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The New 1992



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Change

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Full-Size Pickup

In America?



This One



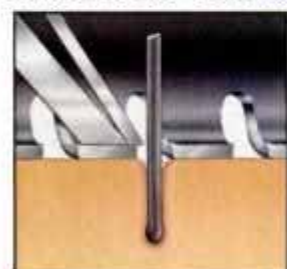
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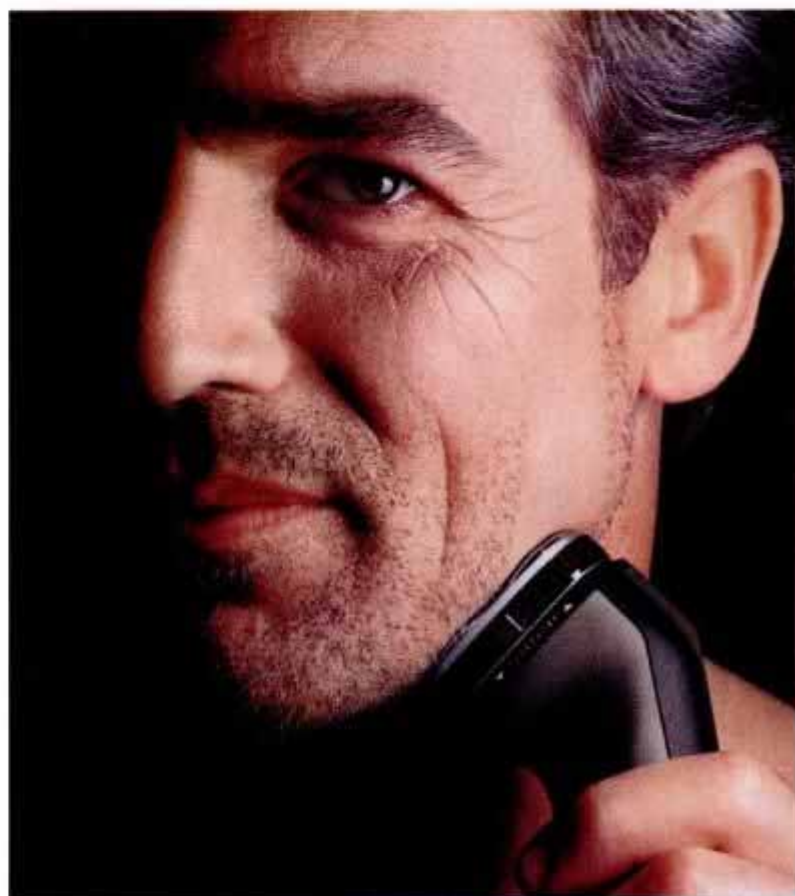
How is this possible?

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Norelco®

We make close comfortable.

Popular Mechanics

DECEMBER 1991
VOLUME 168
NO. 12



45 IMPORTS '92

AUTOMOBILES

45 IMPORTS '92

Power, performance, style and variety mark the new imported cars.

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PM cover illustration by Mark McCandlish

EDITOR'S NOTES

● They call them "black" programs in the Defense Department budget. No one outside a small circle of people—among them the president, the chiefs of staff and the secretary of defense—know anything about them. The congressmen who vote for or against the appropriations in the federal budget each year don't really know what they're voting for when it comes to the black programs. For security reasons, our government representatives are not informed specifically about any black program. On blind faith, they have to take the secretary of defense's word that these systems are necessary to our national defense. Appropriations for black programs are never accounted for, nor is there any congressional oversight on how the monies are spent. As such, sometimes these classified programs work out and sometimes they don't. An example of a program that worked out is the F-117A Stealth fighter. It was developed in the late '70s and made operational in 1983. But the Air Force waited until 1989 to declassify even the smallest details of the program. Breathtaking nose-camera footage taken in the Persian Gulf War of F-117As stuffing 2000-pound bombs down Saddam Hussein's chimney was testimony to the success of that program. On the other side of the coin, you have the cancellation of the Navy's A-12 attack bomber after billions had already been spent on development. This month's cover story on black programs is part investigative report, part speculation. Contributor Greg Pope prowled the back alleys of our defense establishment to dig out some amazing facts and figures about some of the military's top-secret aircraft. Why? Well, besides the fact that you're paying for it and you have a right to know, it's pretty fascinating stuff. . . . Remember "Pong," the first videogame? Your kid and his friend knocked an electronic ping-pong ball across the screen of your TV for hours on end. Have you checked out videogames lately? Man, what a difference. The most sophisticated games are no longer for kids. They're for you. And some of the games aren't even games. They're more like educational TV. Check out our special section in this issue for a complete rundown on Videogames For Grown-Ups. . . . To the Yukon in a Yukon, GMC's new full-size sport/utility. That's what a couple of our editors did recently to test the mettle of this new vehicle—and themselves. . . . After last month's Woodworking Guide, you may be a little wood-worked out. But if you still have room for more, our Home Improvement editors offer up a beautiful chest of drawers made of cherry. . . . For the first time in our history, POPULAR MECHANICS readers made an import their car of choice for purchase. Yes, this year PM readers bought more Honda Accords than any other car. This puts you right in sync with the rest of the country where the Accord has been reigning supreme for the past two years. You're paying more attention to imports and so are we. Our annual coverage of new models starts on page 45. Yes, we know the Honda Accord is made in Marysville, Ohio, and the Toyota Camry is made in Georgetown, Kentucky. But their country of origin is still Japan so we still count them as imports. Till next time.

This is what we—and Congress—know about most of the Pentagon's black programs.




