cases, and they did so under the Grand Am's 3-year/36,000-mile bumper-to-bumper warranty.

Workmanship was considered good to excellent by 99.2% of our respondents, so there's no quibble in that department. And while owners recognized and appreciated the Grand Am's standard antilock brakes, their most frequent request was for airbags. Pontiac has installed a driver's airbag in the 1994 model.

Opinions were divided about the Grand Am's standard automatic door locks (ADL). These secure all doors when the driver shifts the automatic transmission out of Park. (On manual-transmission cars, the doors lock when the speedometer hits 8 mph.) There's no override, so the ADL always locks all the doors. Trouble is, anytime anyone wants out, the doors have to be unlocked manually. Pontiac again has responded to consumer demand and made the change in the 1994 model.

Sightlines came in for a little grumbling, thanks to the bulky headrests and wide C-pillars. Controls and instrumentation fared a little better but didn't exactly inspire ecstasy. In fact, beyond its styling, the Grand Am produced very ordinary owner responses. The consensus seems to be that it's a great-looking car, but it's not a world beater.

Even so, more than 60% of our survey respondents were still so seduced by the Grand Am's looks that they'd readily step up and do it all over again. And another 34.7% said they might do the same. Image may not be everything, but it still counts for a lot.

PM

*Say something
smooth.*

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HOME&SHOP
JOURNAL

HOW TO INSTALL

In-Ground Sprinkler System

How to make the grass greener on your side of the fence.

TEXT AND PHOTOS BY
MERLE HENKENIUS

● If you were to make a list of the most approachable do-it-yourself home-improvement projects, installing an in-ground sprinkler system would probably not top the list. Start thinking about it and the problems of layout and machinery seem to get in the way. It all seems a bit overwhelming.

With that in mind, you may be interested to know that some manufacturers are trying to make the idea a good deal more appealing. Not only will you find all the components for the job at your local home-improvement center, but for the price of a stamp you'll get professional help in laying out the system. And if you still have questions, there's often a toll-free phone number to help you along the way.

Now, before we coax you too far down the path of giddy optimism, we should say that the installation is a lot of work. But when it's done, you'll have saved more than 50% when compared with a professional installation.

The system components we chose

bear the Lawn Genie trademark, which is a division of Hardie Irrigation, makers of the Rain Jet commercial line.

System considerations

We should say now that not every property will accommodate a sprinkler system. If the waterline from the street to the meter is smaller than $\frac{1}{2}$ in. (because of mineral deposits), or if your water pressure is down in the 20-psi range, your options are extremely limited. A heavily landscaped yard, or one with a good deal of concrete or hefty tree roots, will also limit your options and make the job more difficult.

To determine water pressure, you can call your local water company. A more precise method is to measure the pressure at an outside faucet. We used a water-pressure gauge attached with a hose-thread adapter (Photo 1). To help you judge the capacity of your water supply, Lawn Genie offers a worksheet that includes a formula to determine how much water your system delivers in gallons per minute.

No matter what your delivery capacity at the meter, however, it's important to know that friction will reduce the output somewhat. Every fitting, turn and length of pipe will subtract from the raw total, and you may have to upsize the piping that supplies the sprinkler system to achieve appropriate flow rates.



Plan your sprinkler system to begin inside the house, as near the water meter as possible, and exit the house through the rim joist directly above a basement wall. Just outside, you need a code-approved vacuum breaker to protect the potable water system from contaminants.

From the vacuum breaker, plan a single underground line that connects your water system with the sprinkler system zone valves. (Our yard required two groups, three zones for the front yard and two for the back.)

Each zone valve feeds a separate piping run and the sprinkler heads attached to it. The size of the yard and the water delivery rate dictate the number of zones needed. The zone

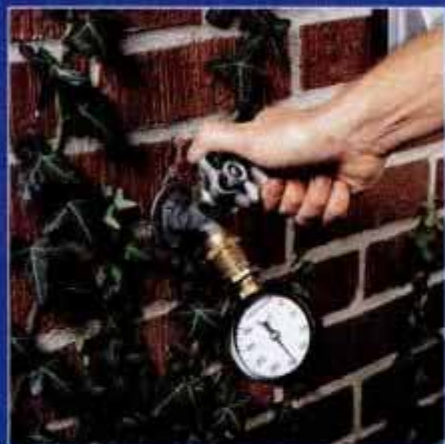
valves are connected, via low-voltage wire, to a central control panel. At the panel, you can program the zones to cycle separately and sequentially. The Lawn Genie control panel has a battery backup that saves the program during power outages. If you're on a tight budget, manual shut-off valves can be substituted for electronic valves.

Sprinkler heads are available in several spray patterns. Some will broadcast 360°, others in only 180°, 90° or 45° arcs. Also available are drip heads designed for gardens.

To ensure proper flow at the sprinkler heads and uniform coverage, we sent our layout worksheet and a scaled drawing of our yard—with the

house, driveway, sidewalks, trees and other significant landscape features—to the sprinkler system manufacturer. We soon received a detailed layout, including pipe sizing, head types and locations, the number of zones and zone valves, and the best piping routes to take.

We used PVC piping because it's familiar and universally available. With this material, the joints are either threaded or glued. Before cementing PVC components together, paint the mating surfaces with a solvent/primer to remove the glaze. To keep pipes from freezing, you need a few pressure-activated brass drain valves. When the water is shut off, the valves open and the lines drain.



1 To test your water pressure at a sillcock, use a pressure gauge and an adapter that connects the gauge to the threaded spout.



2 Begin the trenches by using a spade to slice out sod in squares. Set the sod on a tarp and dig the trenches 10 in. deep.



3 Splice tees into the sprinkler head supply pipes at head locations. Use joint primer and PVC cement to connect the tees.



4 Dry-connect sprinkler heads to nipples and tees and compare height with grade. If necessary, try a longer or shorter nipple.



5 Make final threaded connections with Teflon tape to ensure leakproof joints. Be sure to orient directional heads correctly.



6 Thread pressure-activated brass drain fittings into horizontal drain tees. Use Teflon tape to seal threads and tighten securely.



7 Place coarse gravel under drain fittings to help keep soil from clogging fittings. When backfilling, also add gravel on top.



8 Use threaded male adapters and glue to join the piping to the zone-control valves. Each valve controls one sprinkler branch.



9 Attach white wire from control panel with the white wires from valves. Colored panel leads go to remaining valve leads.

Outdoor work

Use spray paint to mark each head location on the lawn. Then, pick the most convenient locations for the zone valve groupings. Begin the pipe trenches by using a spade to slice out the sod in small squares (Photo 2). Set the squares aside on a plastic tarp and dig the trenches 10 in. deep.

Lay out the piping and splice in tee fittings at each sprinkler head location (Photo 3). Where water will be trapped, and at the end of each piping run, splice a threaded tee on its side for a pressure-activated brass drain fitting. Under each drain tee, dig the trench several inches deeper.

With the zone piping in place, connect each sprinkler head to its tee with a plastic threaded nipple. Using nipples ranging from 1 to 3 in. long, test assemble each sprinkler head, nipple and tee, and check that the head is at the correct height in relation to grade (Photo 4). With all the heads at the right height, disassemble and reconnect the components, using Teflon tape to ensure leakproof joints.



10 Cover the zone valve grouping with an access box and backfill the hole. The top of the box offers access to control valves.

Make sure that any directional heads are turned in the appropriate direction (Photo 5). Then, thread on the brass drain fittings using Teflon tape to seal the threads (Photo 6), and fill the recess under the drains with gravel (Photo 7).

To connect to the zone valves, first place threaded tees in each pipe near

the valves and install brass drain fittings. Then lay the PVC supply pipe in its trench and place an additional drain at the end near the valves. Thread PVC adapters to the valve ports, and glue the piping to the adapters (Photo 8).

While in the area, make the low-voltage wiring connections. From low-voltage cable running in the trench containing the water supply line, join the white wire to one stranded lead from each of the zone valves using a wire connector (Photo 9). Then, join each valve's remaining lead to its own colored wire from the cable. Color coding is important here, as each color will be fastened to a unique terminal in the panel and each valve will be controlled by it. With the zone valve connections made, cover the valves with the access box (Photo 10).

Before backfilling, add gravel to cover each drain fitting. Then, fill and level the trenches a few inches at a time. Tamp each layer firmly in place before adding more soil to minimize settling. Finally, replace the sod.



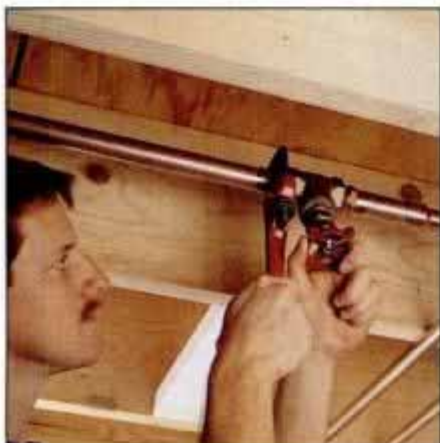
11 Bore a hole for pipe and low-voltage cable. If your home has a brick facade, start with a hammer drill and masonry bit.



12 After assembling vacuum breaker with pipe and fittings, slide assembly through hole. Vacuum breaker remains vertical.



13 After gluing a PVC threaded adapter to 90° fitting, connect to copper feed line. Then, glue PVC supply pipe to fitting.



14 Splice a tee into a 3/4-in. cold-water line to supply sprinkler system. Increase pipe diameter and add a full-flow ball valve.



15 Before connecting inside piping to outside piping, install a reducing tee and boiler drain so the pipes can be drained.



16 Mount the electronic control panel and connect the cable wires from the zone valves to the terminals in the panel.

Connecting to the house

Begin by boring a hole through a rim joist large enough to accommodate the low-voltage cable and copper supply line that will enter the house (Photo 11). Then, build the vacuum breaker and copper pipe assembly. This assembly extends up from the pipe exit hole to the breaker and then down to the PVC supply pipe in the trench. To keep from scorching the vacuum breaker, solder the copper fittings before connecting them to the vacuum breaker.

Assemble the components so that the vacuum breaker will be in a vertical position when the assembly is installed. Feed the piping through the rim joist opening (Photo 12), and attach the other end to the PVC supply pipe with a threaded adapter and 90° fitting (Photo 13).

On a 3/4-in. line near the meter, splice in a 3/4-in. copper tee. Immediately increase the pipe size, if necessary, and route the copper piping into the appropriate joist space. Install a full-flow ball valve and extend the



17 Attach a 9-volt battery to its harness inside the control panel. The battery saves the program during power outages.

pipe toward the incoming pipe from the vacuum breaker (Photo 14).

Just before connecting the pipes, install a reducing tee. Connect a threaded adapter to the reduced piping and connect a boiler drain to it. This assembly will allow you to drain the system before winter (Photo 15).

Screw the control panel box to the



18 Finally, plug the transformer into the nearest power receptacle and program the control panel according to instructions.

wall near a 120-volt receptacle. Join the white wires from the low-voltage cable to the two common screws in the panel. Then, bind each colored wire under its own terminal (Photo 16). Finally, install the backup battery (Photo 17), plug in the unit (Photo 18) and program the panel according to the manufacturer's directions.

HOW TO BUY

Hardwood And Softwood Lumber

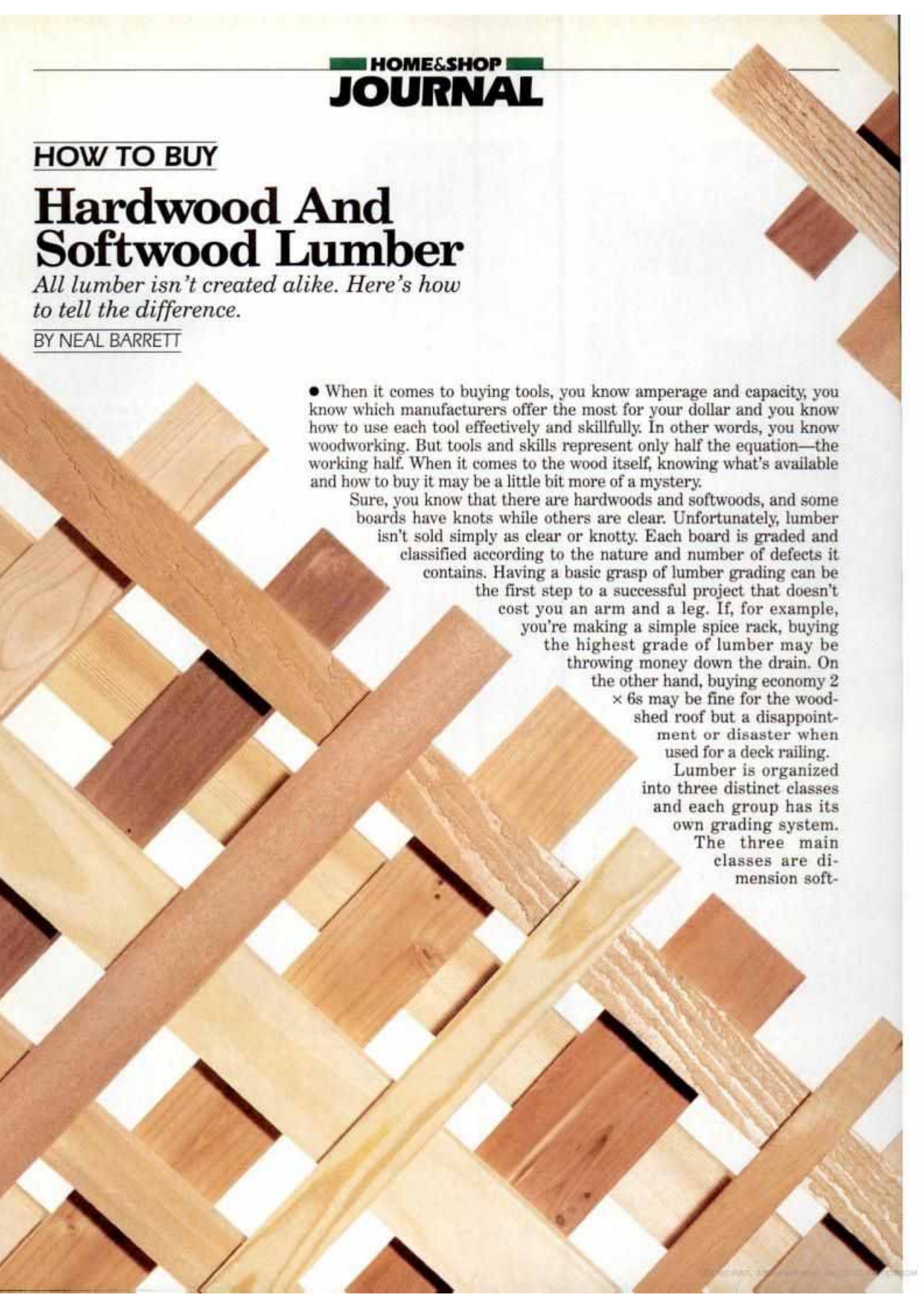
All lumber isn't created alike. Here's how to tell the difference.

BY NEAL BARRETT

● When it comes to buying tools, you know amperage and capacity, you know which manufacturers offer the most for your dollar and you know how to use each tool effectively and skillfully. In other words, you know woodworking. But tools and skills represent only half the equation—the working half. When it comes to the wood itself, knowing what's available and how to buy it may be a little bit more of a mystery.

Sure, you know that there are hardwoods and softwoods, and some boards have knots while others are clear. Unfortunately, lumber isn't sold simply as clear or knotty. Each board is graded and classified according to the nature and number of defects it contains. Having a basic grasp of lumber grading can be the first step to a successful project that doesn't cost you an arm and a leg. If, for example, you're making a simple spice rack, buying the highest grade of lumber may be throwing money down the drain. On the other hand, buying economy 2 × 6s may be fine for the woodshed roof but a disappointment or disaster when used for a deck railing.

Lumber is organized into three distinct classes and each group has its own grading system. The three main classes are dimension soft-





wood lumber, board softwood lumber and hardwood lumber. For each category, there are particular rules for establishing grade differences and unique subclasses that are based on the usual end use of each product. These rules are quite technical and there is really no need to become familiar with all of their intricacies. And even though certain grades exist, they are not always carried by many lumberyards. The particular grades available to you will vary with locality, market conditions, labor disputes, weather, distribution systems and even the prevailing political climate.

Setting the standards

Softwood lumber is graded according to a set of standards set by the American Lumber Standards Committee. These standards are enforced, through inspection, by regional organizations such as the Western Wood Products Association, the Northeastern Lumber Manufacturers Association and the Southern Pine Inspection Bureau, among others. When it comes to hardwood lumber, an entirely different set of grading standards is in force. The supervisory group for these rules is the National Hardwood Lumber Association.

A uniform set of rules ensures that the lumber you purchase, of a given grade and species, has met the same criteria as the same grade of lumber anywhere in the country. While this issue might not always seem relevant to the individual consumer, it can prove extremely important to architects and engineers who must specify materials for jobs outside their immediate locality.

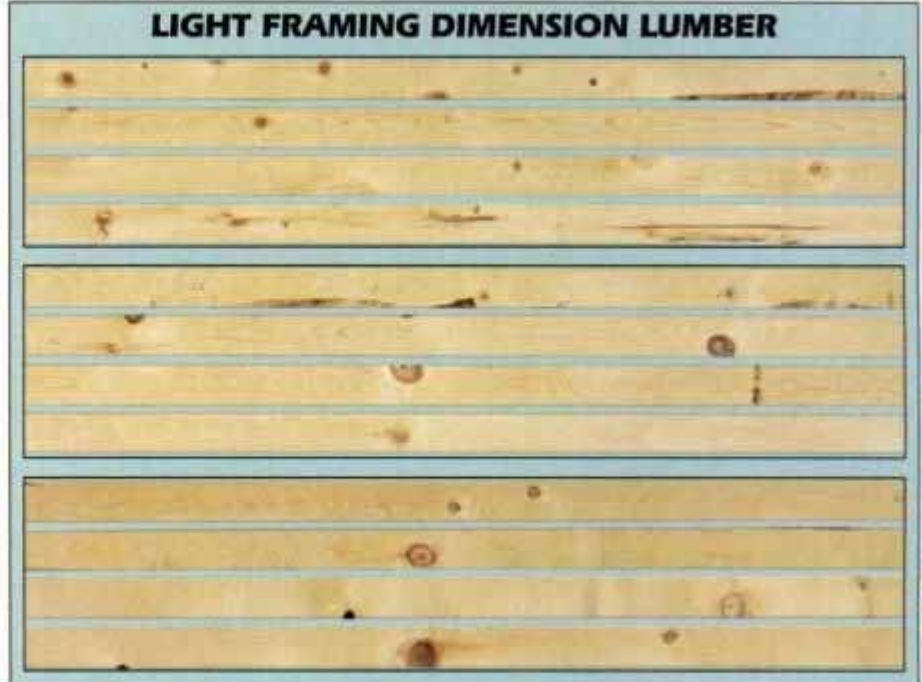
Structural lumber for framing

When you think of structural framing, you probably picture a 2 × 4 or 2 × 6 board. This material is called *dimension lumber*—softwood lumber that has

been planed to nominal thicknesses from 2 in. to 4 in. (actual dimensions 1½ in. to 3½ in.). Also included in this classification are 4 × 4 posts and 4-in.-thick beams.

The grading system for dimension lumber is based on both appearance and strength factors. It is a combination of factors, rather than just one feature, that determines the grade of a piece of lumber. Combinations of different defects may be present in one board but only up to certain specified limits, which vary with grade. The number, size and position of knots and holes, as well as wane (bark on edges), decay, checks, splits and machining defects are all considered. There are also allowable limits for distortions such as cupping, twisting and bowing. Although dimension lumber is classified in several grades, you probably won't find them all available at your lumberyard. The vast majority of outlets stock only two grades of any given product.

Dimension lumber is divided into two main classes. The first is called *light framing*, and includes stock between 2 and 4 in. wide. This class is



Light framing is a subclass of dimension lumber that includes stock from 2 to 4 in. wide. Shown (from top to bottom) are construction, standard and utility grade.

further divided into three grades: *construction*, *standard* and *utility*.

Construction and standard grades are suitable for structural, load-bearing uses. While construction grade is a higher classification (allowing fewer and smaller knots), in terms of strength and function, either grade is suitable. Utility grade is the lowest of the three grades, allowing more and larger knots, as well as some waned edges. This grade should only be used for blocking, bracing, or as studs in non-load-bearing walls. In many locations, a fourth grade, called stud grade, is available. This grade is selected for strength characteristics while allowing certain appearance defects. Stud grade is limited in length to 10 ft.

The second class of dimension lumber is called *structural joists and planks*, and applies to lumber that is more than 5 in. wide. In this group are four separate grades: *select structural*, *No. 1*, *No. 2* and *No. 3*.

Any of the top three grades are considered suitable for structural uses such as joists, rafters and studs. However, when appearance is a consideration, either the select structural or No. 1 should be used. No. 2 is used for general construction purposes, and No. 3 is only appropriate where strength isn't an issue.

In addition to the grade, lumber is classified by species. In years past, Douglas fir was the lumber of choice for structural applications. Today, however, faster-growing species—such as hemlock, spruce, ponderosa

pine and true firs—are widely used for construction. These species are often grouped together into categories such as Hem-Fir. This species group includes hemlock and five true firs.

When examining lumber, you'll notice stamps that indicate the grade, origin, species, moisture content and certifying institution. The symbols and abbreviations used in these stamps may vary, but your lumberyard should have material that explains the stamps used on the lumber it carries.

Softwood board lumber

Board lumber is stock that is widely used in surface applications. While nominal 1-in. stock is the most common (planed to ¾ in. thick), board lumber is available in nominal dimensions up to 4 in. (planed to 3½ in.). In most situations, the different varieties of pine are the species that are manufactured into board lumber. However, other species of softwood, including hemlock, spruce and fir, are also graded under this classification.

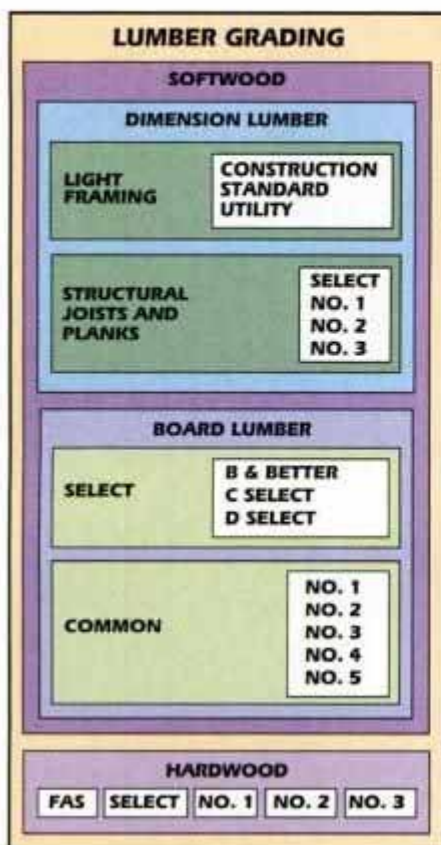
When board lumber is graded, the better face of the board determines the grade. Again, natural and manufacturing defects are considered, but strength isn't as critical a factor as with dimension lumber.

The highest classification of board lumber is called *select grade*. This grade is divided into three categories: *B & Better*, *C Select* and *D Select*. All of the select grades are commonly used for the most demanding finish

STRUCTURAL JOISTS AND PLANKS



Structural joists and planks are more than 5 in. wide. Shown (from top to bottom) are select structural and Nos. 1, 2 and 3.



applications, with B & Better grade offering the highest quality, followed in order by C and D Select.

The next classification of board lumber is called *common grade*. Common boards are subdivided into five numbered grades. *No. 1 common* represents the highest-quality lumber with a knotty appearance. While this

grade is not often carried as a stock item by lumberyards, it's usually available through special order.

No. 2 common is the grade most often specified for applications where a board with some knots is acceptable. This grade is often used for painted work, since properly sealed knots should not be apparent under a good-quality paint job.