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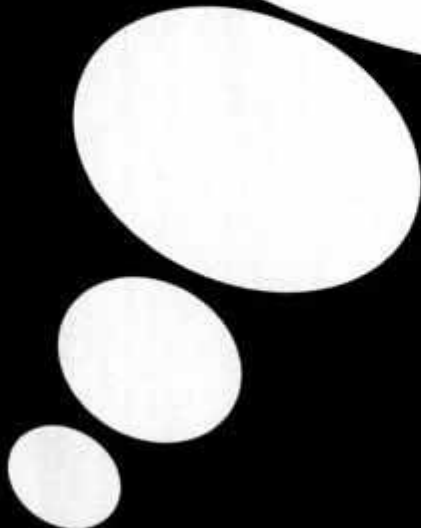
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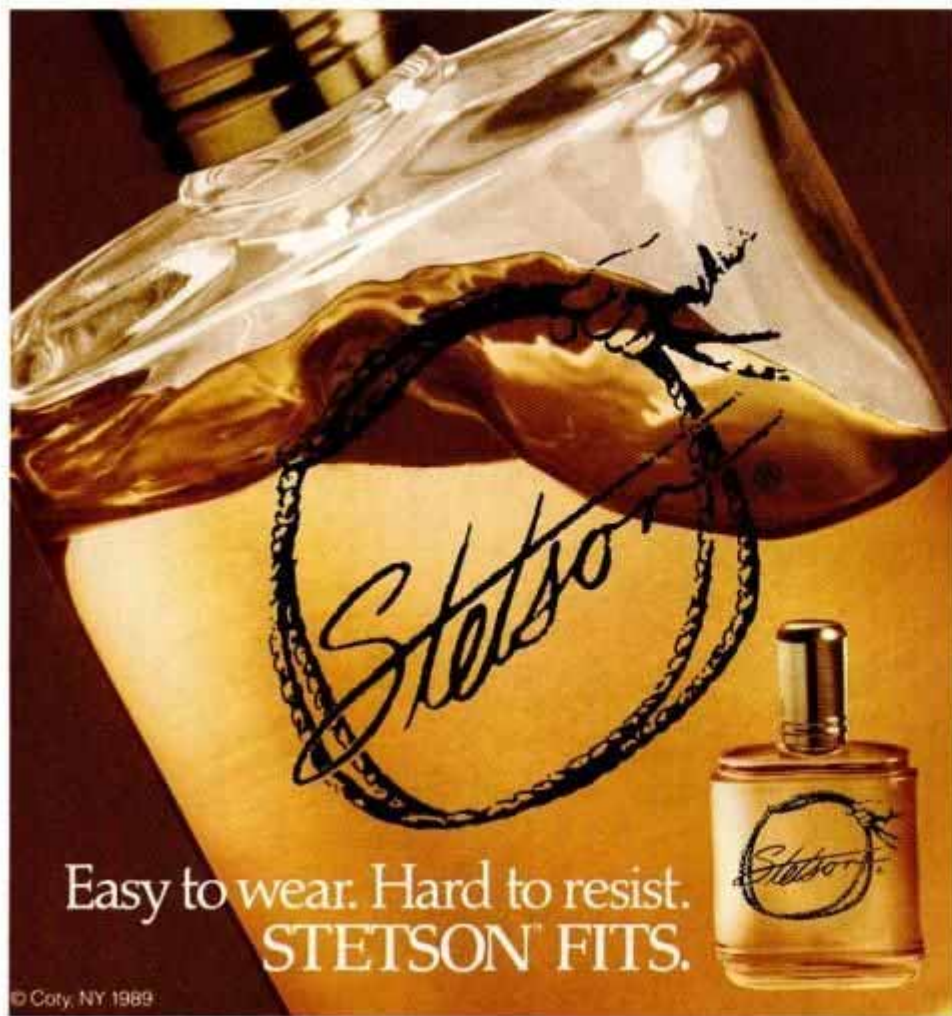
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LETTERS

Concepts



Your "Concept 2000" story certainly featured some nice cars and trucks. Too bad the Big Three automakers don't have the courage to make these cars production vehicles (the Viper is an exception). A few years ago, I saw Ford's Probe V in an I-Max production, but I was greatly disappointed in the showroom version—another copy of a copy. I hope in this round Ford's concept Zig and Zag, and Protosport survive intact and are offered in a price range that is less than my yearly income.

DAVID DELLINGER
AMERICAN FALLS, ID

When I read your Detroit '92 special section, I noticed there was no discussion about an all-wheel-drive full-size sedan. Why haven't American car manufacturers continued to pursue the 4wd passenger car concept?

I currently own a full-size, 4x4 pickup truck that I want to replace with a 4wd passenger car. I travel mainly in the Rocky Mountain area, and find I'm spending less time on back roads and more on paved highways and interstates. While I recognize the grow-

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

ing popularity of sport/utes, it seems to me that these are a compromise between an off-road vehicle and a passenger car, with emphasis on the off-road.

STEVEN R. MACE
ROSWELL, NM

EFI Flap

In your Boating column on "Salmon And Suzuki," the following sentence appeared: "Electronic fuel injection, which debuted in the growling 225, is another technology brought to the outboard market by not-so-quiet Suzuki." The statement implies that Suzuki is the first in offering EFI technology to the outboard market. This is not so. Mercury introduced EFI several years ago. C.J. KOEHLER
MERCURY MARINE
FOND DU LAC, WI

We regret the error. —Ed.

Glock And Spiel

The article on the Glock 17 pistol touched on the debate surrounding the "plastic gun" issue that ensued when this sidearm was first introduced in the United States. Your headline on the cover, "New High-Tech Automatic Is Made Of Plastic," is misleading and helps build anti-gun sentiment among the misinformed public. The fact that 79% of the Glock's mass is metal is buried in the article.

JAMES R. BEST
SANDUSKY, OH

Thrill Ride

I enjoyed the annual Gallery Of Great Cars. I have a 1973 Super Duty Pontiac Trans Am like Gary Yanni's. So few of these cars were built that most people aren't aware of the model.

Pontiac built many white Trans Ams that year, which caused the SD versions to be underestimated at the stoplight. Whenever I think about selling mine, a quick spin down the road always brings a smile to my face and a thrill to my soul, and the little voice says, "Keep it a little longer."

JOHN V. VOGT, III
NORCROSS, GA

Made Where?

I think you should be careful of the words "Hondas," "Toyotas" and so on "made by Americans in America." These cars are assembled here, which is a vastly different story. All the tool room and crafting type of work—which require most of the manhours and skills—is done in Japan. American cars, on the other hand, are pretty much totally made in North America and require a high degree of skills in their manufacture. The Japanese would have us all as semi-skilled assemblers.

W. BULBECK
ONTARIO, CANADA

Hitting Home

In the September Letters column, H. Wayne Earl complained that your article, "Factory-Built Housing," excluded steel-framed houses. Well, I

have no sympathy for Mr. Earl if he represents Tri-Steel Structures. For three months, I tried contacting Tri-Steel to request literature on their garage packages. Then I wrote a letter to the company's CEO. Still no response. Tri-Steel may manufacture quality products, but it won't sell any if it doesn't respond to inquiries.

JAMES GARDEN JR.
CLAIRTON, PA

Coupe Du Jour

My 1/4-scale working model radio-controlled 1934 Ford coupe has an ABS plastic chopped body that rests on a chassis using a 5-link rear suspension and 4-link front suspension with coil-over shocks at each end. The electric-start, functional V8 gasoline engine produces 2.2 hp at 11,000 rpm. Some of the custom-made components include steel engine mounts and crossbar, copper exhaust system, water and fuel tanks, brass hinges, frame and water pump, and a canvas top made by my wife.

JAMES SHELTON
TUALATIN, OR

Watch for our upcoming article on radio-controlled 1/4-scale models. **PM**



Radio-controlled Ford hot rod boasts functional 2.2-hp mini-V8 and sophisticated suspension.

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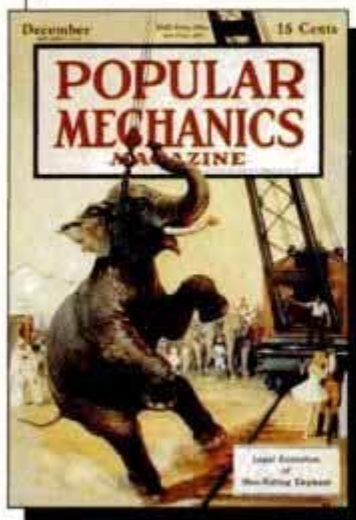
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TIME MACHINE

75 YEARS AGO: DECEMBER 1916



Circus Horror

It's hard to believe that such incidents ever took place in this country, but America's social values 75 years ago were different than they are today. And so in 1916, Tennessee state authorities executed a circus elephant that had killed her trainer. Although many people expressed repugnance, a crowd of 1500 assembled for the bizarre hanging. The event reflected an America making great strides technologically, yet still gripped by medieval attitudes toward animals.

To Catch A Thief

A new crime wave was flooding Los Angeles—auto theft. Local inventors tried to cash in with countermeasures. One gimmick consisted of an inconspicuous steel band that wrapped around the rim of a wheel. The device didn't lock the wheel, but the impact of its spike-shaped outer face against the road made it impossible to drive without attracting attention. In addition to assuring a noisy, bumpy ride for the would-be felon, the spike left a trail of dents on both dirt and paved

roads. What's more, the inventor offered a standing reward for the arrest of anyone caught driving a car with his shackle.



50 YEARS AGO: DECEMBER 1941



Fish Out Of Water

Somewhere between hydrofoil and ground-effect machine floated the flying mosquito boat, proposed by automotive designer George Walker. Laden with a ton and a half of ordnance, the boat would skim across the waves on two outrigger hulls, driven by a big propeller to 110 mph. After loosing a volley of torpedoes and gunfire on a hostile ship, the craft could rise into the air and fly back to a friendly base at between 250 and 300 miles per hour.



Air America

Warbirds were rolling off assembly lines by the thousand. Army Air Forces gobbled up the Lockheed P-38 Lightning, Bell P-39 Airacobra and Curtiss P-40 Warhawk, while North American launched production of the P-51 Mustang. The Navy snapped up Curtiss SB2C Helldivers. But air strategists pinned their hopes on long-range bombers, and in Wichita, Kansas, workers began tooling up for the deadliest air weapon ever: the B-29 Superfortress.

25 YEARS AGO: DECEMBER 1966



Disney D-I-Y

Christmas display projects lit up covers during the 1960s, and for our 1966 project we enlisted the help of Disney Productions in Burbank, California. Pipe clenched in teeth, a consummate do-it-yourselfer named Fred MacMurray took time off from filming "Follow Me, Boys!" to model our mobile. Construction was simple: thin-wall conduit and galvanized pipe formed the skeleton, fleshed out with tinsel wrapping and hardboard cut-outs of Disney characters.

Muscle Birds

Pedaling into the sky has always been a compelling dream, but back in the '60s people tried it without lightweight composite materials, computer-aided design and other modern tools. The British staged a competition that drew helipedes, cyclopters and other outlandish human-powered flyers. Bicycle parts and

plastic sheets figured in most of the projects, along with diets and exercise to guarantee horsepower. **PM**



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TECH UPDATE

News Of Tomorrow's Technology Today



EDSON CHOUSET OFFSHORE ILLUSTRATION

Subzero Scientists Will Break Their Own Ice

LAROSE, LA—Oceanographers have research ships, and the Coast Guard has icebreakers, but an oceanographic icebreaking vessel has been only a fantasy for American researchers—until now. Next month, the brand-new *Nathaniel B. Palmer* will slip from the North American Shipbuilding yard and swing into sea trials.

Built by North American Shipbuilding for the National Science Foundation (NSF), the *Palmer* won't match up to Russia's nuclear-powered icebreakers or the Coast Guard's powerful diesel-turbines. But the *Palmer's* not designed to open lanes for sea traffic. Instead, it will

ferry researchers wherever they desire and park while they conduct their studies.

To bust loose from the ice pack when the science is over, it will fire a controllable-pitch thruster that will heel the ship back and forth for 2 minutes, before starting the 13,000-hp main engines.

Unusual for an icebreaker, the 218-ft. *Palmer* will handle rough open seas, rolling less than 8° in 16-ft. waves. It'll keep 37 scientists out of trouble in temperatures that plunge to -60° F. Operational cruises may last for 90 days, covering 15,000 miles.

Following sea trials, the

Editor: Abe Dane
Assistant Editor: Greg Pope
Contributor: Mike Fillan

Palmer will be delivered to NSF this March, ready for the Antarctic winter that begins in June.

Nathaniel B. Palmer, 2300-ton icebreaking research vessel, puts 5600 sq. ft. of mobile lab space in Antarctica.

Highlights This Month

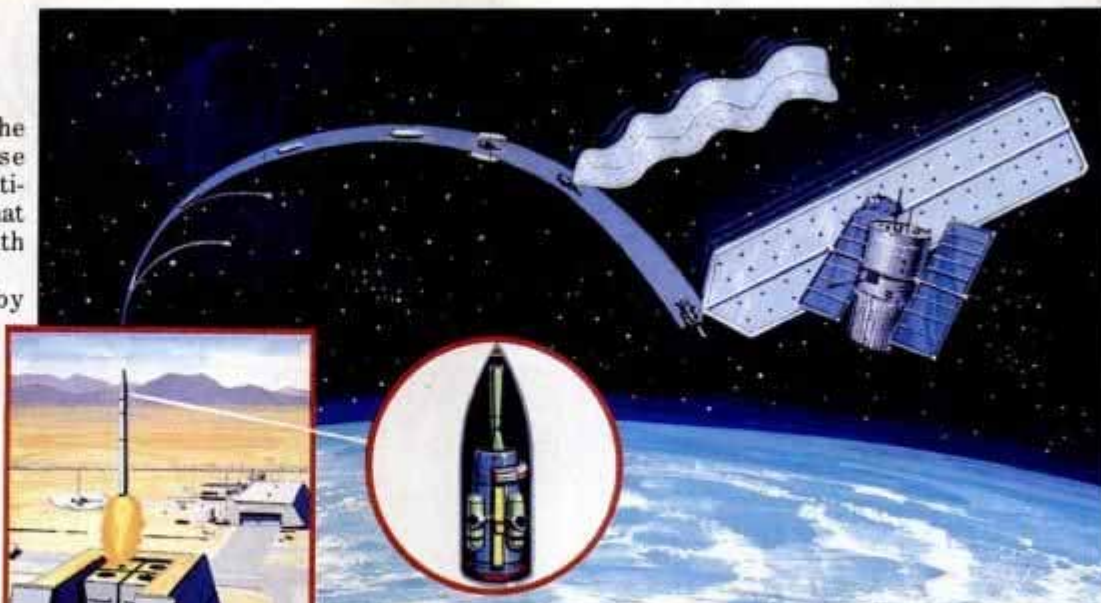
- **Robo-Rotor**—Unmanned tilt-rotor may roost on warship decks.
- **Round-Tripper**—Reusable rocket gets the green light.
- **Lone-Star Express**—Texas wants the tops in railroad tech.
- **Lord Of The Rings**—Brookhaven's heavy-duty atom smasher, plus new quark hunter.
- **Flying Flyswatter**—Army's missile slaps satellites.
- **Look Deep**—New film material promises instant holograms.

Satellite Swatter

HUNTSVILLE, AL—The Army Strategic Defense Command is funding an anti-satellite missile (ASAT) that would cripple its target with a high-speed slap shot.

Under development by Rockwell, the weapon would fire two rocket stages to accelerate a kinetic-energy kill vehicle into low-Earth orbit. A visible-light homing sensor, with a range of between 1000 and 1800 miles, would key in on sunlight glinting off the satellite.