Nos. 3 and 4 common grades are used for sheathing or subflooring, and any use where appearance is not the primary factor.

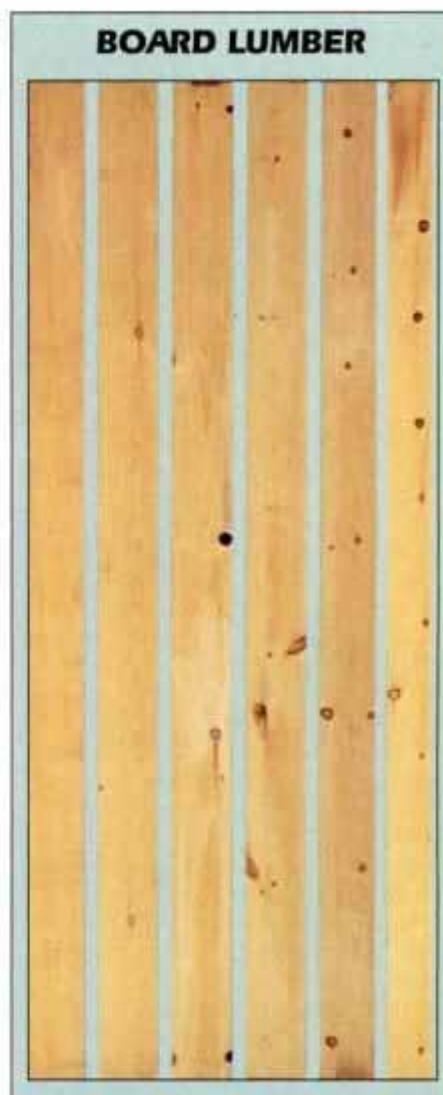
No. 5 common is the most economical, but should only be used in situations where neither strength nor appearance is important, such as crating or temporary curtain walls.

In contrast with dimension lumber, grade stamps are often absent on board lumber—especially on the higher grades—to avoid damaging the board surface.

Hardwood lumber

Grades for hardwood lumber are determined by examining the poorer side of the board and determining the amount and size of clear cuttings that the board will yield.

The highest grades of hardwood are generally sold as one combined grade called *firsts and seconds*, or *FAS*. Boards of this grade must be at least 6 in. wide and 8 ft. long and yield clear cuttings that are at least 4 in. × 5 ft. or 3 in. × 7 ft. In addition, the overall clear yield of the board must



Sample pine boards (from left to right) illustrate the select grades B & Better, C and D, and the common grades 1, 2 and 3.

be at least 83½% when judged from its poorer face. Some species have other requirements relating to color (amount of sapwood) or grain.

The next lower grade is called *select*, followed by *common grade* which is divided into subgrades 1, 2 and 3. Each lower grade has a smaller size and clear-cutting requirement than the grade above it.

Since hardwood grading is directly related to the size of clear cuttings that a board will yield, it is prudent to plan ahead when shopping for this material. If your project requires large clear pieces, then the highest-grade lumber should be chosen. However, if you will need mostly small pieces, considerable savings can be realized by using a lower grade. As with softwood lumber, most suppliers will only stock one or two grades of material, so it may be necessary to shop around for the most appropriate grade.

PM

HARDWOOD LUMBER



Hardwood lumber is typically graded from the poorer side. Oak samples shown (from left to right) represent FAS (firsts and seconds), No. 1 and No. 2.

REVIEW

LandDesigner

BY THOMAS KLENCK,
 Associate Home
 Improvement Editor

● It's that time again in many areas of the country—the time when the graph paper and pencils come out, plot plans are drawn and catalogs perused as you decide whether the corner of the driveway needs a Norway spruce or a row of Lombardy poplar. However, if you've found that the paper cluttering your desk would be easier to handle if your personal computer wasn't taking up so much space, there may be an alternative to making the PC your next lawn ornament. We recently tested new software aimed at solving landscape problems both large and small. It's called *LandDesigner*, by Green Thumb Software, Inc.

LandDesigner is essentially a CAD (computer-aided design) program. Once installed and running on your machine, *LandDesigner* turns the screen into the familiar grid, complete with a mouse-controlled pointer that enables you to draw and move lines, boxes, circles and polygons.

Just to the right of the graph paper image is a row of mouse-activated buttons. The first four represent these categories of landscape design elements: plants, including trees and shrubs; garden and ground covers; hardscape components (everything from fences and decks to birdbaths and picnic tables); and sprinkler parts. Clicking the mouse on a button opens a library of visual elements for you to choose from. For example, open the Hardscape Library to place the walls of your home, and follow by opening the Plants Library to incorporate a few pine trees into your plan.

A fifth button opens a layering scheme that enables you to handle complex designs. Each layer is like a piece of tracing paper and you can choose which layers will be visible.

In addition to placing and arranging static visual elements, *LandDesigner* tests hypothetical sprinkler systems. You'll be given a visual display of the coverage areas and informed of any flow problems inherent in your design.

To keep track of nonvisual data, the program records all relevant purchase information for each landscape



LandDesigner is a computer-aided landscape design program for DOS or Windows-based computers. It comes with a comprehensive manual and sample designs.

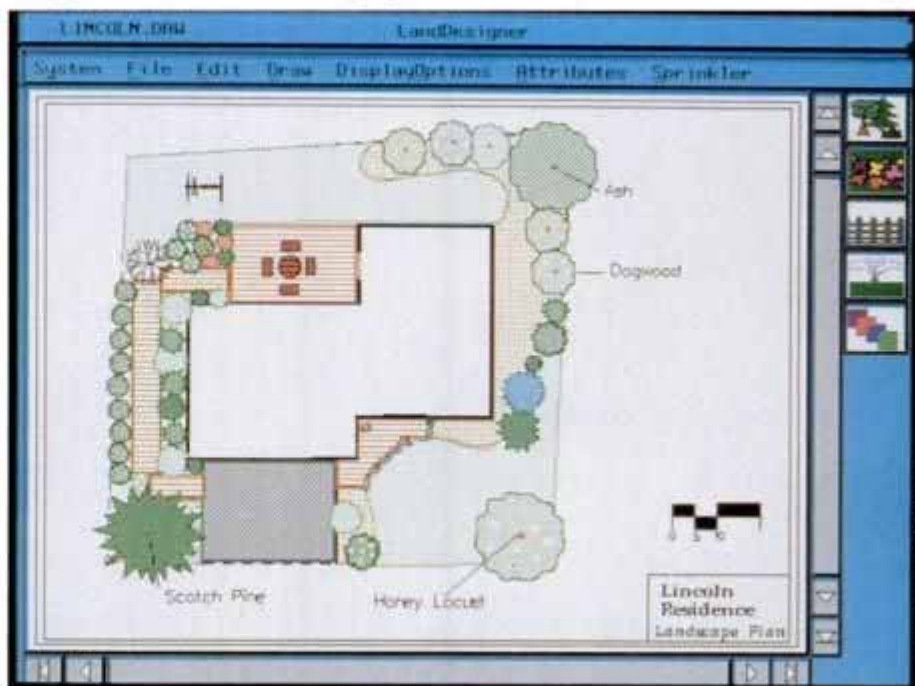
component, and you can fill out predefined databases for the four basic component libraries.

LandDesigner costs about \$39 and works on IBM and compatible machines running on MS-DOS 3.0 or later. A minimum of 1 MB of RAM is recommended. You also need at least 1 MB of free space on your hard disk; a Super VGA, VGA or EGA graphics

card; and a mouse. *LandDesigner* for Windows (about \$49) is also available. The Windows version includes enhancements such as on-line help, grow features to see how your garden will change over the years and interactive materials and cost estimating.

Contact Green Thumb Software, Inc., 75 Manhattan Dr., Suite 100, Boulder, CO 80303.

PM



The *LandDesigner* screen window is a grid on which graphic elements are arranged. Menu bar handles program commands, and four libraries of landscape components are available. A layering feature simplifies creating and viewing complex designs.

THE 1955 FORD FAIRLANE CROWN VICTORIA

Fully authorized by Ford Motor Company.



The definitive die-cast model of the first Crown Victoria, the most luxurious Ford of the '50s. Precision-engineered in 1:24 scale and fully detailed with every sizzling feature that made the original a true automotive legend.

Shown approximately actual size of 8 1/2" (22.23 cm) L. Scale 1:24.



No car captured the spirit of the Fabulous '50s with as much style and flair. The 1955 Ford Fairlane Crown Victoria. Bold. Innovative. And so daringly styled, it appeared to be in motion even while standing perfectly still. Now, the thrill is back—in a die-cast replica so true to the original, it is authorized by



Ford Motor Company. It's all here! From the deeply recessed headlights to the tastefully finned rear fenders and bullet-shaped parking lights. From the distinctive wraparound windshield to the Plexiglas "skylighted" top. Even the Ford Fairlane and V-8 emblems appear just as they did on the real car.



And this model is loaded with a complete array of operating features. The doors and hood open and close. The steering and road wheels turn. And the Continental spare tire actually swings away from the trunk.

This specially imported model is hand painted, hand-polished, hand finished and handsomely priced at



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FRANKLIN MINT PRECISION MODELS.® KEEPING AUTOMOTIVE HISTORY ALIVE.

NEW PRODUCTS

Power Assist

The best in new outdoor power equipment.

BY ROY BERENDSOHN, Assistant Home Improvement Editor



Big Cut, Fewer Passes

Troy-Bilt's Wide Cut is a commercial-like mower designed for residential properties. It has a 33-in. cutting width and enough maneuverability that it should reduce trimming. It's powered by an 8.5-hp engine and a 4-speed transmission with power reverse. We walked the 235-pound machine through a Troy-Bilt obstacle course and found it to be surprisingly agile. Its other good features include a single-lever cutting-height adjustment from 1 to 4 in. and a lever-release blade brake that stops the blade but not the engine. The mower costs about \$1200 (an electric start option costs about \$200).

Next, we took one of the company's new tractors on a test ride. Although this was hardly a comprehensive test, we found the hydrostatic-drive machine easy to use and very comfortable. It's offered in nine models ranging in price from about \$2100 for a 12.5-hp gear-drive model with a 39-in. deck to \$7100 for a 20-hp model with a 60-in. deck and hydrostatic drive. The tractors feature a step-through operator area and a sloped nose for good visibility. The mower deck on all the tractors can be frame hung for cutting rough ground, or it can roll on the turf for cutting smooth ground. The Wide Cut and the tractors are sold at Troy-Bilt dealers and Sears. For more information, write Garden Way Inc., 102nd St., Ninth Ave., Troy, NY 12180.



Rough 'N' Ready

For nearly 50 years Yazoo has built mowers in Mississippi to handle tough, fast-growing grasses, and its latest high-wheel mower shows evidence of this heavy-duty lineage. The S22CB1 is designed for cutting high grass or well-manicured lawns. It's equipped with a retractable mulching screen: Lower the plate to mulch dry grass of normal height, or shift the mulching lever to move the screen back to cut heavy, wet grass and weeds. The self-propelled mower has a 5-hp engine, a 4-wheel height-adjustment mechanism, controlled by turning one knob, and a positive traction differential that ratchets, allowing turning without disengaging the drive mechanism. It costs about \$625 at Yazoo dealers. Write Yazoo Manufacturing Co. Inc., P.O. Box 4449, Jackson, MS 39296.

Clipping Picking

The Clip & Clean takes over where standard hedge clippers leave off: It collects the clippings. Here's how the device works: Poke it into a hedge, and its nylon fingers direct shrubbery into a spinning cutterhead that has fan blades molded between the case-hardened steel blades. Branches up to 1/2 in. in diameter are first cut off, then chewed to the consistency of pipe to-

bacco and thrown into a 2-quart collection chamber. When this UL-listed tool is full, you

can open its back and dump the contents into a wheelbarrow or other container for transport to the compost pile. It costs about \$80 at hardware stores and home centers or (with shipping charges added) from: Titan Products, 4101 Shuffel Dr., Suite 100, N.W., Canton, OH 44720; (800) 262-5777.



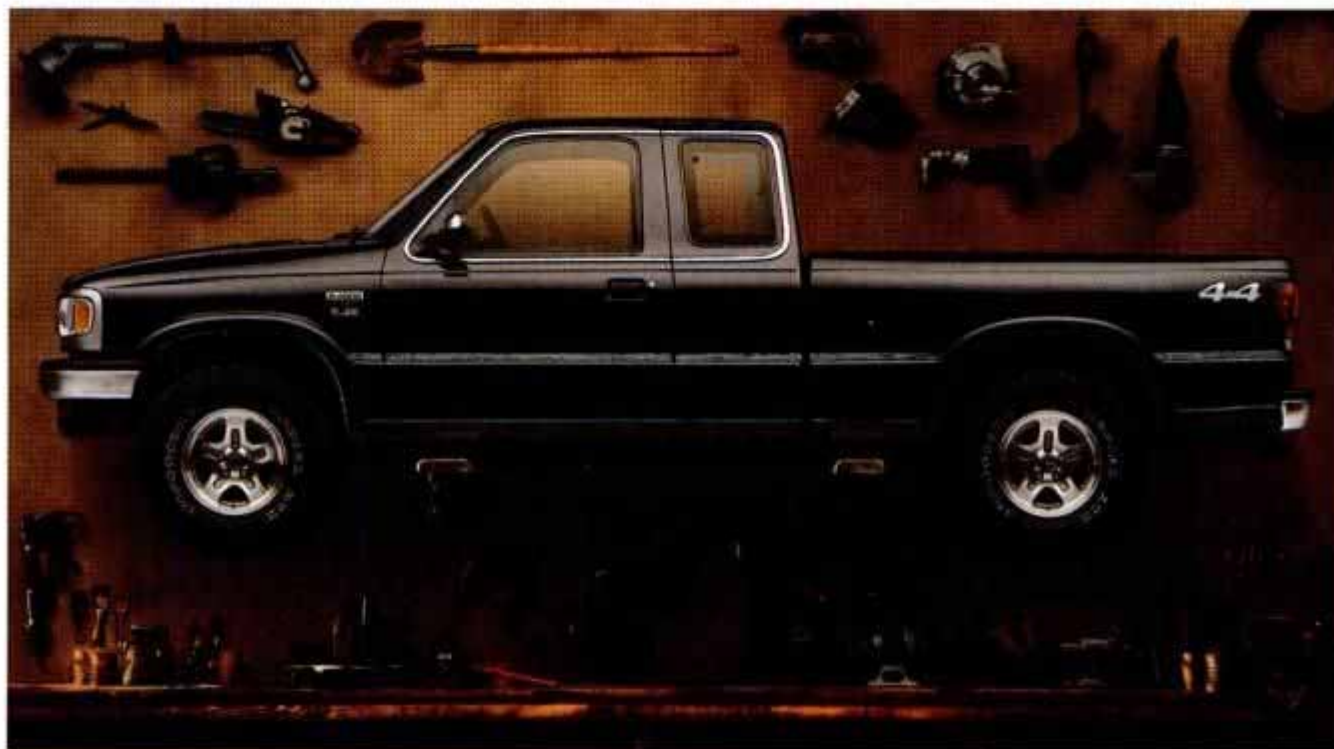
The New Mazda Truck

When it comes to weekends, Mazda owners are quite industrious.

Whether they're putting up drywall, landscaping

gravel. Especially with a bigger available payload than ever. Plus, a 36-month/50,000-mile,

bumper-to-bumper warranty,** so you can put



Introducing the best power tool you'll ever buy.

the yard or just running to the hardware store

to check out that new line of toggle bolts.

Which is why the all-new Mazda truck is a

handyman's best friend. It's the most powerful

import truck in its class, thanks to a rugged 4-liter

V6.* So you can haul, even when you're hauling

all your energy into fixing that leaky faucet.



INFORMATION COMPARISON	MAZDA	TOYOTA	NISSAN
Largest available engine	4.0L V6	3.0L V6	3.0L V6
Horsepower/torque	160/220	150/180	153/180
Maximum towing capacity	5,900 lb.	3,500 lb.	5,000 lb.
Front track (inches) (4x2/4x4)	56.7/58.3	53.3/56.3	54.9/56.1 55.7/56.9 (V6)
Rear track (inches) (4x2/4x4)	57.3/57.3	53.9/56.1	54.5/54.5 56.3/56.3 (V6)
Basic warranty (years/miles)	3/50,000	3/36,000	3/36,000

The new Mazda truck. It won't fit on your tool belt,

but you'll be glad it's hanging out in your garage.

mazda
IT JUST FEELS RIGHT.*

The full line of all-new Mazda trucks is built in Edison, New Jersey. For a free brochure, call 1-800-639-1000. *Available on B4000 only. **See your Mazda Dealer for limited-warranty details. © 1993 Mazda Motor of America, Inc.



Silence Is Golden

When we heard this machine run at the Outdoor Power Equipment Expo, we were impressed by how quiet it was. It's quiet because it's powered by a 4-cycle engine—the smallest 4-cycle in the world for handheld power equipment, Ryobi says. The 26.2-cc engine is used on three tools: a straight-shaft trimmer/edger, a multi-head trimmer (edger/blower/cultivator) and a brush cutter. The trimmer costs about \$180, the multihead tool, about \$200 (the attachments cost from about \$30 to \$90) and the brush cutter, \$220. All are sold at home centers and lawn and garden centers. Write Customer Service, Ryobi, 5201 Pearman Dairy Rd., P.O. Box 1207, Anderson, SC 29622-1207.

Slim Down

The Husqvarna Electric 16 chain saw has much to recommend it. To start with, it weighs only 8.2 pounds, and its 13-amp motor is parallel to the saw's guide bar, which comes in 14-in. and 16-in. lengths. Most electric saws have motors 90° to the bar. An inline motor makes the saw easier to handle by improving its balance and making it feel like a gas engine saw. It also



makes it more compact. The UL-listed tool costs about \$230 at Husqvarna dealers. For more information, write Husqvarna, 9006-J Perimeter Woods Dr., Charlotte, NC 28216.



Encore

Powered by a 12-volt battery, the CMM650 is a 60-pound cordless mulching mower that converts to side discharge or bagging. In the side-discharge mode, the mower can cut 12,000 sq. ft. of grass or mow continuously for 75 minutes, according to Black & Decker (as a mulcher, it's supposed to cut about 45 minutes in heavy grass and 55 minutes in light grass). The mower converts between mulching and side discharging by installing or removing a plate. The machine's battery should completely recharge in about 20 hours. It costs about \$350 to \$400 at home centers. Write Black & Decker, U.S. Power Tools Group, Communications Dept., 701 E. Joppa Rd., Towson, MD 21204.

Like A Car

John Deere has redesigned its venerable 400-Series tractors, making the machines more comfortable and easier to use in the process, the company says. Deere also maintains that the newer machines have simpler and more durable components. The line is powered by liquid-cooled 20- and 22-hp engines. Electronic fuel injection is offered as an option for these machines, and a 22-hp diesel is available with fuel injection standard. Power is transmitted through a pedal-control hydrostatic transmission. All of the tractors have power steering and a tilt steering wheel (4-wheel steering is optional; on the 425 it costs \$1000). The three models take optional mower decks in widths of 48, 54 and 60 in. The 400-Series tractors cost

from about \$8600 to \$10,700 (prices include a 54-in. deck).

The hopper on this chipper/shredder rotates from vertical to ground level, giving you the choice of dumping into the hopper or raking into it. The chipper/shredder comes in 5- and

8-hp models (\$700 and \$900). A 10-ft.-long vacuum hose is available as an accessory, as is a hitch kit (each costs about \$80). It's sold at John Deere dealers. Write John Deere, Dept. PM, Direct Mailing Service, 4905 77th Ave., Milan, IL 61264.

Trimmers Now

Makita, the power-tool maker well known to woodworkers, breaks into lawn care with its homeowner and commercial gas-powered string trimmers. Straight-shaft string trimmer models RBC221 (21.7 cc), RBC251 (24.5 cc) and the curved shaft RST250 (24.5 cc) are designed for homeowners, says Makita. Weighing a little more than 9 pounds each, the company claims the trimmers have the best power-to-weight ratio in the industry. The trimmers have pop-in spool cartridges and automatic string feed. The RBC221 costs about \$330, the RBC251, \$350 and the RST250 costs about \$250 at outdoor power equipment dealers. Write Makita, 14930 Northam St., La Mirada, CA 90638.



Comfortable Cutting

Toro's Wheel Horse 260-Series tractors are designed to blend garden tractor ruggedness with lawn tractor maneuverability. To make the machines comfortable, they have a high-back seat and a tilt steering wheel. To make them easier to use, they have a tight 16-in. turning radius and a cutting height—1.5 to 4.5 in.—that can be adjusted while seated by turning a knob. These tractors come in 14- and 16-hp models with geared and hydrostatic transmissions (a 14-hp 6-speed model is also available). You can choose from 38-, 42- and 48-in.-wide mower decks (about \$600) and various attachments. The tractors cost from \$2350 to \$3200 at Toro dealers. Write Toro Wheel Horse, 8111 Lyndale Ave. S., Bloomington, MN 55420.



Power Forward

The DR Powerwagon goes places a tractor can't, and, with a cargo capacity of 5 cu. ft. and 700 pounds, it carries more than a yard cart. It's powered by a 5-hp 4-cycle engine and a 4-speed transaxle with power reverse. Its frame is 1-in.-dia. cold-rolled steel tubing, and the flatbed frame is 1-in. square tubing of 14-ga. steel. The frame is covered by 5/8-in. pressure-treated plywood and the sides are 1 x 7 pressure-treated lumber. The bed dumps manually with the pivot point centered over the axle. A removable plastic tool tray is located between the body and the handlebars. Wheel weights, electric start and a quick-detach sulky are among its options. The basic Powerwagon costs \$1395, plus shipping, from Country Home Products, Dept. H37045N, Ferry Rd., Box 89, Charlotte, VT 05445; (800) 446-8746.



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Agricultural Products



Hang Tight

The next time a nut vibrates loose on your lawnmower or tiller, don't get annoyed. Instead, try a drop of this removable thread-locking adhesive, a product well known to mechanics. Now, however, you don't have to buy it in a large container to fix a loose nut or two: It comes in a single-application size (about \$1), sold at auto supply stores and hardware stores. Write Loctite Corp., 705 N. Mountain Rd., Newington, CT 06111.



Computer Cart

The computer-designed Rubbermaid Tractor Cart is surprisingly sophisticated. The one-piece cart body is molded from a structural foam plastic and it has a 1200-pound load capacity, thanks in part to a 1-in.-dia. carbon-steel axle. Among its other rugged features are a clevis plate welded to the drawbar, a ribbed sliding tailgate and stake slots molded into the cart body. It costs about \$260 at home centers, lawn and garden centers, and farm supply stores. Write Rubbermaid Commercial Products Inc., 3124 Valley Ave., Winchester, VA 22601.

The Problem.



No Problem!



New PATCH STICK™ fills small cracks and holes in seconds! Dab PATCH STICK™ over the hole or crack, then wipe it smooth with the spackle knife top. Dries in minutes. Requires no sanding. Nothing's easier, faster, neater. Dab on DAP® and the job's done for good.

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Beer Cans, No Problem

Disposing of litter while doing yardwork may be a little easier with the introduction of the Weed Eater Gator Vac, the first residential blower/vac designed to pull up anything from a pine cone to a beer can. Ordinary yard waste is pulled through its impeller and into a mesh bag. Turn the nose lever, and the airstream bypasses the impeller allowing it to suck up beer cans and paper cups without damaging the impeller. Another turn of the lever and it switches to a blower. It costs about \$100 at home centers and hardware stores. Write Poulan/Weed Eater, Marketing Dept., PM, P.O. Box 91329, Shreveport, LA 71149. **PM**



Homeowners Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Falling Water Causes Backpressure

Occasionally the water in my toilet bowl gurgles, and other times it is forced out onto the floor. This doesn't occur when the toilet is flushed but happens at random moments. The toilet works as it should in all other respects. What is the source of the backpressure that is causing this? I live in a condominium apartment on the ground floor of a building several stories high.