But instead of careening into its target, the weapon would clobber the satellite with a huge Mylar paddle that unfurls at the last minute, like an automotive airbag. The impact, jarring



Kill vehicle rockets into orbit and deploys paddle to smack hostile satellite into inoperability.

rather than shattering, wouldn't leave space debris.

Unlike the LTV-developed Air Force prototype

ASAT that fired from a high-flying F-15, the Rockwell missile would launch from ground sites. Presidents

would have to authorize use of the ASAT, but the Army says the system won't be able to knock out high-altitude early warning satellites.

Hover tests of the kill vehicle are scheduled for 1994.

Instant Holograms

SAN JOSE, CA—A photorefractive polymer concocted at IBM's Almaden Research Center could form the film for an instant holographic camera, among other intriguing applications.

Today's holograms arise from chemical changes on so-called photochromatic mate-

rial that, like conventional film, takes hours to develop. But IBM's polymer reacts to laser light by immediately redistributing electronic charges within the material.

This photorefractive effect, which alters the refractive index of the material, has been seen previously only in small, expensive crystals. The IBM substance combines a new polymer with a chemical that's used in photocopier machines.

As well as storing holographic images, the material could form goggles that instantly diffuse laser light to protect retinas. IBM is interested in using the material as a cheap, immensely data-dense optical storage medium.

Crossed laser beams alter electric charges in photorefractive polymer, making a hologram.

Prenatal Heart Monitor

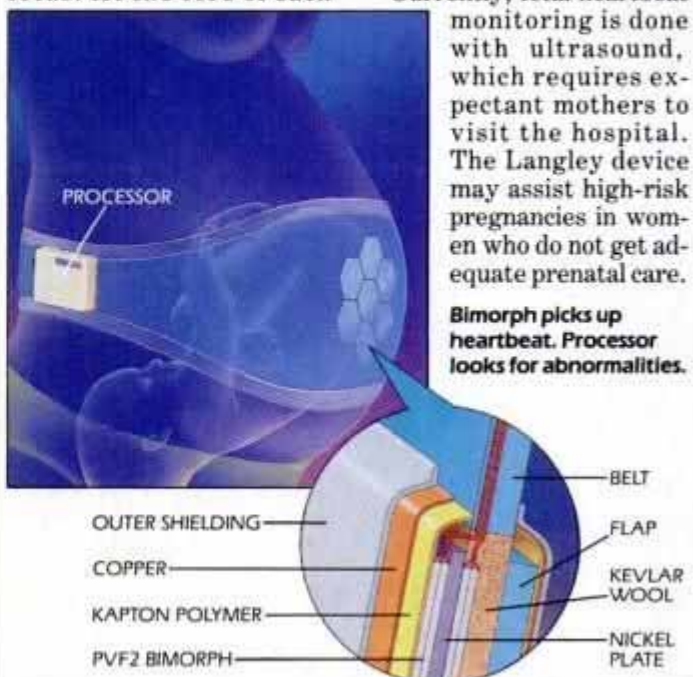
HAMPTON, VA—Devices that measure surface pressure on aircraft wings may find a more down-to-Earth application. Engineers at NASA-Langley have shrunk the technology into a prenatal heartbeat monitor.

Seven passive acoustical sensors worn on a belt monitor the heart rate of the fetus. At the core of each

sensor, a double sheet of polyvinylidene difluoride (PVF2) triggers a voltage when subjected to sound pressure that's transmitted through the mother's abdomen. A belt-worn microprocessor receives the signals and distinguishes a healthy heartbeat from tones that might signal trouble.

Currently, fetal heartbeat monitoring is done with ultrasound, which requires expectant mothers to visit the hospital. The Langley device may assist high-risk pregnancies in women who do not get adequate prenatal care.

Bimorph picks up heartbeat. Processor looks for abnormalities.



- PROCESSOR
- OUTER SHIELDING
- COPPER
- KAPTON POLYMER
- PVF2 BIMORPH
- BELT
- FLAP
- KEVLAR WOOL
- NICKEL PLATE

IBM PHOTO

PM ILLUSTRATION BY ED VALIGURSKY

PM ILLUSTRATION BY THOMAS C. MOORE

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Lasers Versus The Army

WHITE SANDS, NM—How well will our tactical weaponry stand up against a future attack with beams of energy? The Army wants to know, so starting next year—under the auspices of the Strategic Defense Command—engineers will begin peppering combat equipment with an infrared laser beam.

The Pulsed Laser Vulnerability Test System will function out of four standard military vans housing the 10.8-micron carbon-dioxide laser, instrumentation, master controls and a beam pointer/tracker. Both ground and airborne targets, such as tracked vehicles and helicopters, will be rigged with sensors. Radiolinks between test article and control vans will permit instant acquisition of damage data.

The system can be airlifted to any test range in the world, but will mainly operate in the High-Energy Laser Systems Test Facility, home to monster beams such as SDP's megawatt MIRACL laser.



Cobra chopper absorbs brunt of laser beam in threat-surrogate test.

PM ILLUSTRATION BY ED VALIURSKY

Battering Matter Back To The Big Bang

NEW YORK, NY—Particle-chasing physicists won't sit idly waiting for the Superconducting Supercollider to open for business in the year 2000. Before then, new accelerators and detectors will probe the building blocks of matter.

Magnet cell (below) will guide heavy ions in Brookhaven's big collider. D-Zero (bottom right) is newest quark seeker.



Brookhaven National Labs has broken ground on its Relativistic Heavy Ion Collider (RHIC), scheduled to start operations in 1997. No existing accelerator can generate what this machine will—densities 10 times those inside atomic nuclei and temperatures 100,000 times hotter than the center of the Sun.

Inside RHIC, supercon-

ducting magnets will shepherd two counterrotating beams of particles as heavy as gold ions, cruising at near light speed. At six points around the ring, the ion beams will crash head-on.

Each collision will generate a miniature fireball that, physicists hope, duplicates the conditions a fraction of a second after the Big Bang.

Specifically, researchers are looking for the quark-gluon plasma, a primordial soup of fundamental particles.

The 1600 magnets that will confine the clashing beams won't be as powerful as those envisioned for the Supercollider. Brookhaven engineers have already made functional prototypes. But the detectors will have to monitor thousands of exotic particles at once and will be the most complex ever built.

Meanwhile, at Fermi National Accelerator Laboratory's Tevatron Collider, a 5000-ton detector will begin the hunt for the last of the quarks to give up its secrets—the "top" quark. Thought to

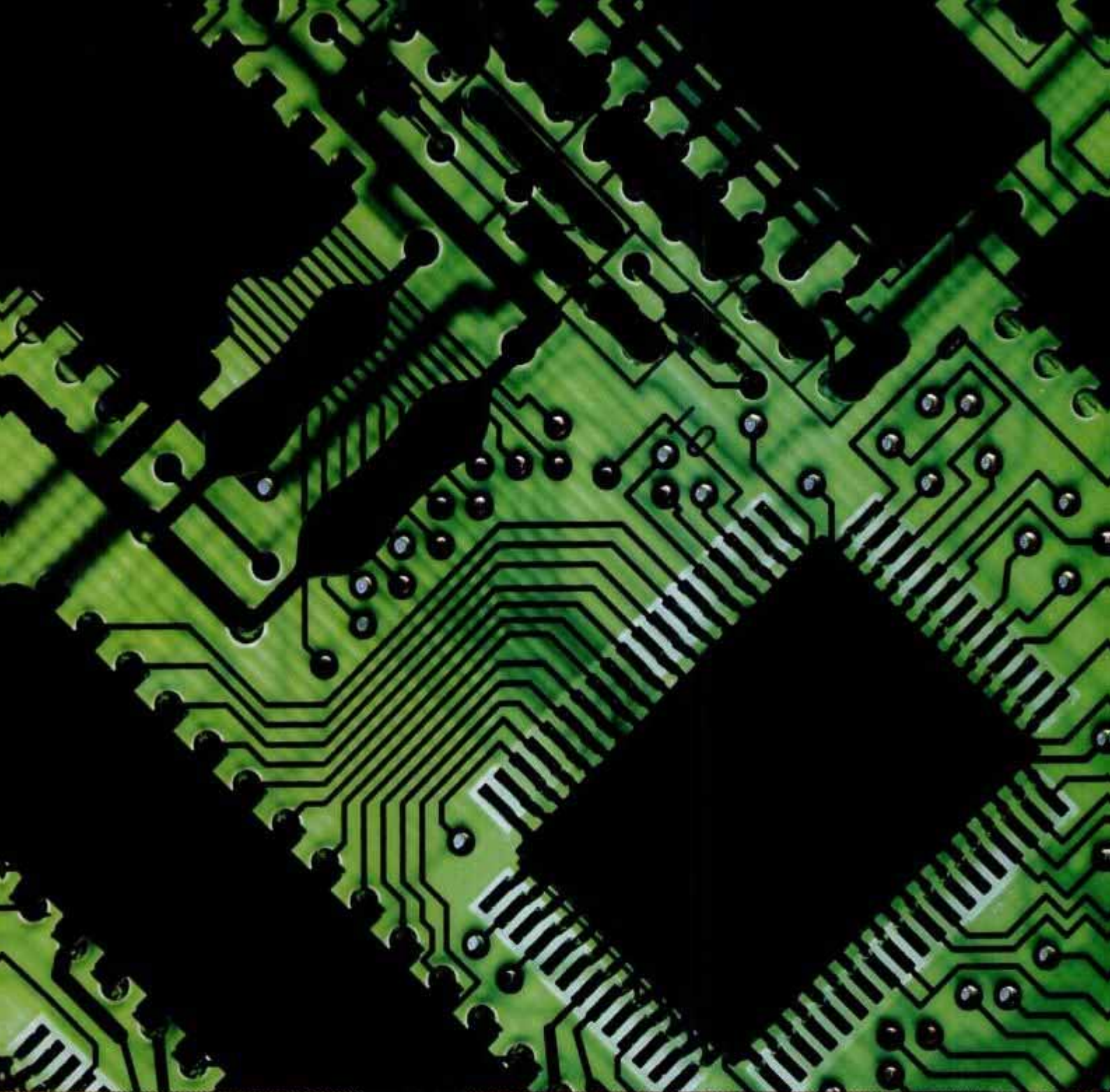
be 90 times as massive as a proton, this subnuclear particle winks briefly into life after high-energy collisions like those in the Tevatron, which slams protons and antiprotons together.

The new detector, named D-Zero after its location in the Tevatron ring, will monitor a broad range of particles—including those elusive neutrinos. It will make the most extensive use yet of cryogenic liquid argon as a medium for detecting charged particles, and uranium plates as a way of containing electron showers triggered by the particles. D-Zero will come on line in January.



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Round-Robin Rocket

HUNTINGTON BEACH, CA—The single-stage-to-orbit, reusable spacecraft commissioned by the Strategic Defense Initiative Office (see [Tech Update, page 9, July '91](#)) won't be a spaceplane. Instead, it'll be the Delta Clipper, a wingless cone designed by McDonnell Douglas. The craft will rocket into orbit vertically, reenter the atmosphere nose first, then use flaps and differential throttling on its eight engines to flip around. Engines will fire at 25% thrust to cushion its landing. Vertical touchdown will allow the

spacecraft to land within a 50-ft. radius. The Clipper will lift payloads of up to 20,000 pounds.

Supporting the rocket's repeat performances are simple on-board systems, such as a giant spring for deploying payloads. They'll keep launch costs down to \$600 per pound, says McDonnell Douglas.

A 1/3-scale demonstrator called the DC-X will fly in 1993 at White Sands Missile Range.

Delta Clipper will feature quick turnaround, readied for launch in less than a week.



MCDONNELL DOUGLAS ILLUSTRATION

Train Technology Rolls Into Texas



GEC ALSTHOM PHOTO

A planned 220-mph TGV may be ready for the Texas project.

Meanwhile, Houston has asked Bombardier to start preliminary engineering studies on the nation's first mass-transit monorail system. The city's plans call for two lines, covering 20 miles, that carry urban versions of the Mark VI straddle-beam monorail operating at Disney World. Single cars carrying 160 pas-

sengers will run independently and hook up into triplicate platoons during rush hours.

Much of the system will scoot along overhead concrete beams, although a short monorail subway section may serve downtown Houston. Construction is expected to begin in 1993. Kiewit Construction has paired up with Bombardier on the project, and the team is competing to build a similar system in Honolulu.

HOUSTON, TX—While flagging economies have derailed several high-tech train ventures across the country, the Lone Star State has attracted two state-of-the-art rail systems.

Texas has granted makers of France's TGV—the world's fastest locomotive—a franchise to build a line linking

Houston, Dallas/Fort Worth and San Antonio. The TGV consortium beat out a rival offering Fastrac, based on Germany's Inter City Experimental, which has seen only limited service.

Bombardier will supply the rolling stock, while Morrison-Knudsen will engineer and build the tracks. The flat Texas plains are a natural for the TGV, which relies on a dead-straight track to build up a speed of 186 mph.

TGV (above) will cross Texas at 186 mph. Disney-style monorails (right) will be Houston's light-rail system, with mass-transit interiors (left).



TGV ILLUSTRATIONS



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Kit Jet Nearly Ready

OSHKOSH, WI—The long-awaited Bede-10 supersonic kitplane (see "Homebuilt Machbuster," page 68, Dec. '89) should soon be ready to fly, if hardware viewed by PM editors at this year's Experimental Aircraft Association Fly-In is any indication.

Designed to reach Mach 1.4 and climb at 30,000 ft. per minute, the little 2-seater will accommodate the

2950-pound-thrust GE CJ-610 turbojet for power. The plane itself will have a normal gross weight of about 2920 pounds.

In a development that lends new confidence to the high-risk project, Jim Bede

recently signed legendary test pilot Bob Hoover to put the craft through its initial paces.

Bede will keep Prototype No. 1 for himself, but produc-

tion kits will sell for just under \$200,000, minus engine and avionics. The powerplant adds another \$40,000 to \$160,000 to the price.



Initial prototype BD-10 awaits engine and cockpit controls.