K.L. CARROLL
BURLINGTON, NC

A backpressure condition is not uncommon in mid- and high-rise buildings, and it occurs in tall houses with a bathroom on the top floor. The fixtures in which this occurs are those at the base of a soil stack or where a soil pipe changes its direction abruptly.

This is how the backpressure occurs:

A large amount of water, usually from a flushing toilet, will discharge into the soil stack. The water falls through the soil stack (sometimes described as a slug of water), and the air in front of it becomes pressurized because it is unable to slip past it and out the roof vent. Note in the drawing below that the air is trapped in the sewer pipe. Since the sewer pipe slopes, the airspace tapers to a point.

The greater the distance that the water falls, the greater the pressure. This is why the problem is found in mid- and high-rise buildings and tall older homes that have had a bathroom added on the top floor or in the attic.

Incidentally, this does not occur when a sink drains into the soil stack. This smaller volume of water

tends to cling to the wall of the soil stack and spiral its way down the stack as it falls. It does not pressurize a column of air as does a large volume released from a single flush.

Your toilet is probably close to the base of the soil stack, and if the pipe serves a number of bathrooms on the floors above, the pressure developed can cause the air to bubble up through the bowl water causing the gurgling sound. If the pressure is great enough, it can blow the water out of the bowl.

Electrically Controlled Dampers

After reading your response in the March '93 Clinic to an inquiry on fresh-air intake dampers for gas-fired forced-air furnaces, I called several heating and air-conditioning contractors. They don't seem to want to get involved or just don't want to handle them.

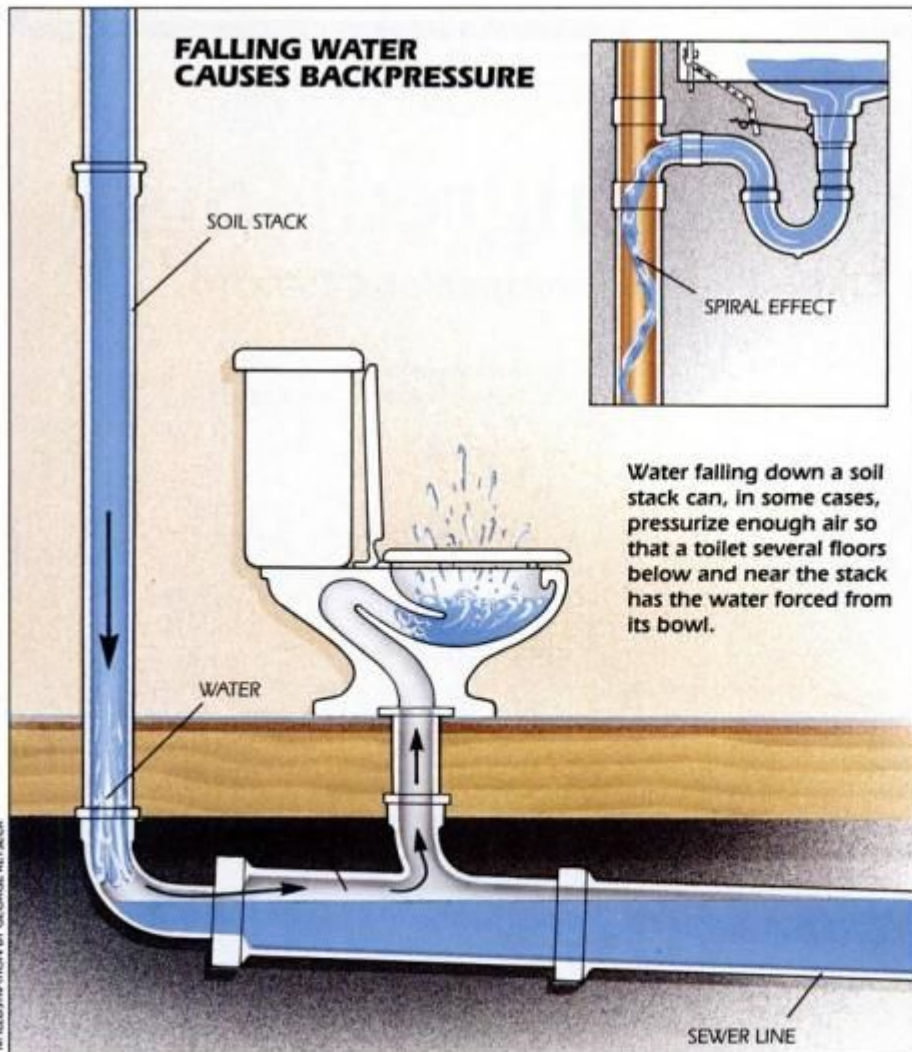
Could you give me some names and addresses of manufacturers and distributors of the electrically controlled dampers?

SAMUEL SORTINO
GLASSBORO, NJ

The electrically controlled damper for the fresh-air intake operates under the same electrical principles as the automatic flue damper that is installed on many new furnaces and boilers. In fact, an automatic flue damper can be used as a fresh-air intake.

Basically, when the thermostat calls for heat, the fresh-air damper motor—usually mounted in a rim joist or on an outside wall above your furnace room—moves the blade to the full-open position before the burner can ignite. While the burner is firing, the damper blade stays in the full-open position allowing fresh air to enter into the room. When the burner shuts off, either a spring will shut the damper or the damper motor will rotate the blade to the closed position, stopping the flow of fresh air into the room.

These dampers are generally available through HVAC (heating/ventilation/air-conditioning) dealers. One manufacturer of these dampers is Trol-A-Temp, 55-57 Bushes Ln., Elmwood Park, NJ 07407; or call



(800) 828-8367. Trol-A-Temp manufactures fresh-air dampers in various sizes and shapes. You can call the company at (800) 828-8367.

The Last Word On Roof Moss

We have a problem with moss growing on the roof of the house. Our roof has several steep gables, and we need a chemical that we can spray on the roof to remove the moss.

MARJORIE PITTMAN
 SPRUCE PINE, NC

BossWorks of Minneapolis has a product called DeckBoss that is supposed to clean mold, mildew and fungus off roofing. According to the company, DeckBoss will not harm plants or animals when used as directed, and it's easy to apply. You spray the liquid on the dry shingles with a garden sprayer, let it sit for 15 minutes and hose it off.

A 1-gallon container of DeckBoss costs from \$6 to \$8 at home centers. For information, write BossWorks, 4510 W. 77th St., Suite 239, Minneapolis, MN 55435; or call (800) 933-8043.

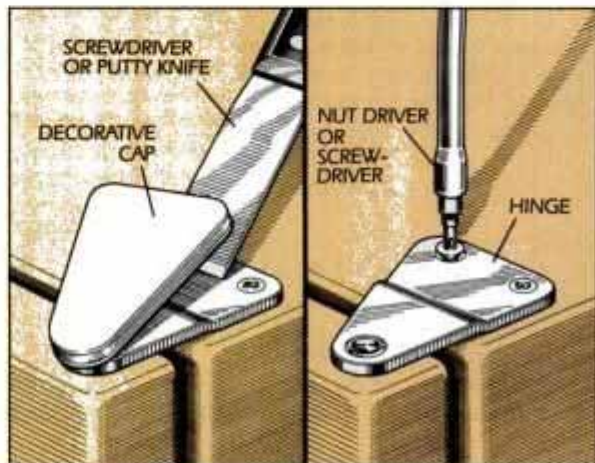
Adjust A Freezer Door

Over time a freezer door will sag. The weight of the door hanging on the hinge above it and the action of opening and closing the door loosens the hinge fasteners. A sagging freezer door forms a poor seal with the door gasket, and this wastes energy and wears the door gasket unevenly.

To gain access to the bolt or screws, first remove the plastic or metal decorative hinge cover. Pry off the cover with a straight-blade screwdriver or a putty knife. Next, use either a screwdriver, a nut driver or a socket wrench, and loosen the hex-head bolt, Phillips or Torx screws on the hinge. Lift the door by pulling up on the door handle until the door fits squarely over the opening. Hold the door in place, and tighten the fasteners. Open and close the door several times to be sure it seals properly. The top of the freezer door should line up with the top of the refrigerator cabinet. —Steve Toth



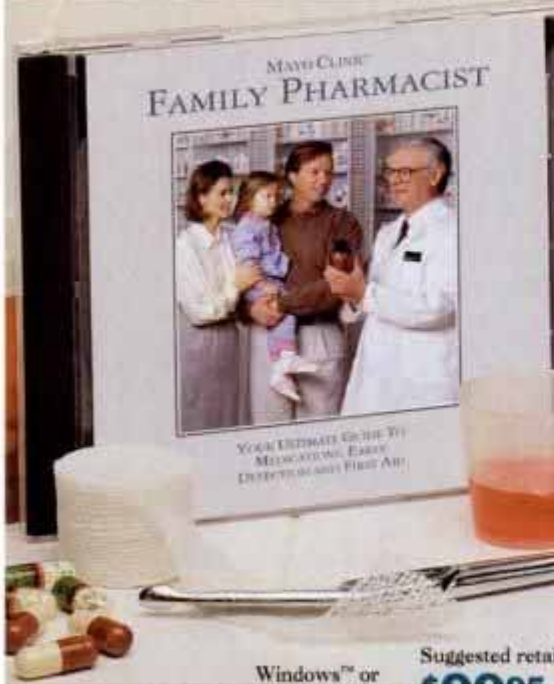
APPLIANCE CARE TIP



ILLUSTRATIONS BY GEORGE RETZKE

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IVI PUBLISHING

Removing Iron Stains

Editor's Note: We recently received the following letter in response to a past column regarding bathtub cleaner. For readers that have a similar problem, the letter should be of interest.

Here in northern Minnesota, our water is colored by iron ore deposits. We have found the best product for removing rust from bathroom fixtures to be Iron Out. Used as directed, it will not damage the surface of any bathroom fixture, as some powder cleansers do. Also, added to the laundry water, it keeps white clothes white.

L.E. "PETE" DAVIS
ELY, MN

Free Info

Removing vinyl/asbestos sheet flooring or resilient floor tiles can be messy, and the thought of dealing with asbestos in the flooring may prompt unnecessary anxiety in homeowners faced with the job.

It turns out that if you treat the flooring carefully, and remove it sys-



tematically, the job is no more difficult than other odious jobs faced by remodelers. At least that's what a free booklet from the Resilient Floor Covering Institute says.

There's no magic to removing this flooring. With sheet flooring, for instance, you basically make several slices along its length, then pry it up a little at a time while spraying a soapy water solution at the point where the flooring peels away from the floor. The job may be slow, and certainly not a pleasure, but at least by using the methods outlined here it's manageable.

For your free copy of the booklet, write to the Resilient Floor Covering Institute, 966 Hungerford Dr., Suite 12B, Rockville, MD 20850.

—Roy Berendsohn


According to Iron Out Inc., an 18-ounce bottle of the company's product costs about \$4 at hardware stores. For more information, write Iron Out, 1515 Dividend Rd., Fort Wayne, IN 46808, or call (800) 654-0791.

Another product, Iron Care, is supposed to be an all-purpose rust remover as well. Iron Care is sold at hardware stores and home cen-

ters, and an 18-ounce can of the product costs about \$3.50. For more information, write Enforcer Products, P.O. Box 1068, Cartersville, GA 30120. **PM**

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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




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**HOME
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**How To
 Insulate
 Basement
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*A new product
 drastically reduces
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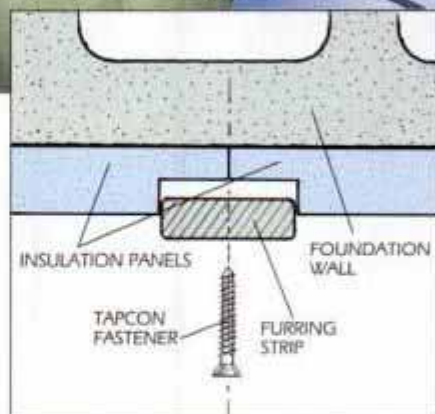
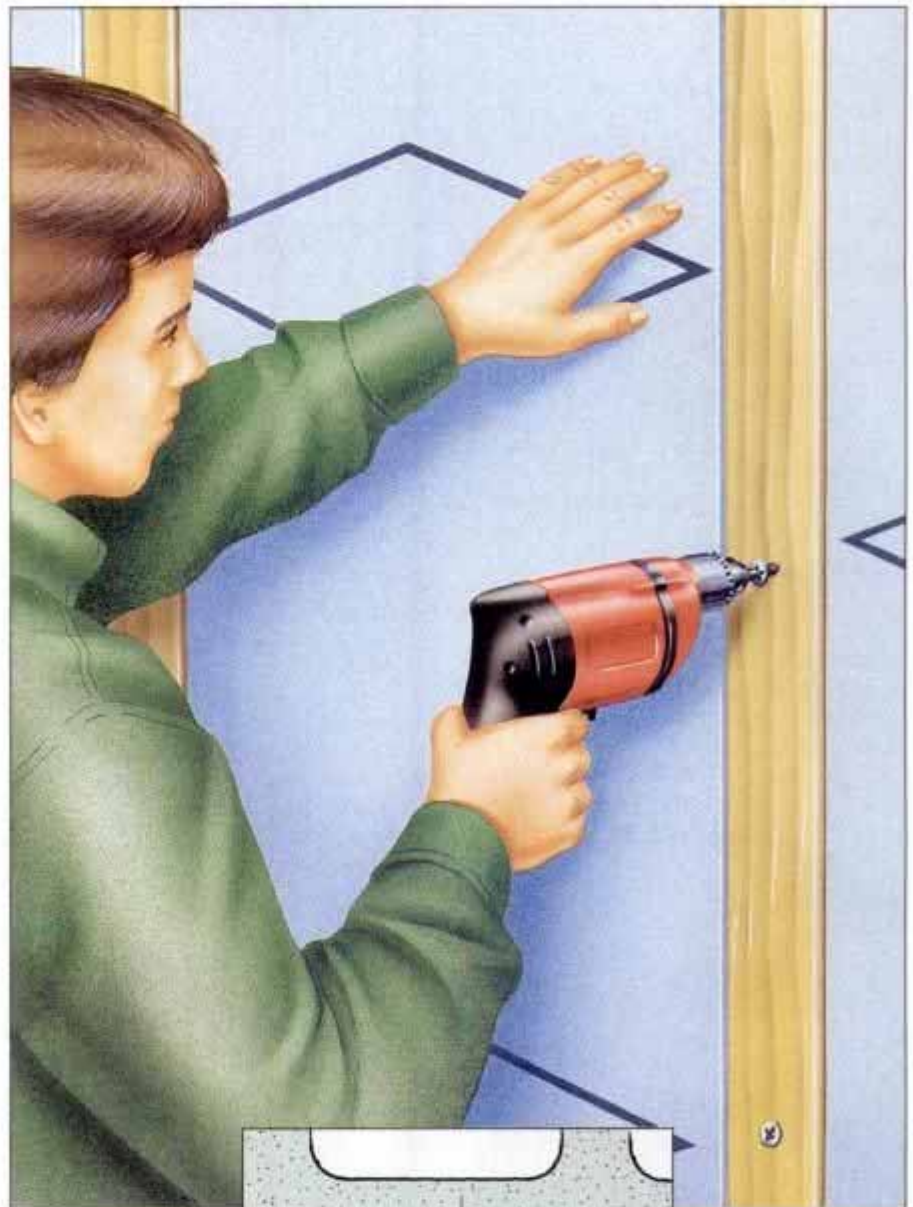
BY STEVEN WILLSON,
 Home Improvement Editor
 PM Illustrations by
 George Retseck

● If you are fortunate enough to have a full basement, you know just how useful this area can be. There's usually plenty of room for doing the family laundry, putting together an extensive workshop, allowing the kids a free-fire zone out of earshot—and even enough square footage left over for storing all that junk you promised to throw away but never did.

A basement has always been a cheap source of extra living space when a family starts to outgrow a house but its bank account hasn't. Turning a basement into a family room or an extra bedroom is a time-honored project and one that just got a little easier.

A new product from Dow called Wallmate was specifically designed to easily insulate basement walls and provide a great support system for standard drywall panels. The idea is so simple, it's hard to believe it's new. Basically, Dow just took its standard Styrofoam product and manufactured it in 1½ × 24 × 96-in. panels, with a ¾ × 1½-in. rabbet along both long edges. (See small drawing at right.) By abutting two panels, the groove that results from the two rabbets matches the size of a standard 1 × 3 furring strip. To install, just stand the panels against the wall, slide a furring strip into the groove and then attach this strip to the wall. When you're done insulating, dry-wall panels can be attached directly to the furring. Wallmate costs between \$7 and \$8 per panel.

The usual approach that this replaces is the difficult, time-consuming and expensive task of building interior 2 × 4 walls and filling their stud spaces with fiberglass insulation. In damp



Each rigid foam board has a rabbet—along both long edges—sized to accept a standard piece of furring. The furring strip is attached to the foundation wall using concrete anchors or Tapcon fasteners.

basements—which are all too common—there's another benefit: When fiberglass insulation gets wet, it loses its effectiveness as an insulator. Polystyrene panels, like Styrofoam, on the other hand, do not lose much of their insulating power in damp conditions. And they have a higher R-value per inch—5 per inch in the case of extruded polystyrene and between 3 and 3.5 per inch for fiberglass. In the case of Wallmate, the panels are R-7.5, and if you double them up, which is very easy to do, you'd get a minimum

R-value in your basement of 15.

The only real drawback to this system is attaching the furring strips to your block or poured concrete wall. Masonry nails are very difficult to drive and installing typical concrete anchors is too time-consuming.

This installation problem, however, is easily overcome

with some clever screws called Tapcon anchors. (See detail drawing above Figure 11.) These screws are designed to function in concrete like self-tapping machine screws do in sheetmetal. All you need to do is bore



1-6-94 8:07 p.m.
Situation: Mother and two children in mall parking lot

The first alarm system designed to protect you as well as your car...

Revolutionary new vehicle security system is the first of its kind to focus on the safety of the vehicle driver as well as the vehicle itself.

By Charles Anton

Do you wonder why car alarms have countless features to protect your car, but nothing to protect you? After all, what's more important your car or the safety of you and your family?

Now there is a car alarm that will protect you and your family. It is the first of its kind to focus on the safety of the vehicle owner as well as the vehicle itself.

Protect yourself. It all begins with the panic button. Imagine you're walking to your car at night and a person approaches. Pushing the panic button on your transmitter lets your car come alive with a shrieking siren and flashing headlights. While the panic alarms of other vehicle security systems have a range of 100 feet, the Smart Alarm's panic alarm lets you call for help or scare away potential attackers from up to 400 feet!

Exclusive feature. Unlike other car alarm systems that begin and end their focus on per-

sonal protection with the panic alarm, that's just the beginning of the Smart Alarm. In addition to the panic alarm, the Smart Alarm also has a car finder feature. You'll never again have to wander around a dark and dangerous parking lot searching for your car. You will be able to know where your car is from anywhere within 400 feet by flashing its lights and briefly sounding the siren. You can activate and deactivate your car's headlights by remote control to light your way in a dark driveway or parking lot.

Carjacking. The Smart Alarm also addresses a growing hazard for today's motorists—carjacking. It's alarming how often drivers are hurt in their cars because they refuse to give them up to carjackers. Because of its anti-carjacking device, the Smart Alarm allows you to safely retain your car when confronted by a carjacker. This is made possible by a delayed panic alarm.

What makes Smart Alarm better?

- **Range.** Most car alarm features only work up to 100 feet away—all Smart Alarm features work up to 400 feet away.
- **Panic button.** Smart Alarm lets you call for help or scare away potential troublemakers by controlling a piercing alarm and your car's headlights.
- **Car finder.** Your car will be able to let you know where it is by flashing its lights and briefly sounding the siren.
- **Carjacking.** Its delayed panic alarm allows you to safely prevent theft of your car when confronted by a carjacker.
- **Easy installation.** Other car alarms are complicated or cost hundreds of dollars to install. Smart Alarm is inexpensive, and you can install it in just minutes.



Smart Alarm is the first car alarm that will protect you and your family.

Easy installation. Installing the Smart Alarm requires no fumbling with wires. Special Plug-In Connectors let you install the Smart Alarm without a single wire-cutter! Simply unplug the headlight connector, plug in the Smart Alarm connector, and then plug the headlight connector to the Smart Alarm. Connect the Smart Alarm to the battery cable with the special clip. In minutes, you and your car can enjoy complete 24-hour protection. Away from your car, you'll feel safer knowing that your car is protected! Near your car, you'll feel safer knowing that you are protected!

All you do is give up your car and activate the delayed panic alarm. When the assailant has reached a safe distance and is no longer a threat to you, a deafening 120dB siren and flashing lights will force him to flee your car, letting you recover it safely.

Vehicle protection. Smart Alarm's current sensor triggers the siren if the trunk or any of the doors are opened while the alarm is armed. To supplement the current sensor, a shock sensor triggers the siren when it detects a blow to your car. Together, these sensors provide your car with blanket protection.

An adjustable shock sensor prevents the siren from being triggered, eliminating false alarms. You can also adjust the shock sensor and the siren with your remote control at any time you choose. The siren's tone and volume can be adjusted to six separate tones. As a result, you'll never confuse it with any other alarm. You can also customize the siren, making it louder in noisy neighborhoods and quieter in more peaceful neighborhoods.

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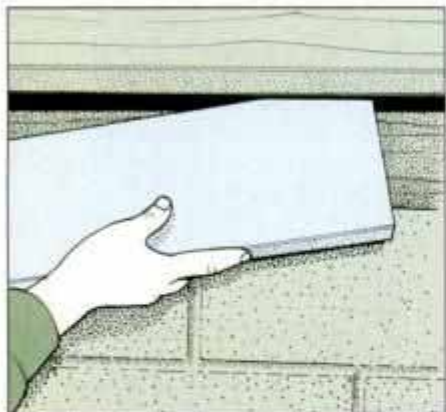
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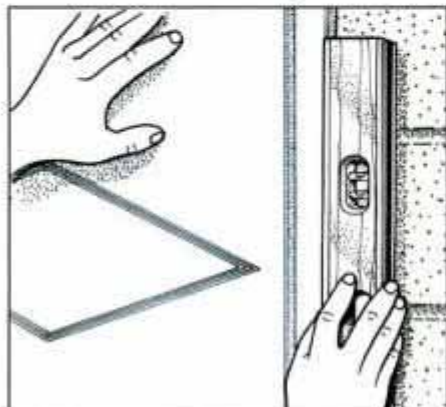
1 Begin by cutting insulation panels to size and filling the joist spaces around the top of the wall with these pieces.

a small-diameter pilot hole with a masonry bit. Then immediately drive the screw into this hole. No matching holes in the concrete and furring are required. We used five screws for each 8-ft. furring strip, and it took 3 minutes to install all five.

Of course, you have to pay for this convenience. The screws cost about \$25 for a box of 100. But the box does include the proper-size masonry bit for boring the pilot holes, which stays sharp long after you've used up the screws. Between the new insulation boards and these fasteners, we were able to completely insulate all four of our basement walls in just one day.

Keep in mind that this system is new and therefore requires more than ordinary communication with your local building inspector, especially when it comes to the electrical system. Generally speaking, you cannot install insulation until your electrical cable is in place and inspected. This rule can be pretty inflexible—at least that was the case in New York State, where we did this job. Unfortunately, this insulation is designed to go up before the wiring.

There are several ways to handle

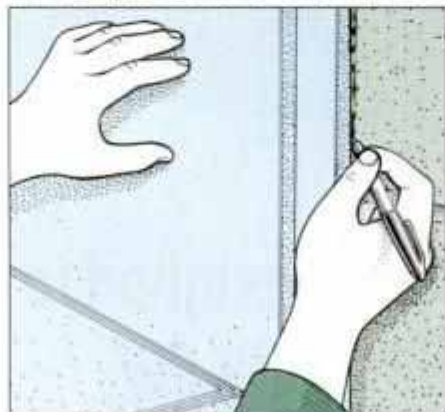


2 Starting in one corner, hold the first panel against the wall and adjust it until its edge is perfectly plumb.

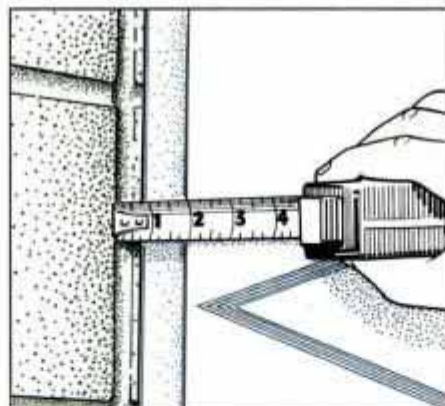
this. You could use rigid conduit, metal boxes and metal covers, and simply surface wire the whole job after the insulation and drywall are in place. You may also be allowed to attach the surface wiring to the foundation walls and then insulate around everything. Or, you may be able to use the system we show here. Just get prior approval for the system you choose.