PM PHOTO BY ALEX WILSON

Unmanned Tilt-Rotor

FORT WORTH, TX—Bell Helicopter Textron and Boeing Helicopters collaborated on the V-22 Osprey and an early unmanned project called Pointer. But now they're leading rival teams vying to land a Pentagon study and development award for a pilotless tilt-rotor.

Bell's offering is Eagle Eye, which features a 15-ft. airframe designed by Burt Rutan's Scaled Composites, Inc. The Allison turboshaft used in the Bell 206 Jet-Ranger helicopter would propel the vehicle. Boeing has submitted a slightly



smaller machine of its own design called Tracer, which is powered by a modified cruise-missile turbine.

Tilt-rotor technology would help unmanned aerial vehicles touch down safely in a small area without nets, parachutes or other attention-getting apparatus. Naval Air Systems Command is especially interested in fielding shipboard UAVs, which would carry electronic decoys, relay communications and spot over-the-horizon targets for surface vessels.

Flight demonstrations are slated to begin sometime next year.

Bell's Eagle Eye tilt-rotor drone cruises on props with three composite blades each.

Wheelchair On Tracks

SUNNYVALE, CA—A new wheelchair brings to the disabled what the tank brings to an army: all-terrain mobility. Developed by

Quest Technologies, the Access power chair allows the user to travel freely without spending time hunting for ramps or elevators.

Twin caterpillar tracks, made of molded rubber and Kevlar, deploy at a keystroke from an armrest command module. A small network of computer-controlled hydraulic actuators lower the tracks and raise or re-

cline the seat as the driver negotiates slopes or stairs. Meanwhile, an automatic seat-tilt mechanism guarantees a stable center of gravity.

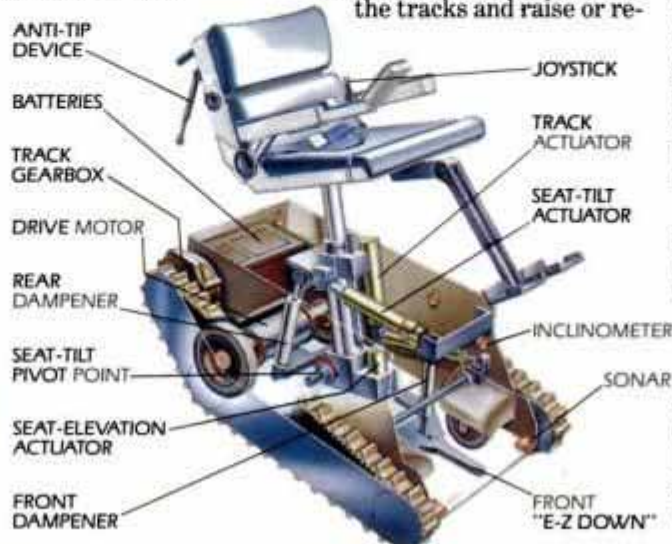
In addition, front and rear sonar devices warn of sidewalk cracks and potholes. On-board inclinometers gauge the steepness of gradients and alert the driver if he is pushing his vehicle beyond its limits. But the Access can handle slopes up to 34°.

Four lead-acid batteries provide enough power for a day's routines, and when the tracks are raised, top speed is 6 miles per hour.

Modifications planned for future models include a cellular telephone, remote-control interface with household appliances, and voice and breath control for the severely handicapped.

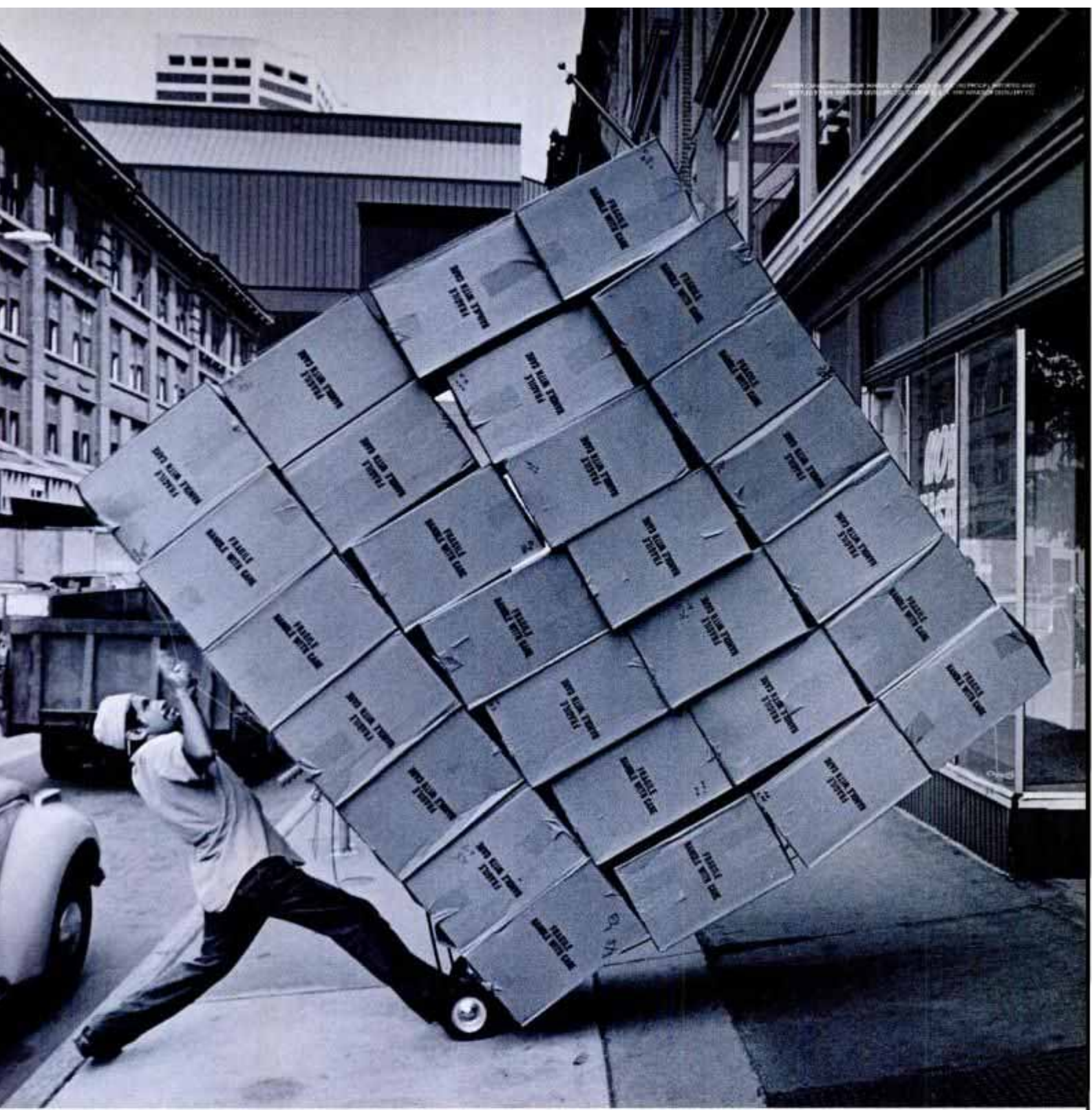


Microprocessor-controlled hydraulics activate tracks and adjust seat on Access power chair.



BELL HELICOPTER TEXTRON ILLUSTRATION

QUEST TECHNOLOGIES PHOTO; PM ILLUSTRATION BY ADOLPH E. BROTMAN



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TECHNOLOGY

HIGH-TECH CRIME HUNTERS

Advances in the sleuthing sciences are extending the long arm of the law.

BY JON ZONDERMAN

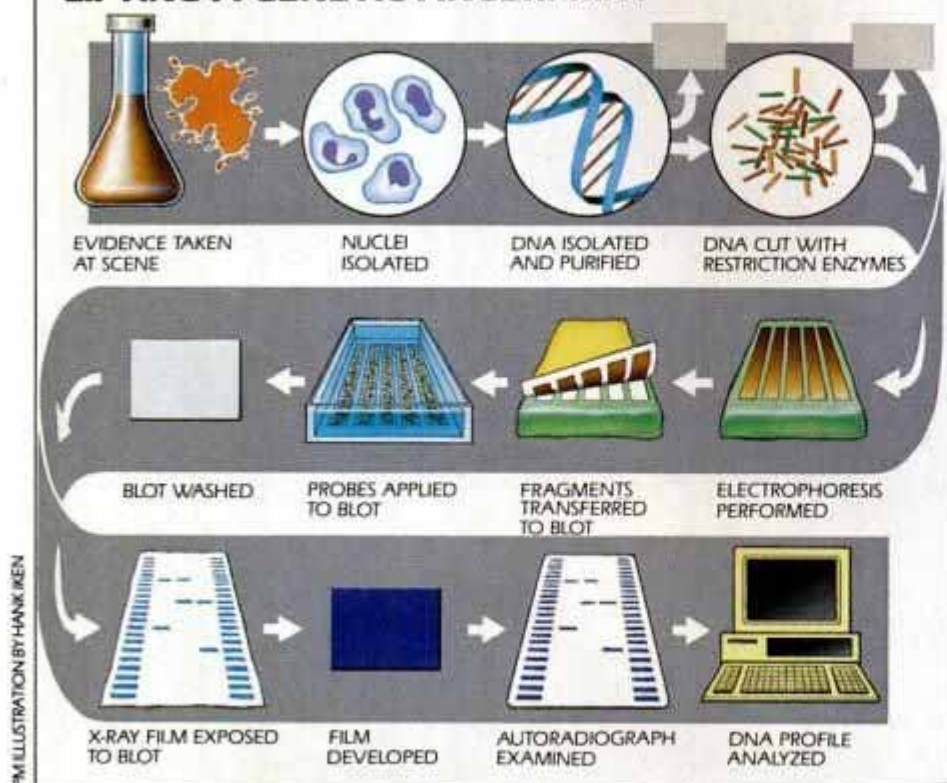
● For six years, the murder of Miriam Slamovich, a 48-year-old woman who apparently surprised a burglar in her home, sat unsolved in the files of the San Francisco Police Department.

The problem was not lack of evidence. A good set of latent fingerprints had been lifted from her bedroom window and windowsill. What stalled the investigation was the sheer volume of police fingerprint records. Although the officers assigned to the case slogged through more than 300,000 print cards over the years, they never found a match.

Until recently, such stories were common. With more than 22 million people's prints in FBI files, the practice of dusting a crime scene often served as much to calm traumatized victims

HIGH-TECH CRIME HUNTERS

LIFTING A GENETIC FINGERPRINT



FM ILLUSTRATION BY HANK IKEN

Complex and expensive, DNA typing nonetheless offers great potential for law enforcement.

as to hunt down perpetrators.

But in 1984, a break came in the Slamovich case. San Francisco installed one of the country's first automatic fingerprint identification systems (AFIS). Within minutes after being fed the prints from Slamovich's home, the computer spat out a short list of suspects, one of whom eventually confessed to the killing.

Since then, AFIS technology has matured and spread to states and municipalities all across the country. It joins a growing number of high-tech anticrime tools that have gone from laboratory curiosities reserved for only the biggest cases to workaday police procedures.

These tools, when combined with sharp, persistent policework, can turn the slimmest shred of evidence into an open-and-shut case.

AFIS comes of age

Although today's AFIS equipment is much improved over that used in the Slamovich case, it still incorporates the same basic components. An optical reader scans the prints, either from file cards or from the crime scene. This information is passed along to a computer, which produces a spatial geometric map of the ridge patterns and minutia of each print. The map is then translated into digital code and stored in memory.

When a search is initiated, the computer uses a mathematical algorithm to compare prints, looking for possible matches based on universal criteria. These "hits" are then examined closely by a detective or fingerprint expert.

Early AFIS equipment had two problems. One was compatibility.

Until 1987 when a national standard was set and software conversion systems created, AFIS devices made by different companies often could not communicate with each other. The second problem was that AFIS

Computer imagery can show a long-lost child as she or he would look years later.



NATIONAL CENTER FOR MISSING AND EXPLOITED CHILDREN PHOTO

could only give the fingerprint examiner a list of possible matches. He had to go to the files and pull the cards himself.

But advanced scanning and computer-imaging capabilities, along with better telecommunications, have made AFIS more practical. Today, detectives on systems like New York's new \$40-million statewide network can scan a print locally, transmit it to a mainframe in the state capitol and get back a digital image on their computer screen for comparison with the new print. Before the New York system was installed, only about 50 searches of fingerprint files would be undertaken in a typical year. In the first two months of 1991, computer searches identified 80 suspects.

Laserprinting

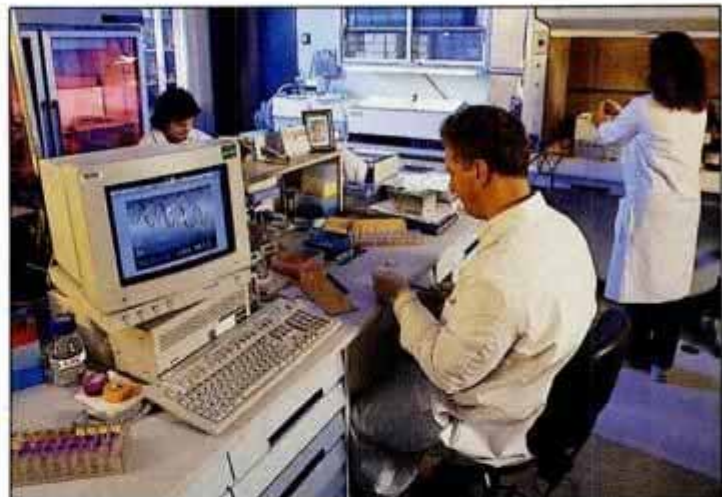
Complementing the advances in AFIS equipment are technologies that bring to light latent prints that might have gone undetected earlier. One of the most successful of these relies on lasers.

The technique first gained prominence in the trial of a former Nazi. In 1975, the Justice Department moved to deport Valerian Trifia, a Rumanian Orthodox priest, on the grounds that he had misrepresented his fascist activities on his naturalization application. The West German government supplied the FBI with a number of documents relating to Trifia, including a postcard he had allegedly written in 1942 to Heinrich Himmler, the head of the Nazi SS.