Where to begin

You can put all the insulation you want on your basement walls, but if



3 While holding the panel in a plumb position, mark the wall alongside the panel to establish a proper reference line.

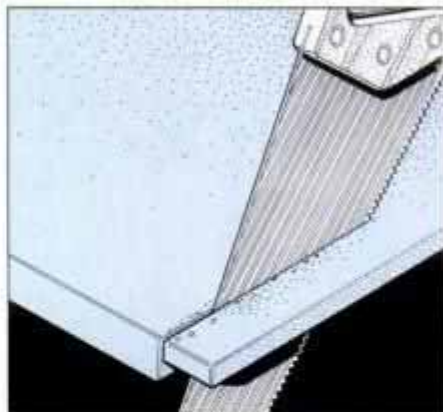


4 With the board still held in its plumb position, measure the gap between the board and the corner at its widest point.

the joist spaces above the walls haven't been insulated, you're not going to save much money on your heating bill. To insulate these spaces, we just cut up pieces of Wallmate and filled the gaps with them (Fig. 1).

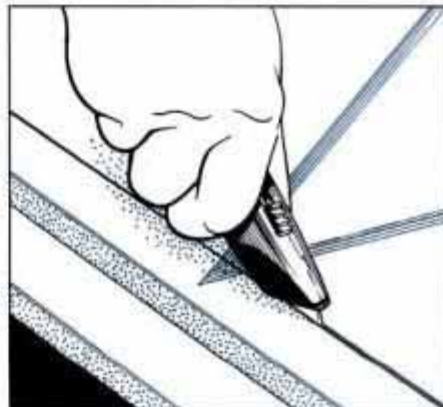
Next, choose one corner for your starting point and push a piece of Wallmate into this corner. Hold a level against the open edge and check for plumb (Fig. 2). Because the position of all the ensuing panels on this wall are based on the alignment of the first one, make sure it's right.

Hold this panel in the plumb position and mark the wall along the outside edge of this panel (Fig. 3). This



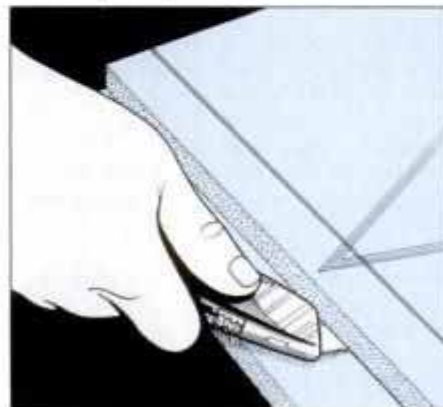
5 Mark the cutline on the back side of the panel, and then cut along the line with a handsaw or sabre saw.

establishes a reference line for maintaining plumb without needing to constantly hold the level in place. Once the wall is marked, hold the board against the line and measure any gap between the inside edge of the board



6 Measure the full rabbet width, then mark this width on the front side of the panel. Make the surface cut with a utility knife.

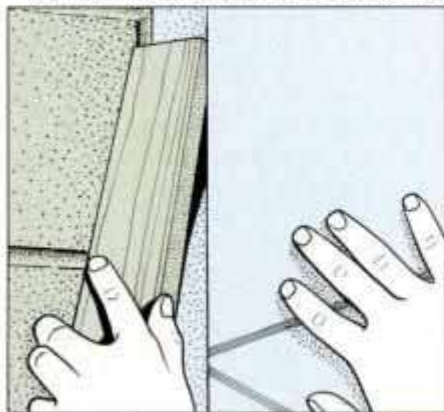
and the corner at the widest point (Fig. 4). Usually, this is at the top or the bottom of the board. Transfer this point onto a panel and mark a line. Then cut along this line using a handsaw or sabre saw (Fig. 5). This material is very easy to cut.



7 Complete the rabbet by making an edge cut with a utility knife. Be sure to use a sharp blade to avoid tearing the foam.

Next, widen the existing rabbet on the face of the first panel so it can accept a full furring strip. Mark this cutline on the surface and make the cut with a sharp utility knife (Fig. 6). Then, make an edge cut with the knife to remove all the waste (Fig. 7).

Once the rabbet is cut, hold the



8 Once the panel is cut, hold it in place and check your reference mark. Then slide a piece of furring into the rabbet.

panel in place, check your plumb mark and slide a piece of furring into the rabbet (Fig. 8). Bore a pilot hole about waist high and drive a Tapcon screw into the hole. Then bore the rest of the pilot holes and drive the remaining screws. We used five evenly spaced screws for each 8-ft. furring strip.

Next, lean up a second panel, abut the two rabbets and slide a furring strip in place (Fig. 9). While holding the new panel and furring strip, bore a

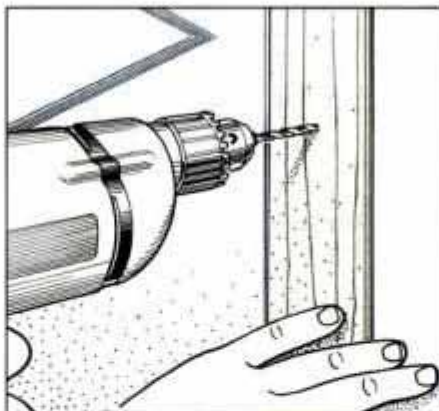


9 Once the first panel is secured, lean a second panel against the first and slide a precut furring strip into the rabbet.

pilot hole (Fig. 10) followed by a screw (Fig. 11). Continue this process until the wall is done. Then move to the next wall and plumb the first panel in place, and repeat the same procedures.

Electrical planning

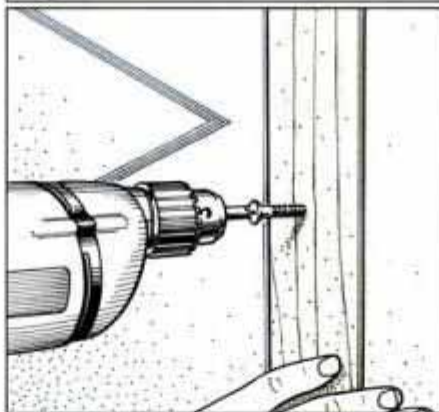
As mentioned earlier, make sure to check with your local building inspector before undertaking any wiring. And if you aren't confident of your



10 While holding the second panel and furring strip in place, bore a fastener hole through the furring and into the wall.

skills, hire an electrician to handle this part of the job for you.

Your best strategy is to limit the number of fixtures on the insulated walls. If you are building partitions,



11 After the pilot hole is bored, drive the fastener into the concrete. These screws (top) have two threads, not just one.

locate as many receptacles, switch boxes and wall lights on these walls as the code will permit, instead



12 To install receptacle boxes, first cut a board or plywood panel to size. Then trace its perimeter onto the insulation.

of on the insulated walls.

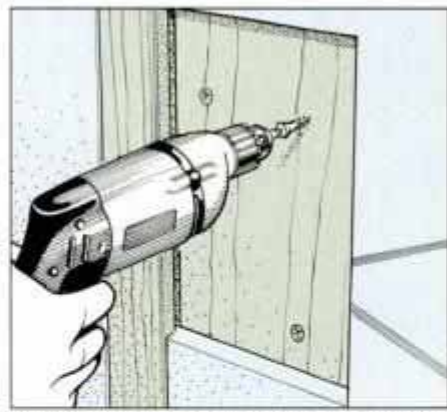
We were able to place all our switches, except for one, on interior walls. And we preferred overhead lights. So our only real trouble was wiring a couple of receptacle circuits. Here's the system we came up with.

Begin by establishing the location of your electrical boxes. Then determine how far away from the wall the boxes should be attached so that the front of each box will be flush with the surrounding wall when you're done.

In our case, this calculation was a little complicated because we planned to first cover the walls with 1/2-in.-thick drywall and then cover the drywall with 3/8-in.-thick paneling. We also decided to use square metal boxes that require cover rings. Be-



13 Use a utility knife to cut the foam panel. Because the blade can't reach all the way through, make the cut in stages.



14 Attach the board directly to the foundation wall using concrete fasteners. This board must be solidly attached.

cause of these requirements, we started with a 3/8-in.-thick piece of plywood against the foundation wall, attached a 1 1/2-in.-deep box to this panel, then installed a 1/2-in.-deep cover ring on the box. This total depth—2 3/8 in.—matched the combined depth of our insulation (1 1/2 in.), our drywall (1/2 in.) and our paneling (3/8 in.).

This also fulfilled a requirement of our local inspector: We had to mount

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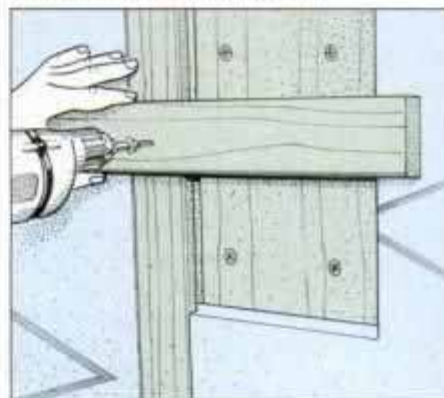
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each box on a wood panel large enough for the full box with room left over to staple the cable—which ran to and from the box—firmly in place.

After establishing the proper thickness for your mounting boards, cut them into pieces that measure about 8 × 12 in. Then trace the shape of each board on the insulation where an electrical box is required (Fig. 12). Cut out the insulation along these traced lines using a utility knife (Fig. 13). Then attach each of these boards directly to the foundation wall using short Tapcon screws (Fig. 14).

Determine the path of your cable and then temporarily attach a straightedge guide to the furring strips to support a router (Fig. 15). Install a 3/4-in. straight bit in your router and set the depth to 3/8 in. Then rout a cable groove across the panels and furring strips (Fig. 16).



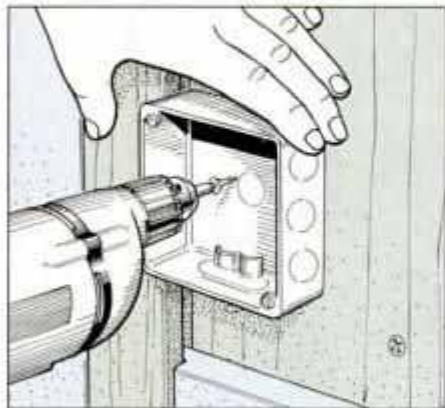
15 Determine the path of your cable and temporarily screw a straightedge guide to the furring strips to support a router.



16 Place a router on the straightedge guide and cut the cable groove through the foam panels and furring strips.

Once all your support boards are attached and cable grooves cut, install an electrical box on each board using short drywall screws (Fig. 17). Keep the box near the bottom of the board, so you'll have room to staple your cable above the box. Then feed the required electrical cables into the box

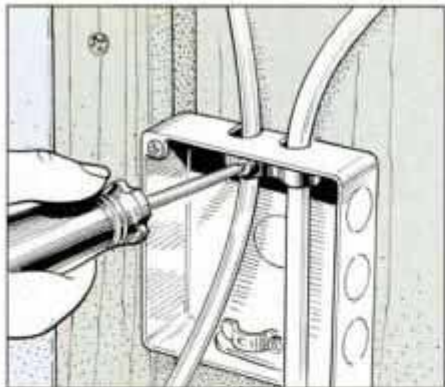
and secure them by tightening the built-in cable clamps or standard box connectors (Fig. 18). Make sure to staple each cable within 8 in. of the box (Fig. 19).



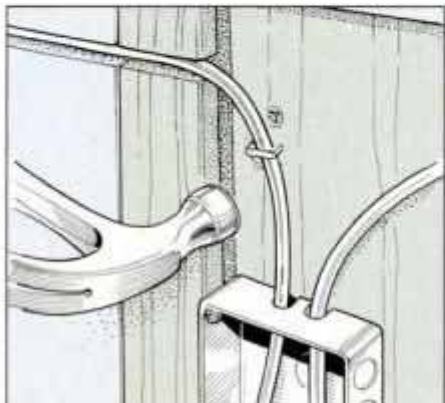
17 Install an electrical box on the board using short drywall screws. Make sure the box is firmly attached.

To protect the cable when it runs over each furring strip, you must install steel plates that bridge the groove and completely cover the cable (Fig. 20). This protects the wire from being pierced by nails or screws used to install the drywall later.

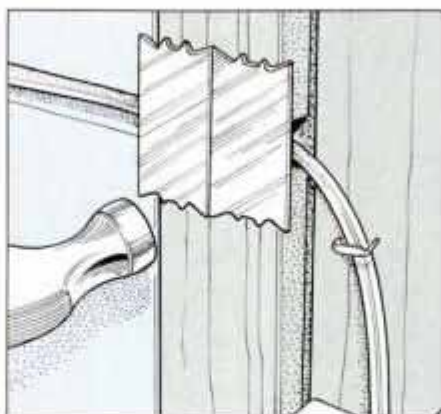
Finish up your rough electric installation by attaching cover plates to



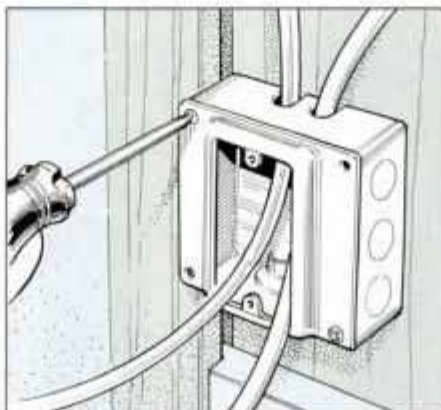
18 Feed the electrical cables into the box and tighten them in place with built-in cable clamps or standard box connectors.



19 Gently staple each cable to the board within 8 in. of the box. Do not tear the sheathing that protects the cable.



20 Drive protective steel plates into the furring so they cover the cable groove. These plates prevent cable damage.



21 Install cover plates for a single receptacle on all the boxes. Then make arrangements for a rough electrical inspection.



22 Once the rough inspection is passed, install the drywall by either driving nails or screws into the furring strips.

the boxes (Fig. 21). Then, after you've passed your rough inspection, just hang and finish your drywall in the usual manner (Fig. 22)—or skip the finishing process and cover the drywall with paneling like we did. **PM**

SOURCE LIST

- Wallmate panels: Dow Chemical Co., Customer Information Center, P.O. Box 1206, Midland, MI 48674.
- Tapeon fasteners: Eleco Industries Inc., 1111 Samuelson Rd., P.O. Box 7009, Rockford, IL 61225.

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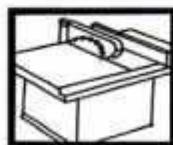


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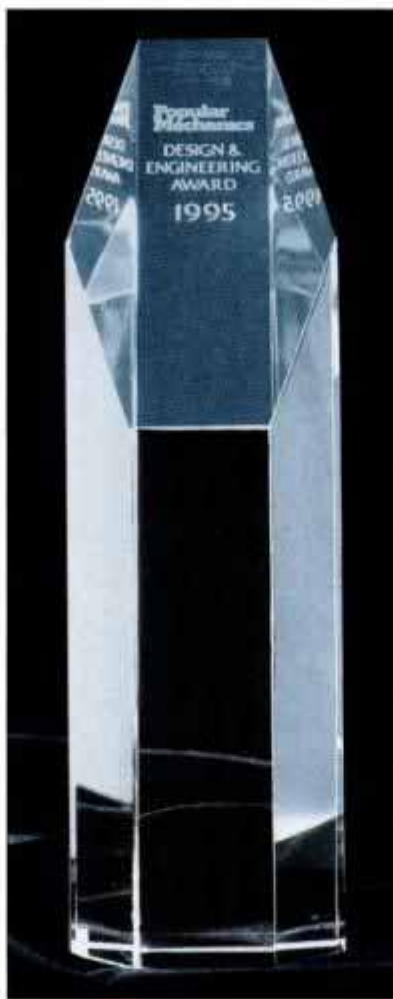
DESIGN & ENGINEERING AWARDS 1995

• It's time again to begin the nomination process for our annual Design & Engineering Awards. As you know, each year we honor innovation, invention and just plain good ideas in each of the areas we cover editorially—automotive, home improvement, shop tools, boating, outdoors, electronics, telecommunications, photography, science and technology.

The winners will be announced in our January 1995 issue.

If you look back at this year's list of winners, you'll get a very good idea of the wide range of innovations we recognized. Everything from a staple gun to a stealth ship, from a new sports car that can go 160 mph to a mountain bike that might get up to 30 mph on a good downhill run.

There is every indication that the 1995 award winners will be just as diverse a group, and just as interesting in their cutting-edge creativity.



Anyone can make a nomination for a POPULAR MECHANICS Design & Engineering Award—readers, manufacturers, distributors, public relations people, anyone. The rules are very minimal. There are no categories or set number of awards. We'll give as many as we think are appropriate. If you want to make a nomination, send a good, clear photo or illustration of the product, project, or whatever it is you are nominating. Include a complete description with all the details of what it is, what it does, why it's innovative and why you think it deserves an award.

The judges are our editors and their decisions are final. Deadline for nominees is Aug. 26, 1994. Mail entries to Design & Engineering

Awards, POPULAR MECHANICS, 224 W. 57th St., New York, NY 10019. Good luck.

Joe Oldham
Editor-in-Chief

SPECIAL SECTION

Car Care Guide



SPRING MAINTENANCE GUIDE
Keeping your car or truck in shape—
by the numbers.

The Case For Periodic Maintenance

There's no doubt that your car or truck is one very complicated piece of machinery. In fact, its various components and subsystems are each far more complicated individually than most mechanical devices you use in your everyday course of events. Therefore, it's no big surprise that maintaining your vehicle can be an intimidating task indeed. Some folks are so overwhelmed by the maintenance schedule as presented in their owner's manual that they select the expensive route of abdicating the chore to a skilled professional. Others take the worse—and ultimately far more expensive—route of simply neglecting rou-

tine maintenance altogether, choosing instead to repair the inevitable damage as it occurs.

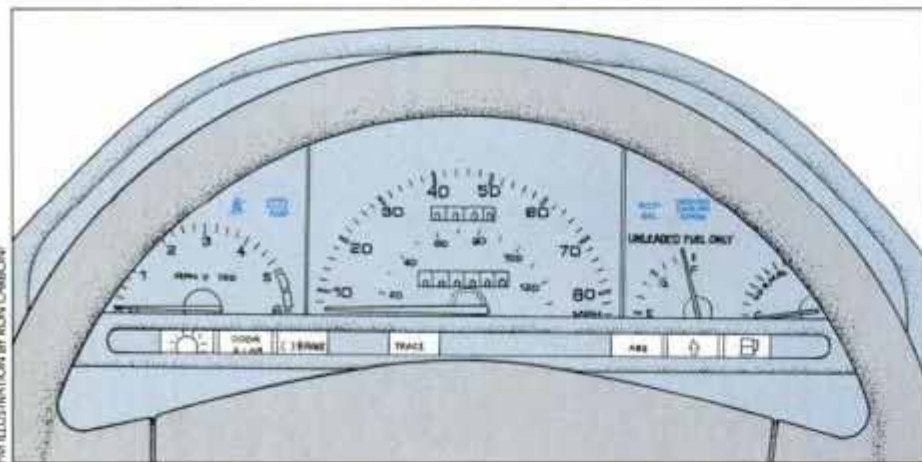
To help you make sense of the long—and somewhat off-putting—maintenance program, we have taken all of the important vehicular maintenance tasks and put them in a logical, easy-to-understand and easy-to-follow format.

Essentially, we explain what you should do every day, every week, every month, every 6 months, every year and every other year to keep your car, truck, minivan or sport/utility running right and looking sharp for as long as you own it.



At least once a day, before driving it for the first time, take the time to walk around your car or truck. As you stroll, look for broken head-

the charging system, the OIL pressure light and the CHECK ENGINE light as well. Some vehicles have a warning light for the antilock brakes, which is separate from the parking brake light. Now start the engine. All the lights should go out within a few seconds. Lights for the airbag and antilock brakes may stay on longer because the self-check for these systems



Turn the ignition key to ON, without starting the engine, and check that all of the warning lamps are lit. After the engine is started, all of the warning lights should go out, though not necessarily all at the same time.

lights or taillights, a tailpipe that's hanging unusually low, puddles of suspicious-looking fluids and make sure the passenger-side doors and the trunk or hatch are all fully closed. If you're backing down the driveway, you can also look for foreign objects like toys, bottles and other hazardous trash, pets and even small children that may be out of your line-of-sight from the driver's seat. When you sit down, set the mirrors and the seat position and fasten your seatbelt.

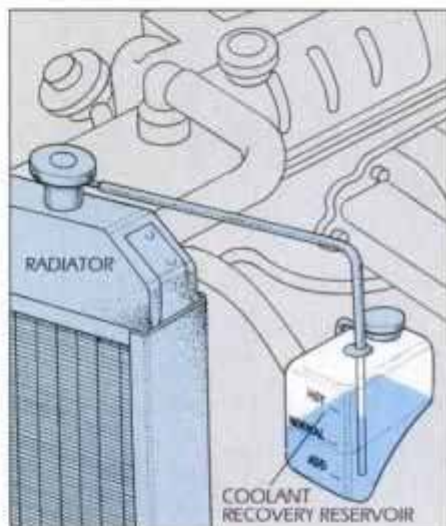
Any time you start the engine, turn the key to the ON position and check the warning lights. They all should come on—the ALT or BATT light for

is longer than for some of the others.

Don't forget to check the gas gauge, too, before heading out.



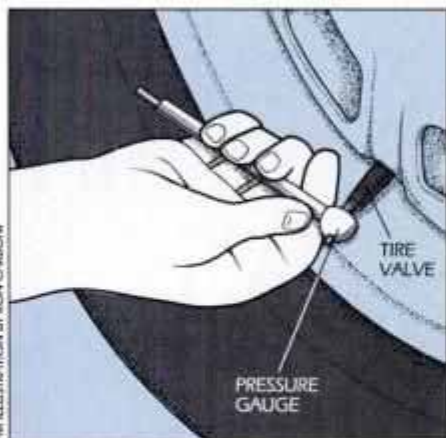
Tire pressures are vital to achieving good fuel mileage and long tire life as well as good ride and handling. Buy a good tire-pressure gauge and keep it in your glovebox. Using the one on the end of the hose in the gas station isn't a good idea—it may



Glance at the coolant level inside the translucent reservoir under the hood. Add coolant to the reservoir if needed.

be a little off ever since Bubba backed his pickup truck over it last week. Consult your owner's manual or the sticker provided on the doorframe for the correct inflation pressures. Check them in your driveway, before driving away, as even a few miles will raise tire temperatures and pressures—another reason to buy your own gauge. Use the vehicle manufacturer's tire pressures (not the max inflation pressure listed on the tire sidewall), and use the highest recommended pressure for best tire life and mileage. Don't forget to check the spare, too. Your pressure gauge may have to read upward of 60 psi to check a high-pressure, temporary mini-spare.

Now's a good time to check under the hood. Many vehicles have translucent reservoirs for coolant, power steering hydraulic fluid and brake fluid, and, in that case, all you have to do is glance at them. If they are opaque, it's only a matter of moments to unscrew the caps and look at the fluid



Using your own quality gauge, check the inflation pressure of all the tires—including the spare—before driving that day.

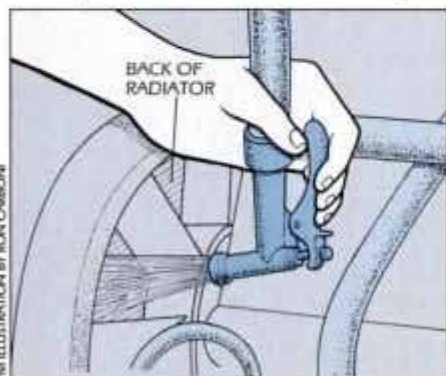
level, or to check the dipsticks. Don't forget the oil and automatic transmission dipsticks, too. As long as you're there, take the time to top off the windshield washer reservoir.

While you're perusing the engine compartment, take a look for leaks, loose wires or obviously disconnected vacuum hoses and fittings. Also quickly glance at the belts and hoses.



Aside from the customary weekly tasks, every month or so give your vehicle a better inspection. On the outside, check all the lights, including the turn-signal indicators, for burned-out bulbs and cracked or broken lenses. As you walk around the vehicle, also look for loose trim and don't neglect to check that the rearview mirrors are still firmly attached.

Check the tread of all four tires for damage. Look for abnormal wear pat-



Spray a strong stream of water through the radiator fins from the engine side of the radiator to clean debris from them.

terns, bulging sidewalls or foreign objects poking out of the tread.

Inside the vehicle, empty the ashtrays. Empty out the back seat, including fishing out all of the newspapers, empty soft-drink cans and kids' toys from under the seats.

Peruse the trunk and put away any unnecessary junk. Carrying around that extra 50-pound sack of rock salt all summer will cost you fuel mileage and adversely affect your ride and handling, not to mention making your headlights point closer to the tree tops than the roadway.

Don't allow leaves, trash and bugs to accumulate in the radiator and a/c condenser. You can usually flush them out by backwashing the radiator from inside with a garden hose.



Spring and fall are traditional times for automotive maintenance. Many maintenance items are often deferred because of the difficulty of working on a car in an unheated driveway. Spring affords an excellent opportunity to get under the hood and inside the car without your fingers sticking to the wrench.

Fall is a good time to prepare your ride for the ravages of winter weather as well—but many of the tasks are the same, regardless of the season.

Under the hood

A greasy engine is not a happy engine. The caked-on grease will make the engine run hot, oil leaks will be harder to spot, and any maintenance you want to do will be much tougher. In addition, rubber belts and hoses don't take kindly to being bathed in oil. Start by running down to the corner for enough cold drinks to get through the day. Don't go far—just a mile or two to warm up the engine. Then when you return, cover the air intake, alternator and any underhood computer black boxes with plastic. Spray down the engine with a biodegradable foaming degreaser. Then hose it all down with the garden hose.

Don't go to the quarter carwash and blast away with the high-pressure hose—modern cars have dozens of low-voltage sensors that all have weatherproofed connections to the computer harness. Weatherproofed means plenty good enough for water



Check nondriving wheel bearings by trying to rock the raised wheel in and out at the 12 and 6 o'clock positions.

splashed up by a puddle or normal condensation—don't push your luck and overpower the seals. Water inside these sensor connections can corrode them very rapidly, and your car will run poorly or not at all.

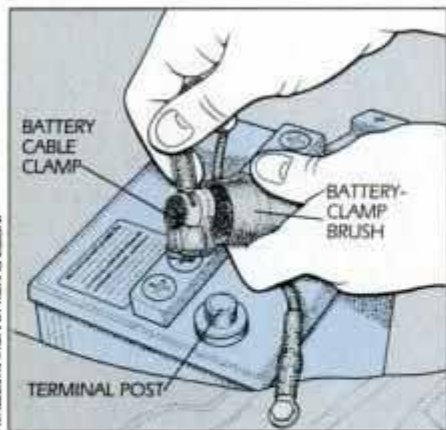
Is the engine still greasy? Let the engine idle for 5 minutes to evaporate the water you've sprayed all over, and



Stubborn grease or salt stains on floor carpeting can be removed with a foam-type carpet cleaner and a scrub brush.

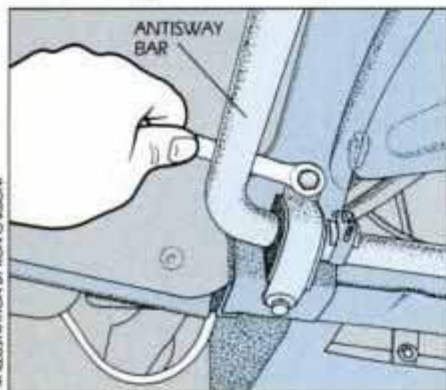
repeat the engine cleaner/garden hose routine while you start cleaning the interior of the vehicle.

Clean enough? Now you can attend to any minor oil leaks that may have contributed to the problem. Take some solvent and clean the plug wires one at a time, removing any grease that represents a potential path for high-voltage leaks. Label the plug



Remove surface corrosion from battery terminals and cable clamps with a special wire brush to ensure starting power.

wires for reassembly and pull off the distributor cap. Don't use solvent here—just polish inside and out with a soft, dry cloth. Any evidence of carbon tracking or cracks is grounds for



Tighten any loose suspension-bushing mounting bolts, particularly at antisway bars. Replace torn or worn bushings.

replacement of the cap or rotor.

Open up the air cleaner and at least inspect it. Most modern cars have remote air cleaners, and many of those are held together with easy-to-open spring clips. Some have hard-to-open retainers that require a screwdriver or socket to disassemble, but in either case you'll need to open the housing to get to the air-cleaner element inside the housing.

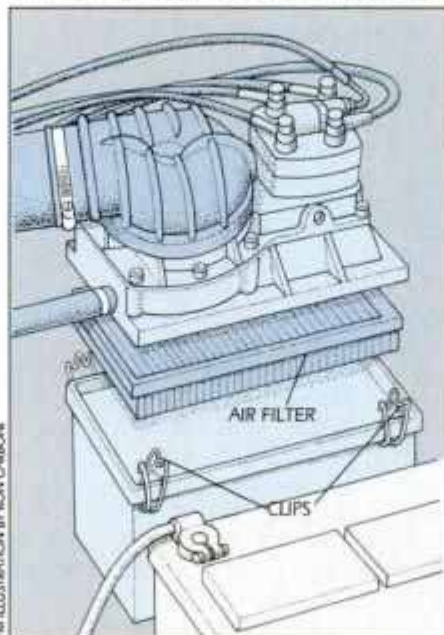
Modern pleated-paper air-cleaner elements will hold an amazing amount of dirt before they begin to restrict the flow of air into your engine, so don't be in a hurry to change yours until it's pretty loaded. What's more important is to be sure that the element isn't torn or cracked, and that unfiltered air isn't sneaking past an improperly seated element. The air cleaner should be hospital-clean in-board of the element. If dirt has bypassed the element, clean the inside of

the housing and ducting to the throttle body with a damp cloth.

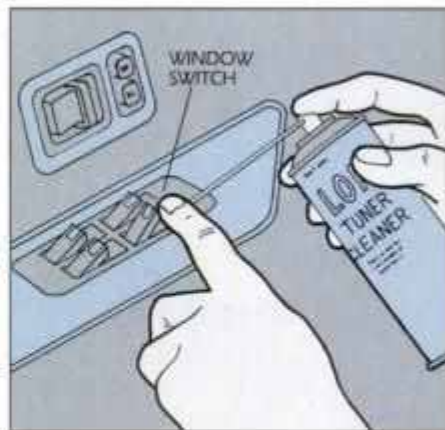
Check the battery terminals for signs of corrosion. If the terminals look like a Chia Pet from Venus, start by dissolving the excess corrosion with a kettle or two of hot water. Once you can actually see the fasteners, remove the cable terminals from the battery posts and clean the electrical mating surfaces with a battery-terminal cleaning brush. If you don't have such a brush, you can use sandpaper in a pinch. You need bright, shiny surfaces on the outside of the battery posts and inside of the cable clamps. Severe corrosion might require application of a paste of baking soda and water. Flush with plenty of water, wear eye protection and beware because the battery acid will eat holes in your favorite jeans. Reinstall the cables, and coat any exposed metal with wheel-bearing grease or petroleum jelly to retard further corrosion.

Pull the battery caps and top off the electrolyte levels with distilled water. Many so-called maintenance-free batteries still have caps that can be opened, and although they're formulated to use less water over their lifetime, it's still a good idea to keep them topped off.

Change the fuel filter in the spring, as then it's most likely to be loaded with water from condensation. Use a flare-nut wrench if the body of the filter has to be held, as the soft aluminum body will distort easily. Be sure to use new copper washers to



Inspect the air-cleaner element, the cleaner housing and all ductwork. Replace a clogged filter. Clean the housing.



Regular cleaning of power-window and seat-switch contacts helps ensure smooth operation. Use aerosol TV-tuner cleaner.

seal the banjo bolts. If the filter is replaced simply by loosening hose clamps, it's a good idea to replace the factory sheetmetal-and-screw or spring clamps with stainless worm-drive clamps to keep things leak-free.

Remove the radiator cap and inspect it. Look for degraded rubber gaskets, cracks or corrosion. Look into the radiator at the coolant. It should be full to the brim if you have a coolant recovery tank.

Getting horizontal

Now it's time to inspect the underpinnings of your car, the parts that normally aren't available for casual inspection. You'll need a floor jack and at least two sturdy stands, or a pair of ramps. Cement blocks are not an acceptable substitute for stands. They're too brittle and are prone to returning to their constituent components while you're under the car. A creeper is handy for rolling around under the car.

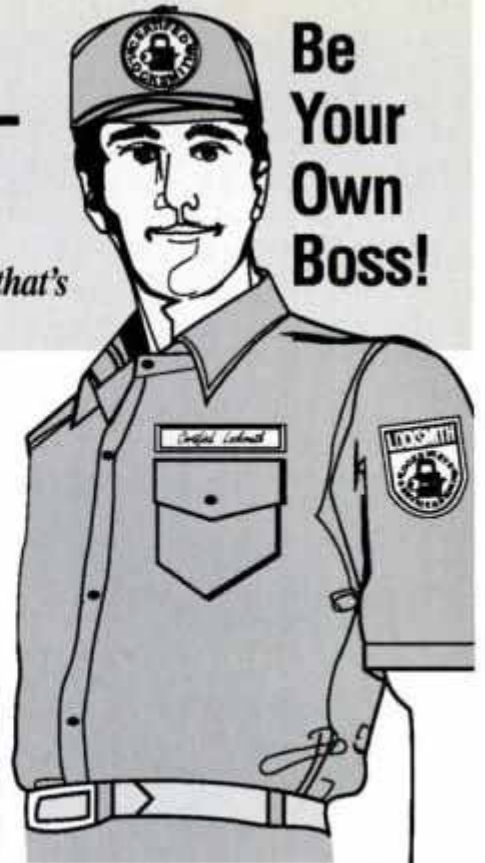
Get the front end of the car up in the air. Stands are preferred, as they leave more room to work than ramps. Loosen all of the lug nuts before you start lifting.

To check your wheel bearings, you'll have to jack up the car to remove the weight from the wheels. So if you must use ramps, do this first. Grab the tire at the top and bottom and pull with one hand while you push with the other. More than an 1/8 in. or so of play calls for adjusting adjustable bearings, and replacing sealed ones. On the rear wheels, repeat the push-pull motion with your hands at 3 and 9 o'clock.

While the wheels are off the ground, remove the wheels and inspect the brake calipers and hoses for leaks or damage. Check the brake

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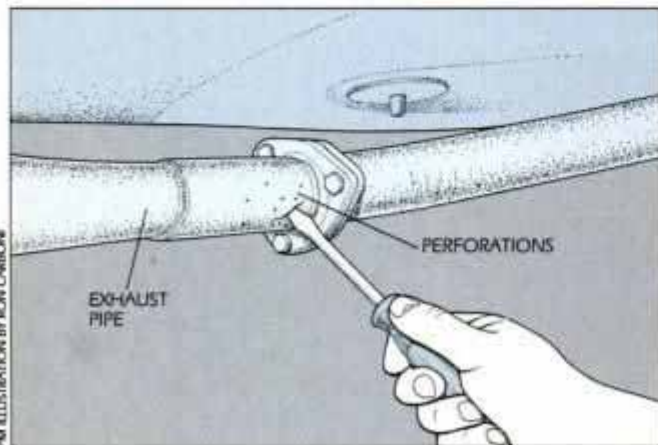
State _____ Zip _____ + _____

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pads for remaining friction material—if there's less than 1/8 in. or so you'll want to change the pads soon.

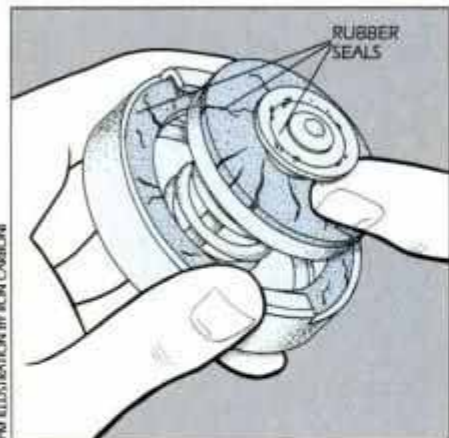
Perform the same checks on the rear-wheel bearings and brakes, and check the hand-brake mechanism and self-adjusting brake hardware while you're back there.

Lubricate the threads and chamfer of the lug nuts with grease or, better



Probe the exhaust system for rust, cracks and pinholes using an old screwdriver. If the screwdriver goes through, replace the pipe or the defective section.

yet, antiseize compound, and torque the nuts down with a torque wrench. (Check your owner's manual, since some vehicle makers do not recommend lubricating the lug nuts.) They don't need to go down until they squeak, but you want them tight



Remove the radiator cap and inspect its rubber gaskets and spring. If the sealing gaskets are defective, replace the cap.

enough to reassure everyone that greasing them won't make them come off in the middle of some freeway off-ramp. Torque specs for steel wheels are usually about 100 ft.-lb. and alloys, about 20 ft.-lb. less, but check your owner's manual.

You may want to defer reinstalling the wheels to provide more room to

work, but we prefer to leave the wheels on whenever we're working directly underneath a car. In the unlikely event that the car does fall from the jacks, you'll still have a few inches of room between the car and the ground.

Ready? Got your eye protection on? Crawl under the car from the front and check the bottom of the engine compartment. Look for leaks, bashes

in the oil pan and loose parts. Then check the suspension. Look for loose ball joints, tie-rod ends, leaky shock absorbers and the like. Tighten any loose fasteners. Antisway bars are particularly prone to self-disassembly. Tighten all of the attaching hardware and inspect the rubber bushings for signs of deterioration. Spray all of the rubber suspension parts with silicone spray lube to

reduce squeaks and to protect the rubber from future deterioration.

Inspect the CV-joint boots on front-drive cars. Any tear or leak is grounds for immediate replacement. If the CV joints have bolted flanges, check those bolts for tightness. Similarly, on rear-drive cars or trucks, inspect the drive-shaft's universal joints. Look for loose flange hardware, missing snap rings and evidence of bearings that have run out of lube.

If your vehicle has any Zerk fittings, now is when you should lubricate them. Force grease into the fitting with your grease gun until the boot swells, but not so much that the boot pops from the pressure. Use lithium-based wheel-bearing grease, not inexpensive chassis grease, as the bearing grease will last longer and provide superior lubrication and better water resistance.

Armed with an old screwdriver, probe the exhaust system for thin spots or minor leaks. The pipe near the catalytic converter usually goes first, as the metal is subjected to tremendous heat. The exhaust system is literally hung from beneath the car by rubber hangers. Inspect all of them. It's not uncommon for winter ice and snow to pull the system free of one or more hangers, so it may simply be necessary to hook the hanger back over its supporting pin. In other in-

stances, the hanger may be damaged or broken and you'll need to replace it.

A clean start

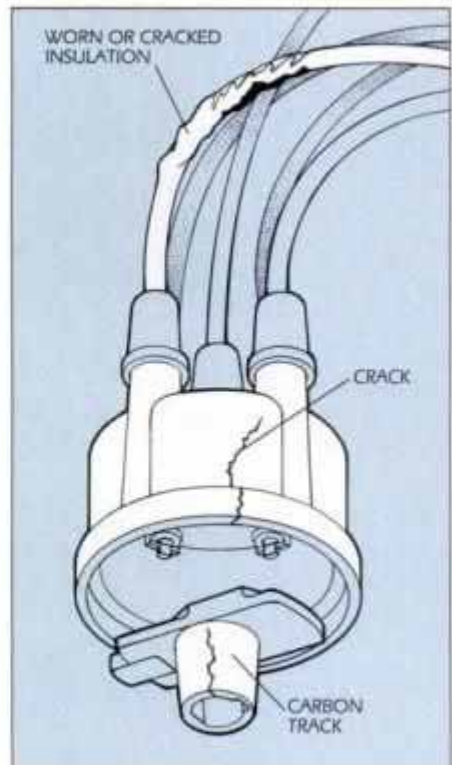
The first step in shaping up the interior is a good cleaning. And that begins with a thorough vacuuming. Vacuum the upholstery—seat cushions and seatbacks—the carpeting, parcel shelf and all dust-holding surfaces. Use a narrow nozzle to get into crevices including map pockets and storage bins. Move the seats full forward and full back to gain access to the floor beneath them. After you've vacuumed the seats and floor, pound everything a few times with a small club (like a little-leaguer's baseball bat). Vacuum them again.

Next wipe down all interior surfaces—dash, console, door trim, armrests, etc.—with a clean, damp cloth.

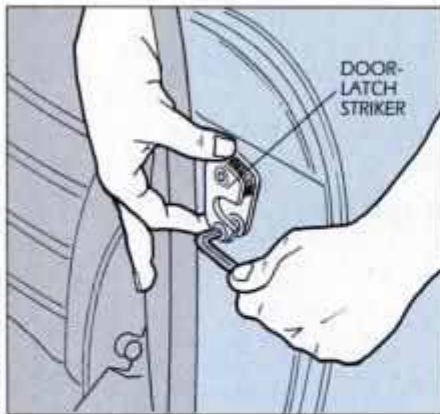
Clean any stubborn stains that may have appeared over the course of the winter. Stains on vinyl usually respond well to some water and general-purpose household cleaner. Carpeting, leather and cloth upholstery may need specific cleaning solutions—a general-purpose cleaner can deteriorate or discolor them.

Patchwork

After you've cleaned all the interior surfaces, inspect them all for damage.



Carbon tracks, inside the distributor cap or on the rotor, as well as fine cracks in spark-plug wires' insulation all lead to misfire.



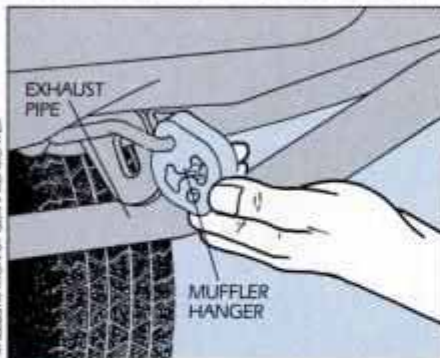
FM ILLUSTRATION BY GERHARD RICHTER

Adjust the door-latch striker in small increments to restore smooth door closing and proper door alignment for good sealing.

Look particularly at the heavy use areas, including the floor mat or carpeting on the driver's side, armrests, window cranks and door levers.

A small tear or crack in vinyl upholstery, the dashboard or a door-trim surface can be patched using a vinyl-repair kit. Following the directions in the repair kit, match the color of your interior vinyl by mixing the pigments included in the kit. Then match the graining pattern of the vinyl to one of the graining stencils in the kit. Apply the patch, cover it with the graining paper and use the kit's heating iron to cure the patch.

You can repair small wear spots, holes and cigarette burns in carpeting by transplanting some of the nap or fabric from a hidden piece of the car-



FM ILLUSTRATION BY GERHARD RICHTER

Inspect the flexible mounts and rubber hangers that support the exhaust system. Replace any that are damaged.

pet. Use a small pair of scissors to trim the damaged area. If the damage goes through the carpet or mat, cut a matching piece from the carpet. If the damage is only to the nap, simply cut off some carpeting loops. Use a water-resistant adhesive to cement the carpeting loops or patch into place. Brush the repaired nap in the same direction to help blend the repair.

Getting a workout

Besides inspecting the interior for obvious and aesthetic damage, take the time to operate everything to check that it's all working properly.

This means raising and lowering each window in turn. As you operate each window, check its perimeter to verify that everything is sealing properly. If any of the windows or doors is less than perfect, correct the problem.

On vehicles with power windows, dirty or gummy contacts inside the window switch can cause erratic operation. Spray some television tuner cleaner inside the switch, to get at its contacts. Operate the switch and repeat the cleaning.

If the window is still balky, or if your obstinate window is a crank-type, you may have to remove the interior trim panel to gain access to the window track inside the door. To remove the door's inner panel, you must first remove the window crank, the door-release latch and possibly the armrest. Check for hidden retaining screws—in the armrest, behind the latch and through a speaker grille.

The window crank may be held by a retaining screw, which can be hidden beneath a center trim cover, or by a spring clip on its underside. Pry up the trim cover to remove the screw. Use a special tool (available at auto parts stores) to pop the spring clip off the crank's underside. Be ready to catch the clip as you slide the tool behind the crank.

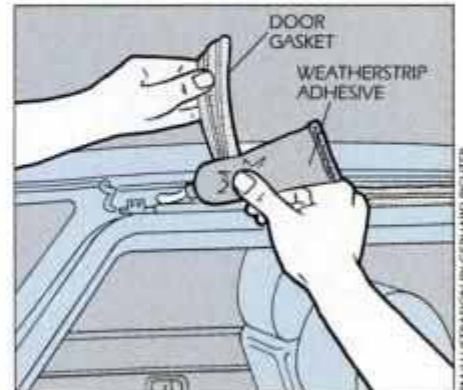
Next slide a putty knife or a special tool along the edge of the panel between panel and door to find plastic retaining pins. When you come to a retainer, gently pop it out of the door.

With the door panel off, you may have to peel back a plastic vapor barrier to gain access to the window mechanism. Be careful of wiring inside the door as you work.

Lubricate a dry window mechanism. Check your factory shop manual for the proper lubricant and lube points for your vehicle's lift mechanism.

If the sealing problem is with one of the doors, it may be caused by either loose or missing weatherstripping. Reattach weatherstripping that's come away from the door or body, using some weatherstrip adhesive. If a small piece of the strip is torn, patch it using RTV black silicone. If a large piece is damaged, cut away the damaged section and splice in a replacement. You can buy replacement weatherstripping either at your dealer or at an auto parts store that sells

body-repair supplies. Cement the repair section of weatherstripping into place and then seal it to the ends of the existing weatherstripping with some RTV black silicone.



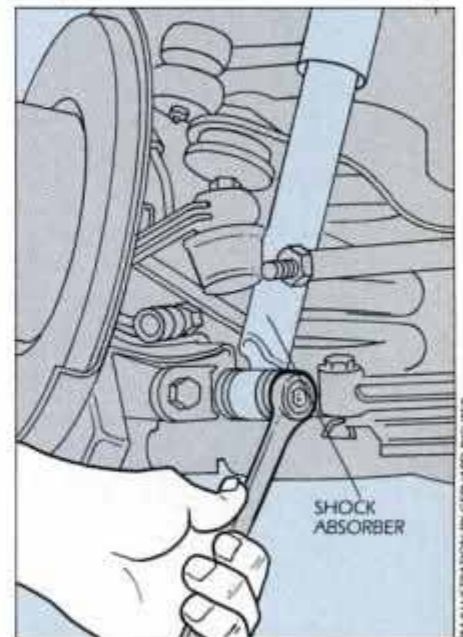
FM ILLUSTRATION BY GERHARD RICHTER

Loose weatherstripping can be permanently reattached with a dab of special weatherstrip adhesive. Wipe up excess adhesive.

Electric power

Check all the interior lights and replace any burned-out bulbs. If the dome light comes on only when some doors are opened but not with others, check the switches at the non-lighting doors. Check the wiring connections at the back of the switch. Clean any corrosion from the switch and be sure that the plunger operates smoothly. Replace any defective switch.

Also check that each line in the rear-window defroster grid is working. If most work, there are breaks in the non-working grid lines. Visual inspection usually reveals the break in the grid line. Patch the break using a



FM ILLUSTRATION BY GERHARD RICHTER

Grasp and try to shake each shock absorber, at both top and bottom mounts. Tighten any loose attaching nuts or bolts.

brush-on liquid sold for the purpose.

If the entire defroster grid does not work, check its fuse. If the fuse is good, check the connections to the power bus—the large bars at both sides or top and bottom where the grid lines connect. If the connections are good, use a voltmeter to check that power is getting to the power bus when the defroster is switched on, with the ignition on. If not, suspect the switch or the wiring from the switch to the defroster. If power is getting to the power bus and the defroster still does not work, each grid line has a break in it.

Now is also a good time to tune up your sound system. Clean the heads of the cassette player or the lens of your CD player. Be sure that all speakers and their grilles are in good shape and snugly mounted. Check all the speaker connections for corrosion.

Now you can finish cleaning the interior surfaces. Clean the insides of the windows, the rearview mirror and the instrument panel cover with glass cleaner. Apply some vinyl or leather polish to the appropriate surfaces. Do not use any product that makes the steering wheel or pedals slippery.

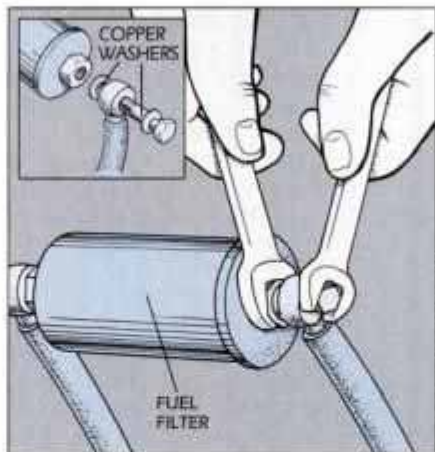
The exterior

With the drivetrain, suspension, brakes and interior tuned and ready, it's time to apply the *coup de grâce* and tune your car or truck's exterior.

As with the passenger compartment, an exterior tuneup is more than a wash and dry. Inspect all of the exterior and repair any of the winter's damage or wear that you may find. Since it's easiest to spot problems on a clean vehicle, the obvious place to start is by washing the car.

A cleansing bath

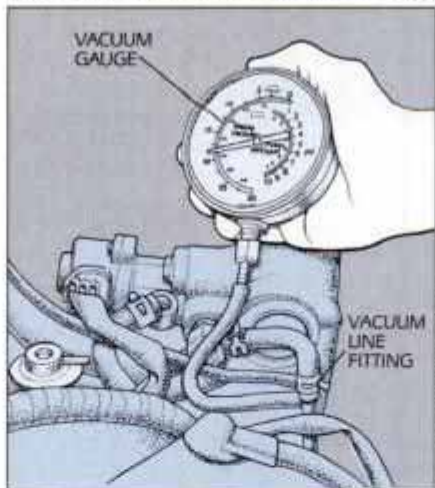
It's particularly important to wash away the corrosive layer of salt residue left by a harsh winter. Road



Be sure to install new sealing copper or nylon washers on both sides of banjo-type fuel fittings when replacing the fuel filter.

salt eats away a vehicle's finish and accelerates the rusting of exposed metal.

Start by deluging the car or truck's body and underbody with a strong stream of water from a garden hose. Spend the time to soak the insides of the wheel wells and all the nooks under the vehicle, including the suspension and exhaust. After you douse the underbody, see that the water runs out of various body channels through



With the engine idling, a vacuum gauge attached to a source of manifold vacuum should steadily read about 18 to 20 in.

the appropriate drain holes. If not, clear those holes using a welding rod or stiff wire coat hanger.

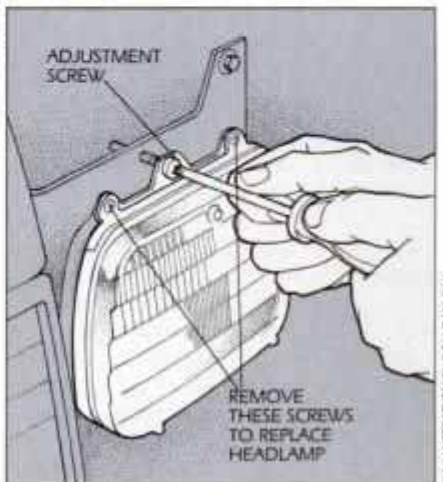
After you've thoroughly soaked the car—top and bottom—wash it. Use a quality car-wash solution with warm water, working in small sections, starting on the roof and working down. Rinse frequently as you go. Change the wash water often so you're not rubbing the dirt and grit back into the finish with your sponge.

Don't waste time and energy on

tough stains. When you're done washing, go back to them and use a special solvent, like bug and tar remover, to get rid of them. Clean the tires and wheels last, using an alloy-wheel cleaner if your car has alloy wheels.

Bodily inspection

Next, slowly walk around your clean car and inspect for stone chips,

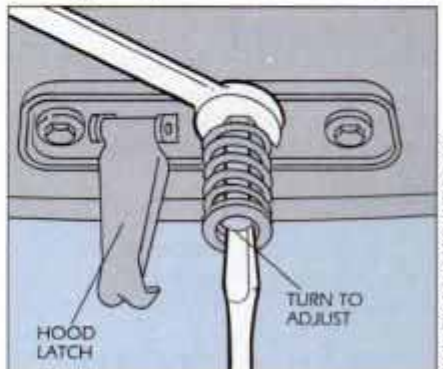


Do not confuse a headlamp's two spring-loaded aiming screws with its three or four solidly attached mounting screws.

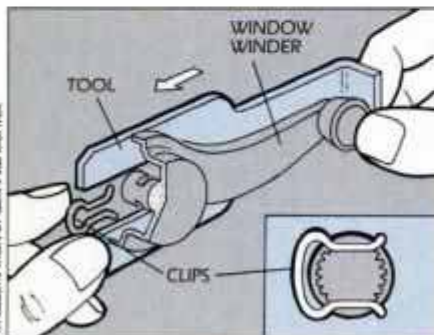
scratches and minor dings as well as other damage or irregularities. If everything is perfect, shine the finish by waxing or polishing it with a quality product appropriate for your vehicle's paint.

However, if you find anything amiss, repair it before applying any wax, as the wax will prevent any paint from adhering properly.

Fine surface scratches in the finish may be buffed out when you polish the paint. However, deeper scratches, chips and even small gouges require more. If the chip or scratch bares the metal beneath the paint, clean the damaged spot and treat the bare



To properly align the closed hood, undo the locknut and thread the spring-loaded adjusting striker in or out as necessary.



To remove window winders held by a hidden clip, use a special tool to push out the retaining clip. Be ready to catch the clip.

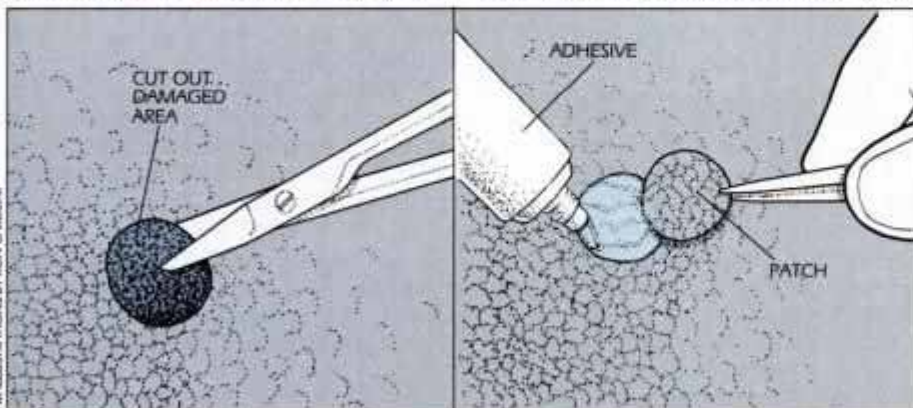
metal with a rust neutralizer. Then apply a primer coat. Wet-sand the primer after it dries and apply the touchup paint. Apply the touchup paint in coats, if necessary, allowing it to dry between coats. Sand each coat and finish by polishing the final coat to seamlessly merge it into the surrounding area.

Damage to plastic body panels—spoiler, bumper or lower body

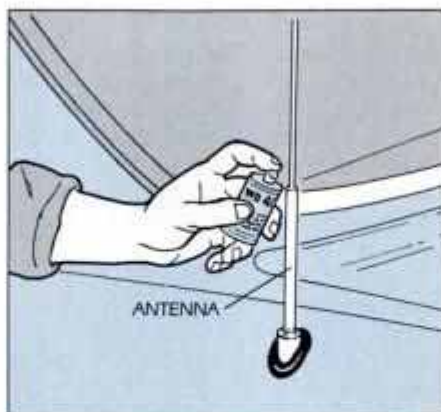


Lubricate all door hinges with clean oil or aerosol penetrating oil. Open and close the door to work the lube into the hinge.

cladding—requires special repair compounds and paints. Follow the directions with the repair product for specifics. Typically, you first apply putty to the damage. After the putty has cured, sand and shape it to blend into the surrounding area. Spray the



Repair small burns or other damage to floor carpeting by transplanting some nap from an undamaged but hidden section of carpet. Use waterproof adhesive to attach the transplant to the carpet backing. Brush the nap to blend it into the surrounding area.



Lubricate the sections of a telescoping radio antenna with a petroleum-based lube, not with insulating silicone.

repair with a flexible-when-dry acrylic primer followed by a flexible touchup paint. You may have to match the color of the repair putty to the color of the plastic composite, the same way you do with an interior vinyl repair (see page 99).



Though a semiannual interior and exterior tuneup will keep things clean and smooth, you should delve a little deeper once a year. So during either of the two 6-month programs, add a few tasks.

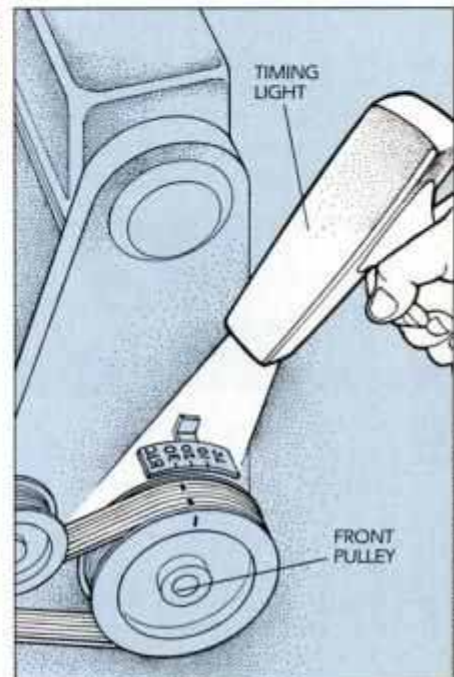
Under the hood, check ignition timing and, on vehicles with adjustable valves, the valve lash. Adjust both as necessary.

On the body, check each door, the trunklid and hood.

Any binding, squeaking or groaning hinges need to be cleaned and lubricated. Remove old grease and grit with some solvent on a clean cloth.

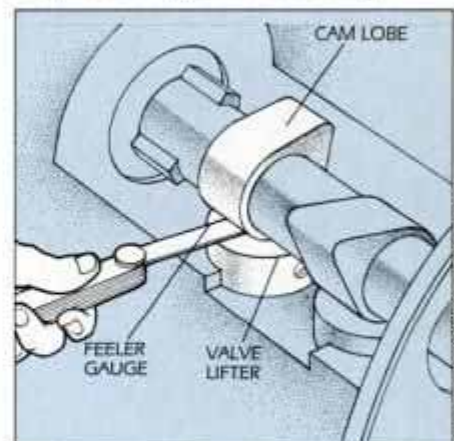
Lubricate the pivots of the hinges with a few drops of clean oil. Work the hinge back and forth to get the oil inside the hinge.

If a door is out of alignment, adjust its striker on the doorjamb. Clean grease and oil off the striker and mark its position as a reference.



Verify computer is doing its job by checking ignition timing, using a timing light. Check underhood decal for procedure.

Loosen the striker's retaining screws, slightly reposition the striker and retighten the screws. Check the door alignment. Repeat as necessary.



Check the clearance between the valve lifter and the round—not raised—section of each cam on overhead cam engines.

Adjust the height of a hood at its bumpers by loosening the bumper's locknut and threading it in or out as needed. Adjust the bumper catch in the same manner.

If the door latch itself is balky or if

its linkage rattles inside the door, it should be tended to. Remove the door's inner panel as you would for checking the window-lift mechanism. If the linkage is binding from lack of lubrication, clean all the pivot points and lubricate them with a dab of white grease. Be sure that all the latch mechanism's mounting bolts are snug. Finally, insulate the linkage rods from fouling against the door metal or each other with small foam blocks if necessary. Lubricate the locks' cylinders with graphite or a special lock lubricant.

EVERY SECOND YEAR



Every other spring you'll be following the manufacturer's recommendation to flush and refill the cooling system. Drain the system into a bucket by unscrewing the radiator petcock. Don't be fooled—the petcock has lefthand threads and needs to be turned counterclockwise to open. No petcock? Look for a drain plug, and in the absence of that, disconnect the lower radiator hose. Coolant is toxic—consult your local authorities for disposal information. If your car has an

aluminum radiator and heater core, the only toxin is the ethylene glycol, which is biodegradable. You can dispose of it in the sanitary sewer—not the storm sewer. Copper construction radiators often leave heavy concentrations of lead in coolant and you'll need to make arrangements to dispose of it properly.

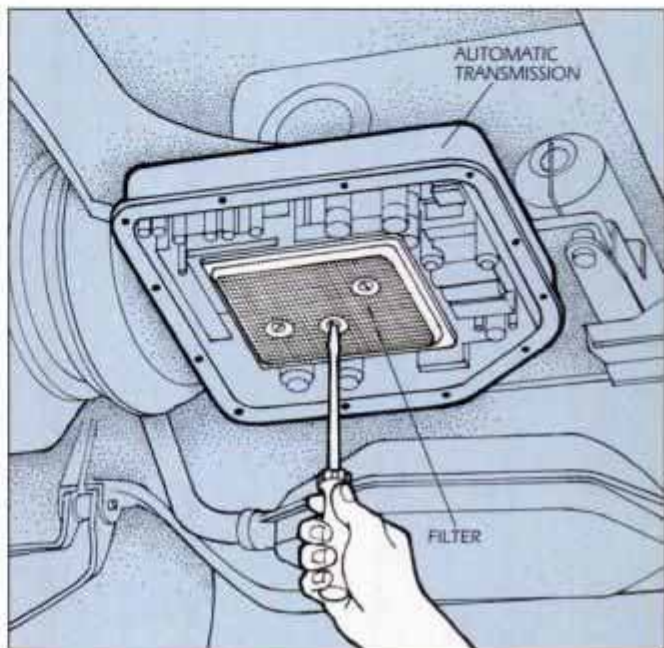
In many areas, commercial shops must dispose of used coolant in approved fashion, so you may be able to get a shop to take yours for you.

To flush the radiator you can either run water into the radiator cap with a hose or use a flush-and-fill kit from the auto parts store that will let you splice a hose cock directly into the heater hose. In either event, fill the system with water and run the engine at fast idle until it warms up enough to open the thermostat. Turn the heater control to full hot, but leave the fan off. When the motor is completely warm, run fresh water in at a trickle until the runoff is completely clear. Don't run the cold water in too fast, or you could crack the block.

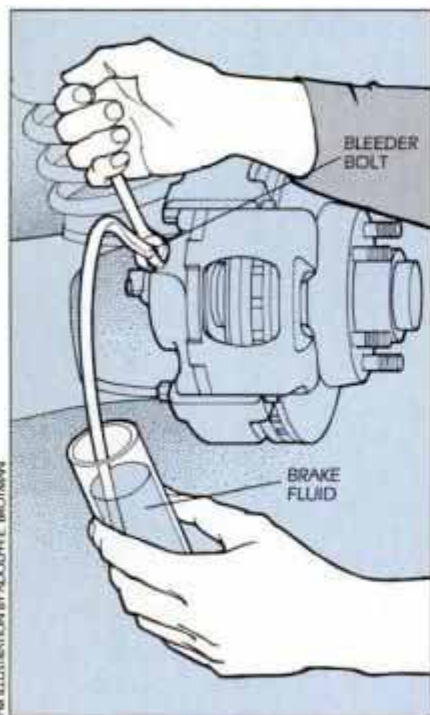
Turn off the motor and the flushing water, and drain the system. There will still be some water left in the block, so you can't simply refill with the recommended 50/50 mix of coolant and water. Find out the cooling system's capacity in quarts from your owner's manual. Close the radiator drain, and add half of the system's capacity of pure coolant. Top off with water and you should have a 50/50 mix in the engine. Take any leftover pure coolant and dilute it with water, and use this mixture to top off the recovery tank. Many newer cars have radiator caps lower than the cylinder head—these cars have special cooling-system bleeding requirements and you should consult the manual.

On the years between flushing the cooling system, you should change the transmission fluid and brake fluid. Most automatic transmissions don't have drain plugs, so you'll have to

drop the transmission pan. Be careful, as it's easy to get a faceful of hot fluid as the last bolt is undone. Then, replace the transmission filter. Reinstall the transmission pan with a new gasket. Top off the transmission with the recommended type of ATF, and don't overfill. For most cars, the transmis-



Drain automatic transmission fluid by dropping one corner of the transmission pan. Then remove the pan to replace the gasket and the filter screen. Refill with fresh fluid.



Bleed fluid through the fitting on each brake as a helper depresses the brake pedal. Close the fitting while pedal is depressed.

sion dipstick should be checked with the vehicle level, warmed up and idling in NEUTRAL.

Start flushing the brakes by loosening up all of the bleeder bolts at the calipers or wheel cylinders. This might be difficult if you've neglected this for a few years. If it's easy to remove the brake fluid reservoir by pulling it out of the grommets supporting it, do so to dump it out and clean out the accumulated mud. Otherwise, simply suck out the old fluid and dirt with a small turkey baster. Fill the clean reservoir with fresh DOT 3 or DOT 4 fluid, and have a helper pump the brakes while you open the bleeder bolts in turn. Have your helper push down on the pedal and hold it down while you open and close the bleeder once. Then he can lift his foot up and push down again. Be sure he doesn't lift his foot up while the bleeder is open, or you'll introduce air into the hydraulic system. Repeat this process until the fluid runs clear from all four bleeders. Keep the fluid reservoir topped up, or you again stand the chance of introducing air into the system.

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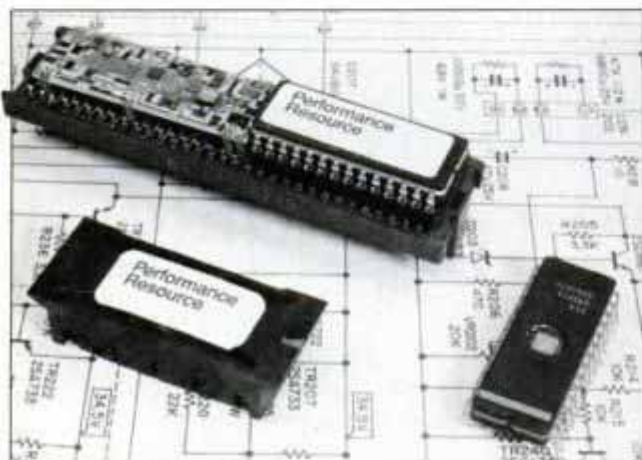
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Electrical Tester

Auto Tester Plus is an inexpensive, easy-to-use tester that checks battery voltage up to 24 volts, continuity and proper functioning of your ignition system. The unit also features a small LED flashlight in its tip. *Contact: Imco Group Inc., 505 8th Ave., New York, NY 10018; (212) 967-0537.*



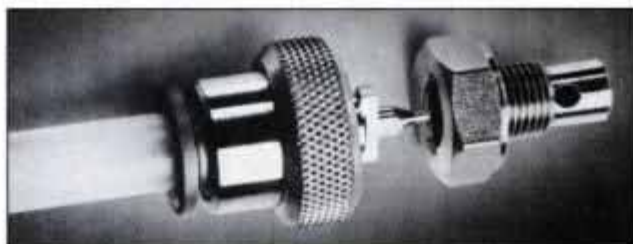
Beverage Heater/Cooler

ThermoBar plugs into your cigarette lighter to heat or cool beverages within minutes. The unit will hold a standard-size beverage can, and uses an adapter for heating baby bottles. ThermoBar can also be used in your home or office with a power transformer. *Contact: Hercules JRP Inc., R.D. No. 1, Box 1416, Stroudsburg, PA 18360; (717) 992-5754.*



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Chevron Pro-Gard Carb, Choke & Valve Cleaner spray-cleans away carburetor gum and varnish deposits, frees up automatic choke action and cleans intake valve deposits. It can also reduce high exhaust emissions, and is available at auto parts outlets and wherever car-care products are sold. *Contact: Chevron Chemical Co., (510) 842-1032.*



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Power Drain System consists of a special oil plug, which never needs to be removed, and an adapter that is used in conjunction with most suction pumps. Oil is drained via a ball-and-spring mechanism. A drain adapter with a bayonet connector is inserted into the plug and the suction pump activated. Oil travels through a clear tube into a waste oil tank. *Contact: Advanced Results Co. Inc., 3042 Scott Blvd., Santa Clara, CA 95054; (800) 272-9898.*



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Dust Muzzle attaches to angle sanders and grinders to remove airborne dust at the source. The flexible and transparent shield attaches to any vacuum system, requires no special backup pads or paper, and is available in disc sizes from 2 to 8 in. *Contact: Lowtech Innovations, 837 Cornish Dr., San Diego, CA 92107; (619) 223-2154.*



Emergency Belt

SeaMaster Emergency Master Belt installs on engines that use separate conventional belts for fan, power steering, etc., in the event of belt failure on the road. Designed as a temporary emergency measure, the belt is easily installed without tools or mechanical skills, and is reusable. *Contact: Nordic Marine International Inc., P.O. Box 611, Crompond, NY 10517; (800) 952-6888.*

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Dash Duster II is compact enough to fit into the glove compartment, and is designed to lift dust off the dash, instrument panel and other interior surfaces of cars and trucks. The duster features a large dusting area of 100% cotton fibers specially treated with a baked-in paraffin wax to prevent scratching. *Contact: Original California Car Duster Co., 21125 Superior St., Chatsworth, CA 91311; (818) 998-2300 or (800) 282-8828.*



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Lift Supports

StrongArm gas-charged replacement lift supports hold up hatches, hoods, trunks and liftgates. The supports offer a lifting capacity of up to about 250 pounds per support. *Contact: AVM Inc., Highway 76 East, Box 729, Marion, SC 29571; (803) 464-7823.*



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Mul-T-Lock is a case-hardened lock that attaches to the gearshift of an automatic or manual transmission to thwart car theft. A tempered steel U-shaped shackle lock that resists cutting or sawing, it uses a special key that cannot be copied to prevent the shifter from being moved. The unit is anchored by a steel rod that is bolted to the car's chassis. *Contact: Mul-T-Lock of California, 1762 Westwood Blvd., Suite 230, Los Angeles, CA 90024; (310) 470-0919.*

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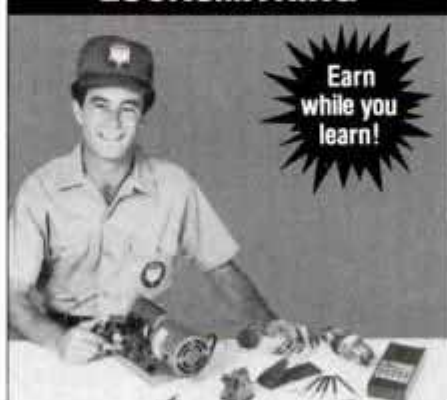
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| <input type="checkbox"/> Gunsmithing | <input type="checkbox"/> Electrician | <input type="checkbox"/> Paralegal |
| <input type="checkbox"/> Home Inspection | <input type="checkbox"/> Electronic Music Technology | <input type="checkbox"/> Bookkeeping & Accounting |
| | <input type="checkbox"/> Basic Electronics | |

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Gonzo Gadgets!

BY STEPHEN A. BOOTH, Contributing Editor

• Even against the high-voltage hoopla of January's Consumer Electronics Show in Las Vegas, the most innovative of the new products always manage to stand out. There's plenty in the way of outstanding gadgets coming this season. In video alone, we'll see new ways of receiving, viewing, recording and even interacting with a program. And in a world that's fast coming unwired, you won't be tethered to an AC outlet for work or play. You won't even have to hold a telephone handset to have a clear conversation. Even riding a bike has a new spin.



Virtual Virtuoso

Okay all you air-guitarists: It's time to put up or keep your day jobs. Come fall, Virtual Music from Ahead Inc. will show if you've got what it takes to make the band, or if you'll play all your gigs in the Polyester Lounge. The Virtual Guitar (\$70) is a video- or computer-game controller that responds like a real ax to CD-ROMs (\$37 to \$100) for computers or Sega videogame consoles. You play along, get advice from R&B-man Lloyd and other virtual band members, agents and studio fat cats. Don't worry: "VM" is tolerant of different skill levels.

Wrist Zapper

If you have trouble finding the remote control, then maybe you should wear it. That's the thinking behind Casio's CMD-40B (\$130) wrist controller. Like bigger universal remotes, this wrist piece can learn the infrared codes for TVs, VCRs and cable-converter boxes, and memorize 16 commands such as power, channel selection, volume, play, stop, fast forward and rewind. It's also a calculator, and it tells time, too. The CMD-40B is an upgraded version of Casio's original wrist remote, the CMD-10B, introduced last year.



Multimedia-To-Go

Media Vision calls it Reno, the first personal, portable CD-ROM player (\$400 to \$550). We call it double-down: You can couple the battery-powered disc drive to your laptop PC for on-the-go multimedia. Or, you can just plug in headphones and dig some CD tunes. Reno sports a double-speed drive for fast action, and it's Photo CD-ready. The price spread covers three versions.



Just The Fax

Here's a PDA (Personal Digital Assistant) that doesn't offer more than it can deliver. The Handifax HF1000 (\$400) from Smith-Corona is the size of a reporter's notepad, weighs 13 ounces, and lets you type 120 business pages for faxing—wirelessly—from any phone. It has an RJ-11 modular jack but, if you're at a pay phone, an acoustic-coupler pops up from the keypad to transmit through the phone's mouthpiece.



Grid-Block

If "depixelization" sounds like Pentagon jargon, you're close. It's yet another bit of military-inspired tech applied to consumer gear, in this case through Projectavision's patented method of removing the grid-like pattern from LCD (liquid crystal display) projection TV. The goal: a slide-carousel-size video projector that throws a big, super-bright image with no special screen and costs less than \$1000. The first prototype comes from the MGM brand of Taiwan's CMC Magnetics. Japan's Matsushita, parent of Panasonic, has a license, too.



Gut Reaction

That's what happens when you play videogames while strapped into Aura Systems' Interactor virtual-reality vest (\$90). Plug it into the audio output jack of any videogame, TV or stereo and Interactor translates bass waves into body vibes you'll feel. The lightweight vest and its electromagnetic actuators are an offshoot of Aura's military work.

Look! In The Sky!

Flying by the seat of your pants takes on new meaning with "Supersonic" (\$80), a multimedia CD-ROM from Interactive Publishing. Without leaving your computer you'll get a cockpit view of some 100 warbirds. This means you get to take 'em up, too. Besides being an encyclopedic reference CD that includes motion video of the aircraft in flight, this disc is a nifty flight simulator with detailed takeoff instructions.



Telephone Manners

Look Ma Bell—no hands! ClearSpeak technology from Bell Labs curbs the rudeness of speakerphones: namely, that annoying feedback you hear when your voice echoes back from the speakerphone end of the line. Bell's digital signal-processing technology also eliminates the tin-cans-on-a-string chopiness peculiar to speakerphone conversations. And the big shot on the speakerphone end won't sound like he's talking from inside a can, either. You'll find ClearSpeak in AT&T's Speakerphone 870 (\$160).



Space TV

So you think only PM's Detroit bureau comes up with spy pictures of things that don't yet exist? Agent Double-L, our man in Indy, pinched these pictures of Avilar—RCA's next-generation TV with a built-in Digital Satellite System (DSS) receiver. DSS promises 150 channels of laserdisc-quality TV with CD-stereo sound, delivered via the high-powered Hughes DBS-1 bird (shown on-screen) to home antenna dishes just 18 in. in diameter. Transmissions are slated to begin this spring.

Biker Music

Here's something old and something new. From Emerson, one of the oldest names in radio, comes the innovative AR2515 Bicycle Radio (\$30). The AM/FM battery-powered portable clips into a mount on your bicycle's handlebars. It snaps out for safe-keeping and portable use. Speaking of safety, it's got a horn, a front-facing reflector—and no headphone jack, thank goodness. **FM**



Horsepower, 2000 B.C.

BY GREGORY T. POPE, Contributing Editor

● Think high-performance vehicle, and a sleek new Mustang or a classic Charger might roar into your imagination. Now shift your mind into reverse, going back 4000 years, to a time when men measured horsepower in the rhythm of galloping hooves. Back then, as Egyptian and Mesopotamian cultures reached full flower, a new technology was about to revolutionize transportation. The ponycar of antiquity, the chariot was coming.

While many archaeologists point to the civilized Near East as the cradle of the chariot, they've lately faced arguments. A competing scholarly faction believes that the wide-open grasslands of the Russian steppes gave birth to the fast, lightweight vehicle. Today, new evidence from Kazakhstan—brought to light only since the dissolution of the Soviet Union—weighs in on the side of the steppes.

Those who favor a Near Eastern origin cite a chariot image on a clay seal, unearthed from a Mesopotamian outpost in Turkey—pictorial evidence, dated between 1950 and 1850 B.C. But along the Kazakhstan-Russia border, east of the Ural Mountains, excavators have found remains of the chariots themselves. And radiocarbon dating of the artifacts suggests that the steppe vehicles may have come first.

Russian archaeologists have been digging in the steppes for more than a decade, reconstructing the story of a mysterious people known as the Sintashta-Petrovka culture. Warlike herdsmen, they were about as different from the city slickers of Mesopotamia as Texans are from New Yorkers. They dwelt in fortified settlements, revered horses, and mined copper and arsenic to make bronze. They also buried their chieftains in rich grave-mounds known as kurgans. Along with the warlords' bodies, these mortuaries contained weapons, pottery, horses' heads and hides—and chariots.

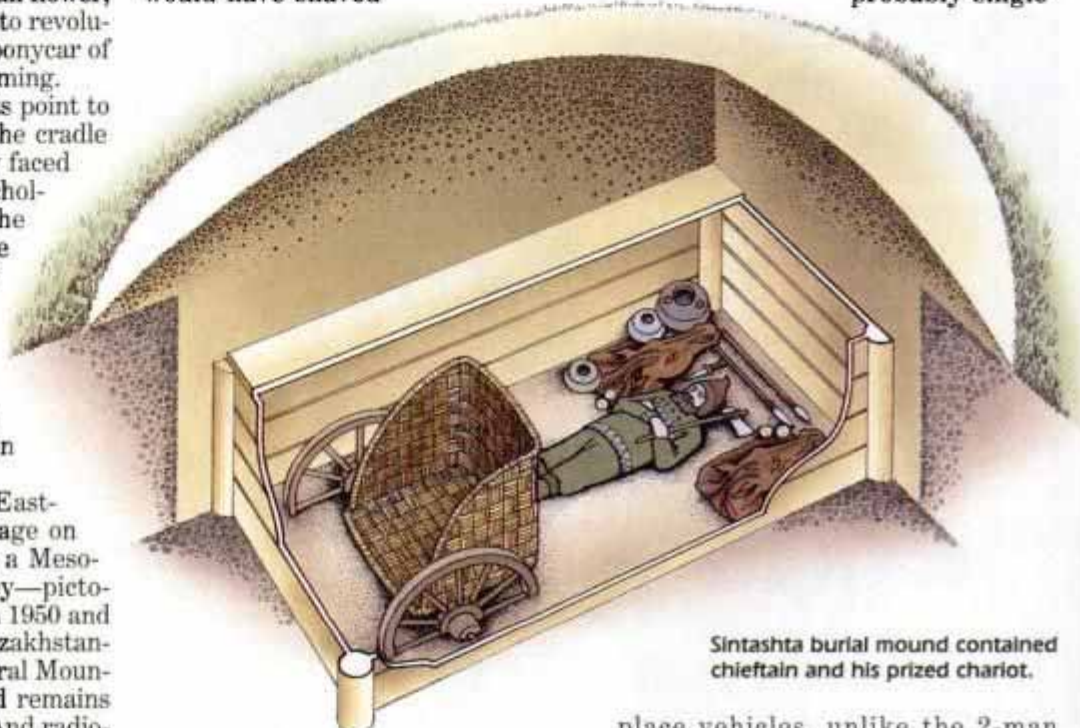
Although little remains of the wooden vehicles, the ravages of time have left blueprints of their construction. In each burial site, the chariot's wheels were half-sunk into slots dug in the kurgan's floor. As the wheels

rotted, they stained the slots' sides with telltale patterns. From these, coupled with floor stains from the chariot's carriage, archaeologists can glimpse the engineering of these ancient machines.

Most significantly, the chariot wheels had 10 or 12 spokes, which would have shaved

"Chariots weren't required to carry heavy loads," says Anthony, "but they probably transferred that narrow wheelbase to chariots without thinking. So this is evidence that these chariots are early models."

Because of their compact construction, the Sintashta chariots were probably single-



Sintashta burial mound contained chieftain and his prized chariot.

pounds off a horse-drawn vehicle's weight. "There's a tremendous jump in technological difficulty between old solid-disc wheels and spoked wheels," notes David Anthony, professor of anthropology at Hartwick College in Oneonta, New York. "The appearance of spoked wheels is a major advance. And with 10-12 spokes you'd have a very strong wheel even if you lost a spoke or two."

Other details, however, hint that the Sintashta people hadn't quite mastered their new invention. For one thing, the chariots weren't more than 4 ft. wide. They rested on the same narrow wheel gauge as the heavy ox-wagons that people of the steppes had been using for a thousand years. Their wagons were slim for a reason. In order to reduce friction between carriage and axle, woodworkers whittled the axle down to as small a diameter as possible. But a thin axle can support a heavy load only across a short span—hence the narrow gauge.

place vehicles, unlike the 2-man machines made famous by later Egyptian armies. To steer while shooting arrows, Anthony believes a charioteer would have wrapped the reins around his body and twisted left and right.

Anthony visited the Sintashta sites last year and brought back slivers of bone from horse skulls found with the chariots. Using radiocarbon dating, Anthony puts these relics at between 2200 and 1800 B.C., suggesting that the steppe chariots might be centuries older than their Near Eastern counterparts.

If the dates hold up, it would be no surprise that high-speed transportation originated in the rough-and-ready steppes, rather than the urbanized river valleys of Mesopotamia. After all, wild horses had roamed the steppes for millennia, and the steppe people were the first to tame and ride them. It's only natural that they converted these resources into mankind's original performance engines. **PM**

charging the technique by adding a second gene to crank out a cancer-killing protein called interleukin-2. "Most cancer treatments require more than one drug," says Culver, "so as I approach gene therapy, I'm trying to build on the same principle."

Meanwhile, several research centers are exploring a more direct genetic attack against cancer. Biologists have now pinpointed the genetic mutation that turns a lung cell cancerous. Engineered retroviruses could introduce a mirror image of the defective gene into lung cancer cells, canceling out the effects of the cancer gene. Jack Roth of the University of Texas in Houston is a leading proponent of this approach, which has not yet reached human trials.

Cold warriors

Its affinity for dividing cells makes the retrovirus an effective saboteur in cancer therapy. That poses a drawback, however, in many other *in vivo* applications. For that reason, researchers are looking for other viruses to press into service.

One is a familiar pest: the adenovirus, purveyor of the common cold. Its predilection for cells of the nose, throat and lungs may make it an ideal medium to deploy genes against respiratory illnesses.

In one of the most promising therapies in trials now, researchers are using an adenovirus to fight cystic fibrosis. The disease, caused by a defective gene identified four years ago, thickens mucus linings and debilitates its victims, who seldom live to reach 30. But an adenovirus could bring the correct gene straight to lung cells without affecting the rest of the body. Ronald Crystal of Cornell University Medical Center in New York City is collaborating with others on the technique.

Another potential recruit is the adeno-associated virus, or AAV, which has a natural advantage: Even unaltered, it causes no known diseases in humans. What's more, the AAV has a knack for inserting genes into specific sites along a cell's DNA. Its consistent action means that an AAV won't inadvertently plug genes in at the wrong spot and cause more problems than it solves. For this reason, the virus could safely—and permanently—repair DNA in the long-lived cells in bone marrow. These so-called stem cells give rise to a steady flow of the short-lived blood cells that circulate in our veins and arteries. Research is under way to see whether AAVs can introduce genes into stem cells to cure hereditary blood disorders such as sickle-cell anemia.

But although adenoviruses and AAVs are raising excitement, they come with their own limitations. For one thing, the AAV is so tiny that it can only hold small, simple genes. As for adenoviruses, our bodies are primed to resist them. After all, most of us fight off a cold in a week or so.

"It's a problem that's plaguing everyone," admits Nelson Wivel, director of the NIH's Office of Recombinant DNA Activity. "But a lot of labs are already working on second-generation adenoviruses, removing the genes likely to cause an immune response."

Wivel, like others in the field, are quick to point out that gene therapy is a brand-new technology. While it enjoys great attention now, it's nowhere near perfect and sure to bring disappointment as well as success. "When a pediatrician can take a vial off his shelf and inject a gene as an outpatient procedure," says Wivel, "then you can talk about widespread application. Clearly we're eons away from that."

Still, nothing can dampen the enthusiasm of researchers in the field. "No one's cured cancer with gene therapy, but it's going to happen," says Culver. "This is the great revolution in medicine that we've been anxiously awaiting." **PM**

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The Violence Chip

BY MURRAY SLOVICK



● From the earliest days of television in this country, the medium has been associated, rightly or wrongly, with promoting violence. Now, in an attempt to head off congressional legislation aimed at regulating program content, a cable TV group has proposed the adoption of circuitry that would make it possible for parents to block reception of shows loaded with violence and gore. The proposal has ignited fears of censorship.

Dubbed the V (for violence) chip, this silicon sentry would be activated by a special code, inserted by broadcasters into the TV signal, that would scramble reception of the incoming picture. To unlock a program, viewers would use their remote controls to key in a special access code.

Between the frames

The coded V-chip signal would be transmitted to your set via the vertical blanking interval. This space is available because a complete TV picture, or frame, is comprised of two fields totaling $\frac{1}{60}$ th of a second in duration—too fast for your eye to see either of the two interconnected halves. The break between the two halves is called the vertical blanking interval. Synchronized pulse information on the timing of each field is broadcast to ensure picture stability

and prevent vertical rolling. Indeed, you normally do not see the vertical blanking interval unless your television set loses vertical hold—it is the black bar that rolls on screen.

Currently, the vertical blanking interval carries closed-caption information for deaf viewers, but there is plenty of room for V-chip information and other data. In all, the vertical blanking interval occupies a 42-line segment of the standard 525-line NTSC picture. Twenty-four of the 42 vertical blanking interval lines are available to carry V-chip data. Line 21 of field 2 has been specifically mentioned as the likely location for V-chip information. (The other 18 lines are used as a buffer.)

What's in a line

Some hints may be gleaned on how best to implement V-chip technology by reviewing important aspects of the Extended Data Service (EDS) television format approved last year by the Federal Communications Commission (FCC). EDS signals sent by means of the vertical blanking interval can contain program information, emergency alerts, weather advisories and promotional messages to be decoded and displayed on screen. Broadcasters expect to use EDS to provide information on Motion Pic-

ture Association of America (MPAA) ratings such as PG and R as well as a program's title and length. If a V rating is added by cable or network broadcasters, it, too, would be sent to your TV set as an EDS signal.

Tape extender

A second dividend of EDS is automatic programming of decoder-equipped VCRs to delay or extend recording, as in the case of sporting events that last longer than anticipated. Future EDS information display applications will be activated when viewers change channels or press a button on their TV's remote control.

Acting quickly to provide technical support to broadcasters planning EDS transmissions, the Electronics

LINE 21 of field 2 in the vertical blanking interval—the black bar that rolls on the television screen—could conceal a censor that would scramble TV shows that are considered too violent.

Industries Association's Television Data Systems subcommittee last year proposed a voluntary technical standard designated EIA Draft 608. Since these EIA guidelines could well form the engineering basis for V-chip technology, the major issues in hardware and software development for V chips have been tackled and appear well on their way to becoming reality.

According to Draft 608, a V-chip-coded data packet sent in the vertical blanking interval would consist of non-ASCII information characters containing the violence rating and/or standard MPAA ratings. Three data bits, designated r0 to r2, are used to encode the motion picture rating. For example, a PG-13 picture is coded 1,1,0 for r0, r1 and r2, respectively. Similarly, a picture rated R is coded 0,0,1 for r0, r1 and r2. The bit coding technique allows a distinction to be made between a rating that is not available (all zeros for r0 to r2) and one where a film is not rated, such as a made-for-TV movie (all ones for r0 to r2). Three other bits, c0 to c2, are reserved for program content advisories.

Adding information

To add more specific information, the EIA proposal provides for a Detail

Group containing key words describing a TV program. Yet another packet of information, defining the contents of the main and secondary audio programs, may also be included.

While the program censor is called a V chip, the hardware to make it run does not use a special chip at all. Instead, the V coding sent as a data packet in the vertical blanking interval will automatically trigger circuitry similar to that found in current TVs with a channel lockout feature. However, design engineers note that tailoring the block-out mechanism to individual taste—like allowing V-rated shows to be viewed only after 9 pm, for example—would require a control chip that TV owners would have to encode themselves.

TV politics

Evidence of concern about violence on television is everywhere in Washington, D.C. The proposed V chip is being endorsed by Rep. Ed Markey, D-Mass., chairman of the House Energy and Commerce Committee's subcommittee on telecommunications. Markey wants to make V-chip technology mandatory. Ted Turner, president and chairman of TBS, also supports the technology. Semiconductor technology may help prevent children from being exposed to violent programs and at a price most consumers can afford—the chip set could cost as little as \$5 per set.

But before you jump in the car and drive into town looking for a V-chip-equipped TV, there's more to the story: There is considerable resistance to the plan from network broadcasters and some cable program suppliers. The broadcast networks say that while monitoring programs for violent content may be an understandable goal, on-set electronic censorship suggests government control that has gotten out of hand.

Internal debates

Even within the cable TV industry there is significant resistance to V-chip schemes. In a study conducted by the Greene Marketing Group for Crain's publication *Electronic Media*, 74% of TV station general managers polled said there was too much violence on TV and 65% of those surveyed said basic cable was the worst offender. Nevertheless, 74% of those polled were against use of the V chip.

Broadcast and cable TV executives also are concerned about how adoption of the V chip could affect their pocketbooks, as scrambled programming means a smaller audience for advertisers. So it may be quite a while before supporters of the V chip are able to flash the "V for Victory" sign. **PM**

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Detroit Spy Report

BY JIM DUNNE, Detroit Editor



Bulging Ford Taurus

● Prototype models of Ford's next-generation Taurus, like the one shown above, have been sporting curious-looking bulges in the doors. These mysterious lumps surround the exterior door handles, protruding about an inch from the surface of the doors' sheetmetal. Ford insiders say these protrusions are not fully representative of the 1996 Taurus. The Taurus is going to

the wings. The Dodge Avenger is the replacement for the Daytona and is Dodge's share of a new Diamond-Star model. The new car will be different from the new '95 Eagle Talon and its near-twin, the Mitsubishi Eclipse. Chrysler dealers will get a model similar to the Avenger, which will be called the Sebring. The front-drive Avenger will offer a choice of engines and will be priced at the friendly end of the spectrum. The base Avenger gets

ta's smaller size, you can look for the same "big truck" appearance in the front styling and extra room for both the driver and passenger. However, the dimensions inside the Dakota's cab will be about the same as the current model. Fact is, if Dodge were to add any more space inside the Dakota it would no longer qualify as a midsize pickup. It would cross over that all-important line into the hotly contested full-size category.



Dodge finally gets a Diamond-Star coupe, the '95 Avenger.

get new doors that have a totally new door-lock mechanism, which is thicker than the current variety. The new, thicker lock mechanism is ready, but the rest of the new doors is not. Therefore, to save time, the thicker mechanism is being tested on existing, thinner doors. Hence the bulge.

The Dodge Avenger

There was no way that Dodge was going to stay away from the personal sporty coupe market for very long. And with Chevrolet launching its new Monte Carlo to compete with the Ford Thunderbird, the Dodge boys have been champin' at the bit, knowing that they have their Avenger waiting in

power from a 2.0-liter Four. Options will include a 2.4-liter Chrysler-built Four and a 2.6-liter V6 from Mitsubishi. The Avenger and Sebring will be built at the Diamond-Star factory in Illinois. Dodge is aiming for a 1995 model-year introduction of the Avenger. The Sebring should follow about six months later. The Eagle Talon and Mitsubishi Eclipse will be here sooner.

Baby Ram

Dodge plans to put a lot of its widely acclaimed Ram pickup into the Dakota pickup when that vehicle is completely restyled for 1997. Not surprisingly, Dodge designers are using the Ram as a styling theme for the midsize Dakota. So despite the Dako-

Flashing The Badge

Reaching back—way back—into its history, Chrysler will start putting its old badge on its new models. The red, silver and blue seal-with-



After a 30-year hiatus, Chrysler's original logo returns on the grille of the Cirrus.

ribbon will be seen on new Chrysler models starting next fall with the Cirrus sedan. The Chrysler badge dates back 70 years to 1924, when the crest became Chrysler Corp.'s official logo. However, in 1962 the ribbon-and-seal was retired and replaced with the



Now in its final—and most revealed—stages, the Lincoln Continental shows some graceful new lines blending nicely with some traditional Continental cues.



now-familiar pentastar. Chrysler's intent for this rebirth is to reaffirm the company's 7-decade-long styling and engineering heritage, while adding some nostalgia to the new Chrysler.

Close To Final

Prototype cars go through numerous and varying stages of disguise before they are finally unveiled to the public. This Lincoln Continental prototype is in its final stage of disguise, with just a flimsy bra in front and black paint stripes across the body. Still, through it all you can readily see that Lincoln plans major changes for the 1995 model. The new Continental's body lines are more rounded, giving the car a somewhat more massive appearance. You can also see that the Continental's trademark shovel nose is more pronounced than before. The designers have given the car some added style by gracefully curving the C-pillar. Incidentally, as the car continues its development, the automakers begin to strip away its camouflage so the body panels are exposed to road wear, making it easier to find flaws before it goes into production.

Who Wants Them?

The nagging problem facing the world's carmakers is that currently, at least, not too many people are lining up with cash in hand to buy an electric vehicle. In fact, given the huge investments required to build the large numbers of electric vehicles needed to improve the nation's air quality, hardly anybody at all is seriously interested in trading in their internal-combustion-driven vehicle for an electric. Understanding this potentially huge sales problem, none of the automotive sales divisions want to carry the electrics in their dealerships. The latest to beg off is Lincoln-Mercury Division. "Less than 1% of

our customers express an interest in electrics," reports one L-M official. "And besides, our model lineup is complete. We don't need another vehicle." Similar opinions are being heard around the offices of the GM divisions. From the various divisions' standpoints at least, the bottom line is that electric cars figure to be more trouble than they are worth. Automakers' sales divisions are interested in high-volume models, and there just are not a great many prospects for electrics.

The 3-Door Pickup

Both Ford and GM are probably going to offer a new type of extended-cab pickup truck in two years. These trucks will have an extra door on the driver's side. This door is meant as a convenience move to help drivers load light gear into the rear of the truck's cab without the hassle of pushing the seat forward and squeezing past the door-lock post. The rear-hinged doors will be about half the normal size. These doors are not designed for humans—strictly for cargo in the rear compartment.

More Airbags

The latest safety ideas continue to focus on airbags, specifically on more of them. Even while the auto industry is still trying to catch up to public demand and equip its cars and trucks with two front airbags, new locations are being studied. The latest suggestion from Ford is for a 3-airbag door. These doors would have one bag at the passenger's hip level, another for the shoulder and yet another above the door to protect the head. It sounds like great protection, but the costs are enormous. Besides the cost of the bags themselves and their inflaters, the doors would have to be reinforced to support the bags on the back side. That means more steel, more weight and a more complex door. **PM**

TELECOMMUNICATIONS

(Continued from page 55)

bugs should occur less frequently as technology improves.

If you already own a cellular phone that isn't NAMPS or digital, don't worry about being left with an unusable phone. While the different cellular companies that operate across the country are free to convert their systems to the new technology, they are still required by law to support traditional AMPS cellular service. Also, the new NAMPS and digital phones are dual-mode, meaning they can automatically fall back on or default to the universal AMPS standard.

While the cellular spectrum is used primarily for phone calls, it can also be used for wireless transfer of computer files. In fact, cellular operators think that data transmission will eventually be a huge part of their business. IBM and a group of cellular operators announced a standard in 1992 for a transmission scheme called Cellular Digital Packet Data (CDPD). In the CDPD system, files are sent or received over the air with a special modem, which breaks up the data into smaller packets. These chunks are transmitted at a number of different frequencies, as space in the spectrum becomes available, and reassembled at the receiving end.

Non-CDPD modems already allow people to transmit data over cellular networks. But the new standard has several advantages, say its backers. One is speed: The data rate promised for CDPD is a healthy 19.2 kilobytes per second. A second is security. A third is space: CDPD transmission doesn't require a full voice channel to transmit information.

For people who need to transmit a lot of brief data, the savings could be tremendous. Because of cellular companies' usual pricing structures, you have to pay for a full minute of connect time to transmit data on a conventional cellular modem even if the transfer takes only a second or two, points out Andy Willett, director of data for Sprint Cellular. Meanwhile, he says, the company is looking at prices of 3 to 5 cents per 100 bytes for CDPD wireless data transmission.

Because CDPD could be employed in many situations requiring wireless data transmission, CDPD's usefulness is limited only by one's imagination. Plugged into handheld PDAs, CDPD modems could be used to receive Dow Jones reports, send and receive electronic mail and connect to other on-line services. A person could make last-minute airline reservations while they're in the back seat of a taxi. A vending machine even could communicate to a central computer that it's out of Pepsi. That's a cool soda. **PM**

BOATING

Rough Riders

BY JOE SKORUPA, Boating/Outdoors Editor



● "It's really honking out there," says John Wooldridge, a friend I encounter in the hallway of my hotel on the island of St. Martin. John is a fellow boat tester—one of the few, brave, elite corps of journalists who travel the globe to push the limits of marine technology and, whenever possible, corporate expense accounts. But what does he mean by honking? A lost flock of geese? Caribbean gridlock? Before I ask, I round the corner and the wind nearly flattens me. John just smiles.

Ah, the Windward Islands. Sounds lovely doesn't it? But why not call them something more benign? Something whimsical? Why not the Breezy Islands? I'll tell you why.

First of all, who can complain about an assignment like this? A long weekend at the luxurious Conrad Resort Hotel testing Kawasaki Jet Skis in the middle of the worst winter in living memory. It sure beats the New York National Boat Show and the Detroit Auto Show, two recent assignments.

But remember, St. Martin is just north of the Windward Islands, which are located on the receiving end of the same trade winds that blew Christopher Columbus to the New World in a boat without an engine.

The good news is that our resort

is facing north, and not the windward Atlantic side. The bad news is that the wind is coming out of the north, which means that it's blowing right down Marigot Bay, the location of our testing headquarters. But we are the few, brave and elite, aren't we? So with high fives all around, we buckle up our vests and head out to shred some churning surf.

To be perfectly honest, wave jumping is my all-time favorite Jet Ski sport. However, lawyers and water-bike industry honchos hate seeing this sentiment in print. They hate even more to see it in photos. I can't understand why, other than the fact that it might have something to do with a minor concern like product liability.

But the point is, on a day

when the wind is honking, how else can you ride on Marigot Bay without jumping waves? You can't go around or through them. You can only go over them. And while you're at it, you might as well let the good times roll, as advised by the Kawasaki corporate slogan.

So, after two full days of getting serious air, and enduring several spectacular wipeouts, here are my tips for Jet Ski rough-water riding:

1. *Get a grip.* If you remember nothing else from this column, remember this: Hold on to the handlebars



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no matter what happens. My hands are calloused from various physical activities, but after a couple of hours of wave jumping, blisters started to form. The solution? I bought riding gloves—another good tip.

I learned about the importance of getting a good grip from a Jet Ski expert who told me no matter how out of shape you get, just hold on and your jump will turn out right.

2. *Don't be afraid to bail out.* This is a corollary to rule No. 1. I tried both approaches and they work. I've held on and pulled out crazy jumps when every nerve in my body was saying, "You're going to crash and burn." And I've also bailed out when it felt as though I was midway through a double gainer with a full twist. Of course, this is the embarrassing route, but live to fight another day, I always say.

3. *Stand and fight.* Anyone who tries wave jumping on a sit-down Jet Ski and actually sits down is doing his body a disservice. You can probably sit down at slow cruising speeds, but your spine and butt will love you more in the morning if you take weight off these stress points.

4. *Leg it out.* Use your legs as shock absorbers, and make sure you bend at the knees. Don't forget to bend your arms, too.

5. *Timing is everything.* Not every wave is an ideal jumper. Look for waves with the most concavity. Also, make sure there's a large enough trough between waves to allow you to build up speed. Cruise at a moderate throttle setting—not slow but not fast enough to force you to jump unintentionally. Then, when you see the perfect wave, nail it. For light, torque waterbikes like the Kawasaki Super Sport Xi, lean back on your heels and at the last moment pull back on the handlebars.

6. *Safety, safety, safety.* First, all Jet Ski riders and especially wave jumpers must wear a flotation vest. Second, attach the engine-stop lanyard to your wrist. Third, don't go out in dangerous weather conditions. Fourth, don't jump in shallow (6 ft. or less) water. Fifth, jump far away from other Jet Skiers, boaters and swimmers. Sixth, stay several hundred yards from shore, docks, floats, anchored boats and so forth. Seventh, know your limitations.

The purpose of my wave jumping expedition in St. Martin, in addition to visiting a clothing-optional beach and a surprisingly generous casino, was to witness the roll-out of the new Kawasaki XiR (\$7999). This is a limited-edition high-performance machine based on the championship waterbike that burned up the racing circuit last

year under the control of ace driver John Stewart.

What differentiates the XiR from last year's Super Sport Xi is a tweaked engine that generates 84 hp (9 hp more than the Xi) and pumps out 675 pounds of thrust (50 pounds more).

Aside from the engine, which is moved back 8 in. to keep the pump hooked up in turns, a big change is evident on the hull. Two chines or strakes have been added to improve cornering and handling. The change it produces is dramatic.

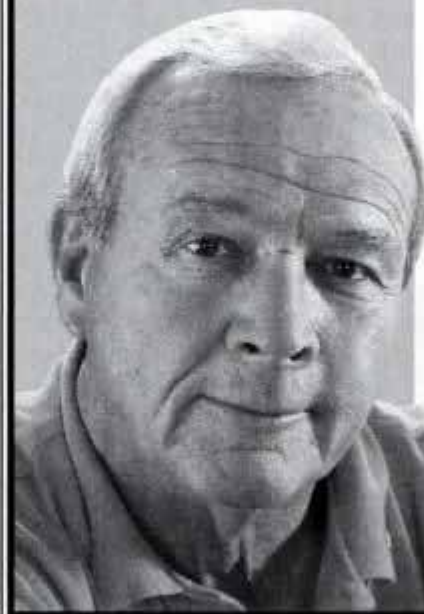
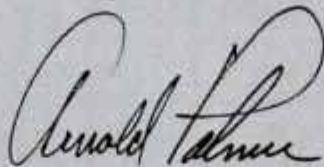
Despite the lack of flat water, I took the XiR for several spins around

the slalom course and compared it with the Super Sport Xi. All it took were slight flicks of the handlebars to enable the XiR to whip around the course. Even more amazing: Response time was instantaneous, even in lumpy water. The familiar lag time between input and execution is entirely eliminated.

As Jet Ski fans already know, the booming waterbike industry is in the midst of a performance war, and the Kawasaki Jet Ski XiR clearly escalates the rider-pleasing conflict. Now if only Kawasaki could do something about all that honking. **PM**

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Video Servers

BY GEORGE MANNES

● The technology behind pay-per-view movies will change radically in certain communities around the United States this year. In areas such as Orlando, Florida; Castro Valley, California; and Omaha, Nebraska, cable subscribers or telephone customers will enjoy the debut of full-fledged video-on-demand. If they want to watch a recent movie, they won't have to wait for its starting time to roll around on a pay-per-view channel—they'll be able to begin watching whatever movie they want, the moment they sit down.

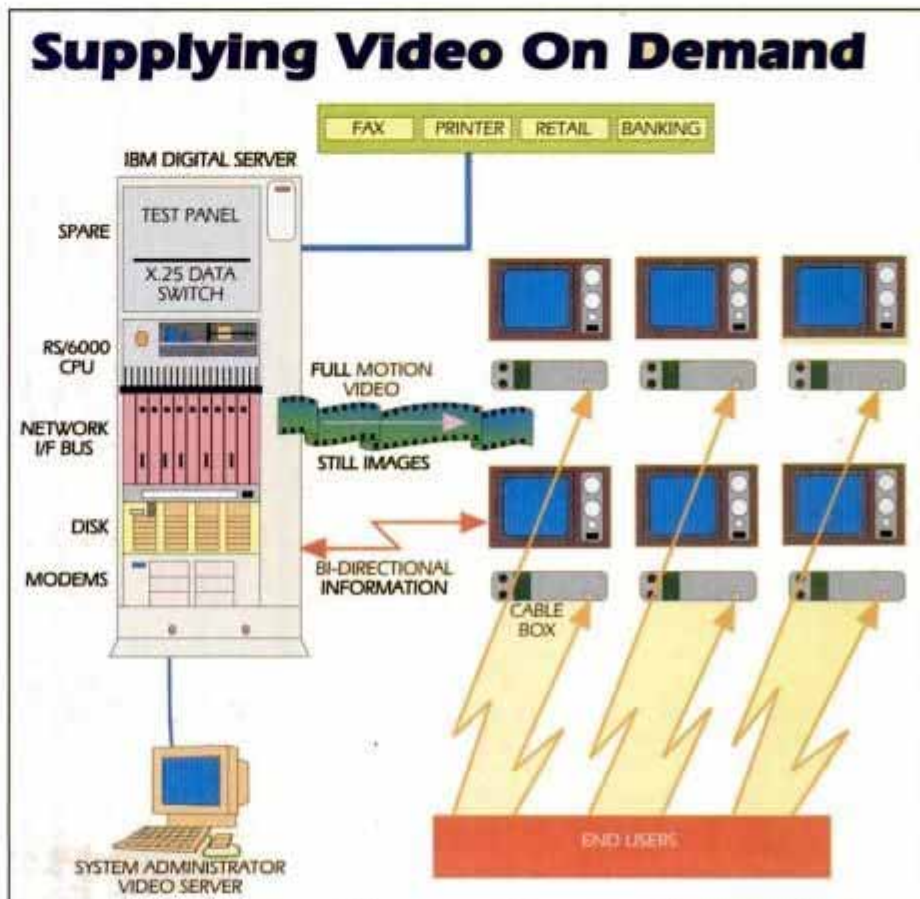
At the heart of video-on-demand (VOD) is an essential piece of equipment: a computer known as a video server (or alternately, an interactive video server or media server). Tied into the local cable or telephone system, these servers will operate as communal movie-playback devices, allowing thousands of families in a community to watch any movie they choose. Each household will be able to start, stop and rewind the movie—completely independent of the hundreds or thousands of other households that may be tuned in to that movie at the same time.

Movies won't be all. With the help of a server, according to companies that are making or installing them, you'll be able to watch TV shows whenever you have time for them—without having to tape their scheduled broadcast. You'll be able to retrieve educational programming. And you'll be able to shop at home by taking a self-guided video tour of a department store.

What's a server?

What exactly is a server? It's simple, says Kevin Gorey, product manager for video servers at Silicon Graphics, which is supplying servers to Time Warner for a high-profile test of interactive television in Orlando. Any computer that performs a task at the command of another computer is a server. The computer that makes the command is called a client.

"By the strictest definition," says Gorey, "any server that transmits video data from itself out to a client is a video server. But in the popular terminology, a video server is really something that's doing interactive television. And your client is a set-top box."



A central computer or server sends the same movie to numerous homes at varying times.

As you might expect, a computer that can handle thousands of simultaneous users is a lot bigger and more powerful than the one that sits on your desk. For starters, an Ncube computer that can supply a 1000-movie library to 10,000 households would contain 512 processors similar to the single 486 chip that's the heart of a desktop machine, according to Chris Marino, director of product marketing for the computer company Ncube. (Ncube is supplying a media server for Stargazer, a VOD service that the phone company Bell Atlantic plans to launch in northern Virginia.) Total random-access memory would be 16,000 megabytes (that's 16 gigabytes, or 16 billion bytes)—dwarfing the 4 megabytes you might find in a desktop computer.

Movies and other programming will be stored in the computer in the form of computer bits. How many bits each movie takes depends on the degree of data compression a phone or cable system chooses to employ. Using the

MPEG 1 compression standard, which Bell Atlantic plans to employ in its Stargazer system, a 90-minute movie requires 1 gigabyte of data. That's 1000 megabytes. By comparison, your home computer's hard drive probably contains from 20 to 200 megabytes.

Meanwhile, Time Warner is planning to use the higher-quality MPEG 2 protocol for its experimental cable system, slated to launch later this year in Orlando. The same movie would require more than 2 gigabytes of data. Multiply 1 or 2 gigabytes by, say, a thousand movies in a server's library, and you end up needing terabytes of storage capacity—trillions of bytes.

One second, please

While servers operating in cable and telephone systems will be powerful computers, their strengths are not designed to be in number-crunching. "It's not a computationally intense problem," Marino says. "The real challenges occur when you want to have 10,000 users all accessing 'Terminator 2' one

second apart from one another."

As part of meeting that challenge, companies marketing video servers are putting a lot of thought into the most efficient and economical ways to store programming libraries. Neube's 1000-movie server, for example, would require 500 hard drives holding 2 gigabytes of data apiece. But you wouldn't want to store a popular movie such as "Terminator 2" all on one disk, because only a handful of households could watch it at the same time. Instead, companies plan to use a technique called disk striping—putting one second of a movie on one hard drive, the next second on another, the next on another and so on. This way the system could handle numerous households watching different parts of the movie at the same time by feeding the different viewers from different disks.

Especially popular movies—perhaps 20 hours worth—could be loaded into more expensive semiconductor-based storage devices, says Hope Jurgensen, IBM's interactive video server market manager for AT&T Network Systems, which is supplying server technology to Viacom's experimental cable system in Castro Valley. "You have to weigh when a title should be in a more expensive [storage] medium, and when a title should be kept down in an inexpensive medium," she says.

Balancing acts

Of course, not every household in a neighborhood will want video-on-demand at every moment of the day. That's why, says Marino, a server that can accommodate one-third of the users of a wired community at a time should be sufficient. Put another way, a server that can field 10,000 video streams simultaneously should suffice for a community of about 30,000 households.

Servers are only one part of a large and complex system that will deliver interactive entertainment to thousands of people at the touch of a button on a remote control.

One of the other significant challenges is to build a communications link between the server and the home. A movie destined for a particular household might exit the server as a fraction of a 155 megabytes-per-second digital stream combining feeds to many households. Eventually, that particular signal has to be routed to the proper household and converted into a conventional analog TV signal that's viewable on a standard television.

To make that transition, "There's a lot of breakdown equipment that's required from point to point," says Jurgensen. "It's not a simple deal. The

end results look simple to the end users, but the providers have to invest a lot of time and money to get their networks prepared to handle this."

Into the unknown

The companies that are taking servers out of the computing environment and putting them into cable and telephone systems are venturing into unknown territory.

"As we move into large-scale deployment...these things have never been done before," says Barry Willner, project manager for large-scale multimedia and interactive television

for IBM's research division. An IBM server will be used in an interactive TV test run by Cox Cable Communications in Omaha. "As you start to spread it out to thousands of people, you're going to learn things that you didn't know before."

The pace of development is tremendous. At Neube, work on video servers began in earnest only about a year ago, says a spokesman. "Engineers are pulling out their hair," says Jurgensen—an engineer herself. "We are working at Mach 3, and the industry wanted it yesterday. And it's just not all figured out." **FM**

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MAILORDER BOOKS. Excellent profits. Mascor-PM, Box 8308, Silver Spring, MD 20907.

PRIVATE INVESTIGATION TRAINING! BIG INCOME! OWN BOSS! FREE INFORMATION. PROBE, BOX (PM) 2133, BEVERLY HILLS, CALIFORNIA 90213-2133.

BUY WHOLESALE! U.S.A., Orient. Write: Key-Ways, Box 8684-PM3, Portland, OR 97286

EXPLOSIVE 900# OPPORTUNITY! \$15,000 MONTHLY EARNING POTENTIAL. No investments. Details: BCD, Box 820562-M, Vicksburg, MS 39182

NOVICE can start wholesale food distributing company on shoestring. Free information. FAY Enterprises, Box 1061, American Fork, Utah 84003

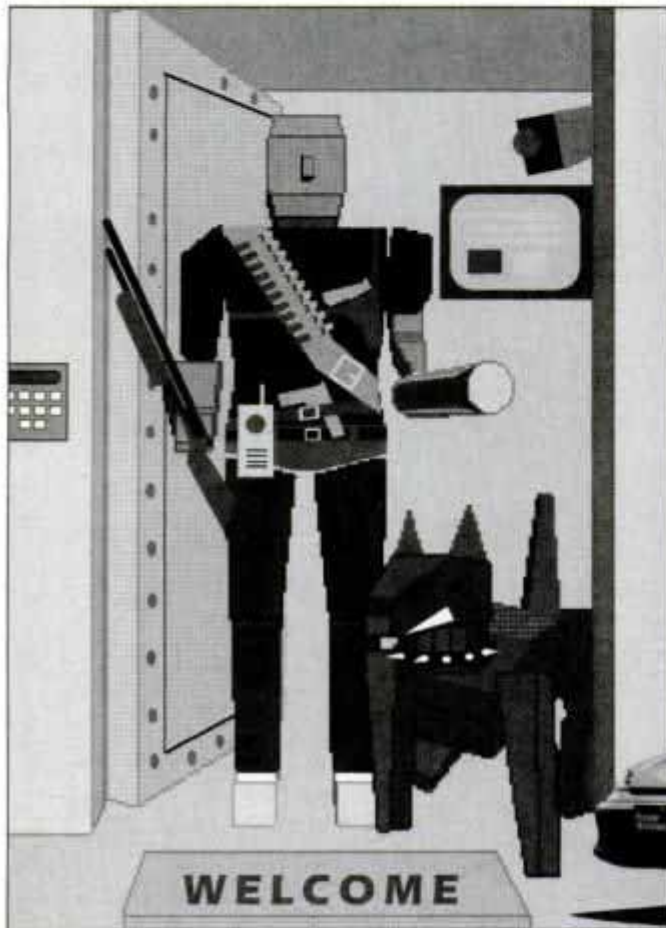
\$1,300,000 IN 12 MONTHS! Free Details! CJR, 532 OldMarlton, Suite 185-PM, Marlton, NJ 08053-2075

GOVERNMENT GIFTS! You & Your business can receive \$1,000's! Write: UTC, 6488 Avondale, Oklahoma City, OK 73116

(Continued on next page)



COMING NEXT MONTH



LOU CASARETO/NBA PHOTOS



Burglarproof Your Home

With crime on the rise, home security is on everyone's mind. Our cover story takes the confusion out of selecting the right protection system for your situation.

Mechanics Of A 3-Pointer

Mark Price might make it look easy, but there's a lot of science happening when he sinks one from 25 ft. An NBA shooting coach analyzes the techniques and physics involved in shooting a 3-pointer, and his tips can improve your own performance on the court.

Happy Landings

Here's an inside look at Denver's new ultra-high-tech airport, which has everything from true all-weather operating capability to automated baggage handling.

Zap That Commercial!

Like to watch movies, but not commercials? Call in the zapper. It lets you record your favorite programs, but automatically eliminates those annoying commercials on playback.

Info Superhighway Turns North

A super-telecommunications system is about to go on-line in Canada. Find out what it'll do for you if you're in the UBI network.

Dodge Intrepid Owners Report

It's not just price that has the Intrepid out-selling its LH cousins, the Chrysler Concorde and Eagle Vision. Owners say it's simply a tremendous value.

Editor's Note—Due to changes in production schedules, an article may not appear when originally planned. We apologize for any inconvenience this may cause.

THE 220 HORSEPOWER BACKPACK.



	Engine	Horsepower/Torque	Towing	Cab/Cargo Volume	Safety	Warranty
DODGE DAKOTA 4X4 CLUB CAB Dakota Superiorities	Available 5.2L V-8 MPI A V-8 compact pickups don't offer	220 @ 4400 rpm/ 295 @ 3200 rpm More available power	Max - 6400 lbs. More available towing	80.6 cu ft/47.9 cu ft Larger cab & cargo bed	Std. driver's airbag Avail. 4-wheel ABS More safety features	3/56 Bumper-to-Bumper or 7/70 Powertrain Dodge provides the only choice of warranties, our Owner's Choice Protection Plan, offering longest powertrain protection. ¹
TOYOTA 4X4 XTRA CAB	Available 3.0L V-6 EFI	150 @ 4800 rpm/ 180 @ 3400 rpm	Max - 5500 lbs.	72.5 cu ft/41.2 cu ft	No driver's airbag No 4-wheel ABS	3/56 Bumper-to-Bumper & 5/60 Powertrain
FORD RANGER 4X4 SUPERCAB	Available 4.0L V-6 MPI	160 @ 4000 rpm/ 225 @ 2500 rpm	Max - 5600 lbs.	75.0 cu ft/35.5 cu ft	No driver's airbag No 4-wheel ABS	3/56 Bumper-to-Bumper
CHEVY S-10 4X4 MAXI CAB	Available 4.3L V-6 CPI	195 @ 4500 rpm/ 260 @ 3600 rpm	Max - 5500 lbs.	74.0 cu ft/39.9 cu ft	No driver's airbag Avail. 4-wheel ABS	3/56 Bumper-to-Bumper

A mid-size Dodge Dakota Club Cab packs an available 5.2L Magnum V-8. It can pull trailers up to 6,400 lbs. And it has plenty of room inside for you and your friends. Compared to Dakota, compact club cabs like Toyota, Ranger and S-10 aren't even on the map.

DAKOTA CLUB CAB



THE NEW DODGE

A DIVISION OF THE CHRYSLER CORPORATION



Data based on information available at time of printing, including some '93 competitive data. See dealer for latest information. ¹See Dodge's limited warranties, restrictions & details at dealer. Normal maintenance, adjustments and wear items excluded. Warranty provisions vary by manufacturer. Always wear your seat belt. **TREAD LIGHTLY!**

**SURGEON GENERAL'S WARNING: Quitting Smoking
Now Greatly Reduces Serious Risks to Your Health.**

Kings & 100's Soft: 10 mg "tar," 0.8 mg nicotine av. per cigarette by FTC method.
11 mg "tar," 0.8 mg nicotine av. per cigarette by FTC method.

Marlboro Lights