Complicating matters was the fact that the German government required that the evidence not be harmed in any way. So the FBI decided to make an attempt with the relatively untried laser technique. When they did, they found a latent thumbprint that matched 11 reference points on an inked impression of Trifia's left thumb. On August 13, 1984, Trifia was deported, his past given away by a piece of paper he had touched 42 years before.

Although still in their infancy as a forensic tool, lasers can already be used to lift prints from surfaces that often defy traditional powder or chemical techniques, including glass, paper, cardboard, rubber, wood, plastic, leather and even human skin.

The laser works by fluorescing components of perspiration, body oils and foreign substances characteristic of latent prints. This residue absorbs the single-wavelength light of the laser and re-emits it at longer wavelengths—approximately 550 nanometers and above. By observing an illuminated specimen through a filter



FBI labs use lasers (left) to check evidence from crimes all over the country for fingerprints. DNA typing (above) is another technology of growing importance to the bureau, with efforts now underway to develop a database of genetic "fingerprints."

that excludes all wavelengths below 540nm, technicians can spot the faintest trace of human contact.

Genetic detectives

However sensitive the detection methods, though, there are still many crime scenes at which there are no usable fingerprints to be found. In these cases, a tremendously promising, but still controversial, technique from the frontiers of biotechnology has come into play. DNA fingerprinting relies on the fact that every cell in an individual's body contains a strand of genetic material that is unique to that person. Thus, the tiniest fleck of saliva, blood or semen at a crime scene can, in theory, be positively linked to whoever left it.

The identification process starts when DNA brought to the lab is mixed with a restriction enzyme that cuts the DNA at points where specific genetic sequences occur. The lengths of the resulting fragments vary according to the makeup of the original DNA strand. These fragments are sorted by length through a process called gel electrophoresis, which makes use of the fact that small pieces of DNA travel through an electrically charged gel more quickly than large ones. The sorted fragments are transferred to a nylon blot and treated with radioactively tagged genetic probes. Designed to seek out genetic sequences that vary from individual to individual, these probes form an identifying pattern on the blot. This is

then turned into a photographic image called an autoradiograph.

The process is expensive, complex and, if not carried out to exacting standards, prone to inaccuracies. But all agree that the scientific principle is sound and that eventually DNA typing will be 100% reliable. Already, the FBI is at work on software that would allow computers to store and compare DNA data, much as they now process fingerprints.

Image problems

Despite the move toward lab techniques in law enforcement, one of the best ways to identify a suspect, or a victim, still resides in the human ability to recognize a face. This ability may be thwarted, however, by the changes that naturally occur with age.

To counter this, two medical illustrators, Scott Barrows and Lewis Sadler, began to develop techniques for producing "age-progression" drawings in the early 1980s. Originally an outgrowth of efforts to project what children would look like after cosmetic surgery, the drawings were later found to be highly effective in identifying missing children.

Today, thanks to a computer algorithm, the same process that used to take hours using calipers, ruler and pen can be completed in seconds. Developed by a colleague of Barrows and Sadler, the program systematizes their knowledge of the anatomy of 14 major bones and more than 100 muscles, and how they grow. It also shows

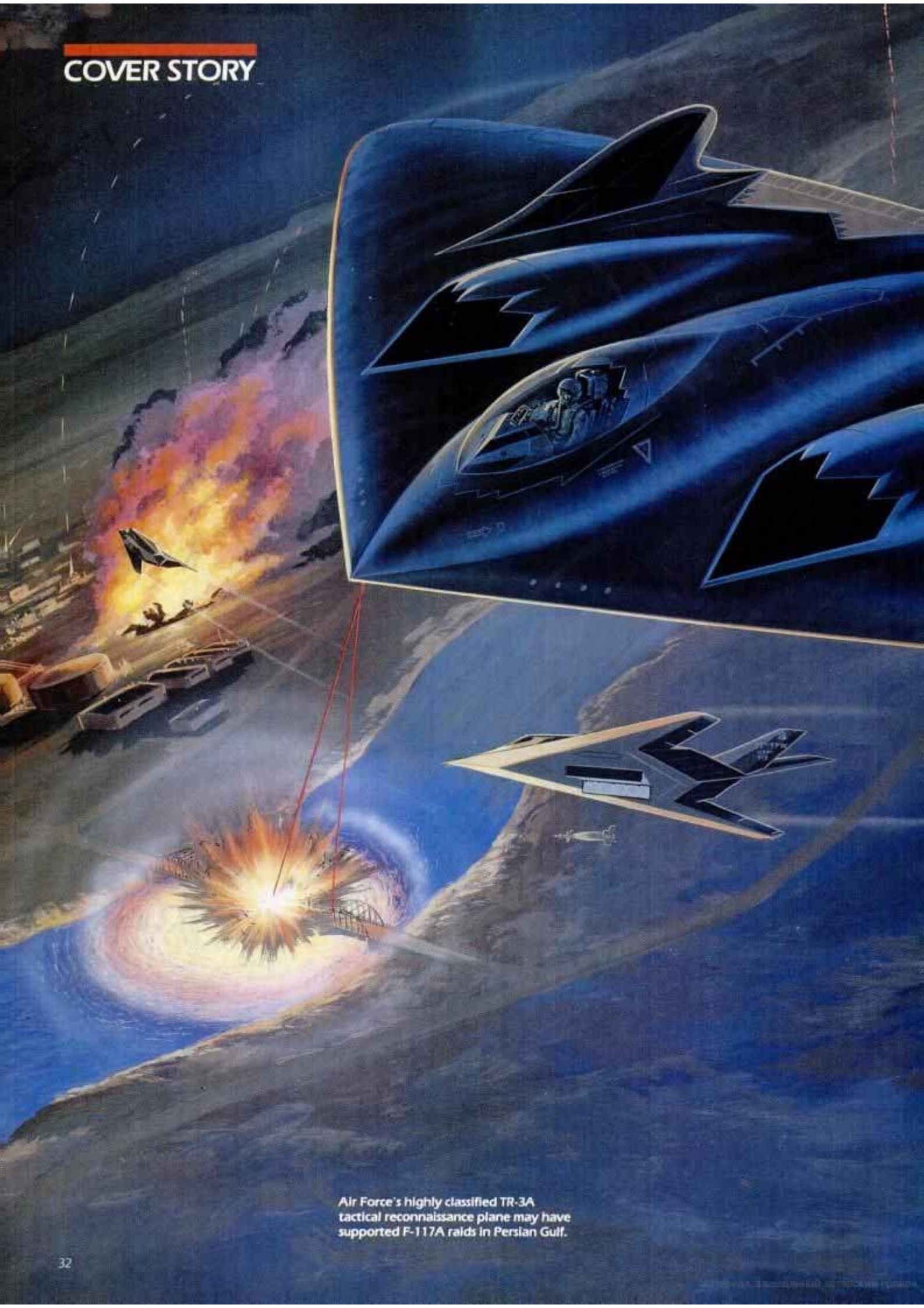
the change in relationship over time of 48 facial landmarks, such as the corners of the eyes and the nose.

Computers have enabled the National Center for Missing and Exploited Children to get thousands of age-progressed pictures onto milk cartons and flyers.

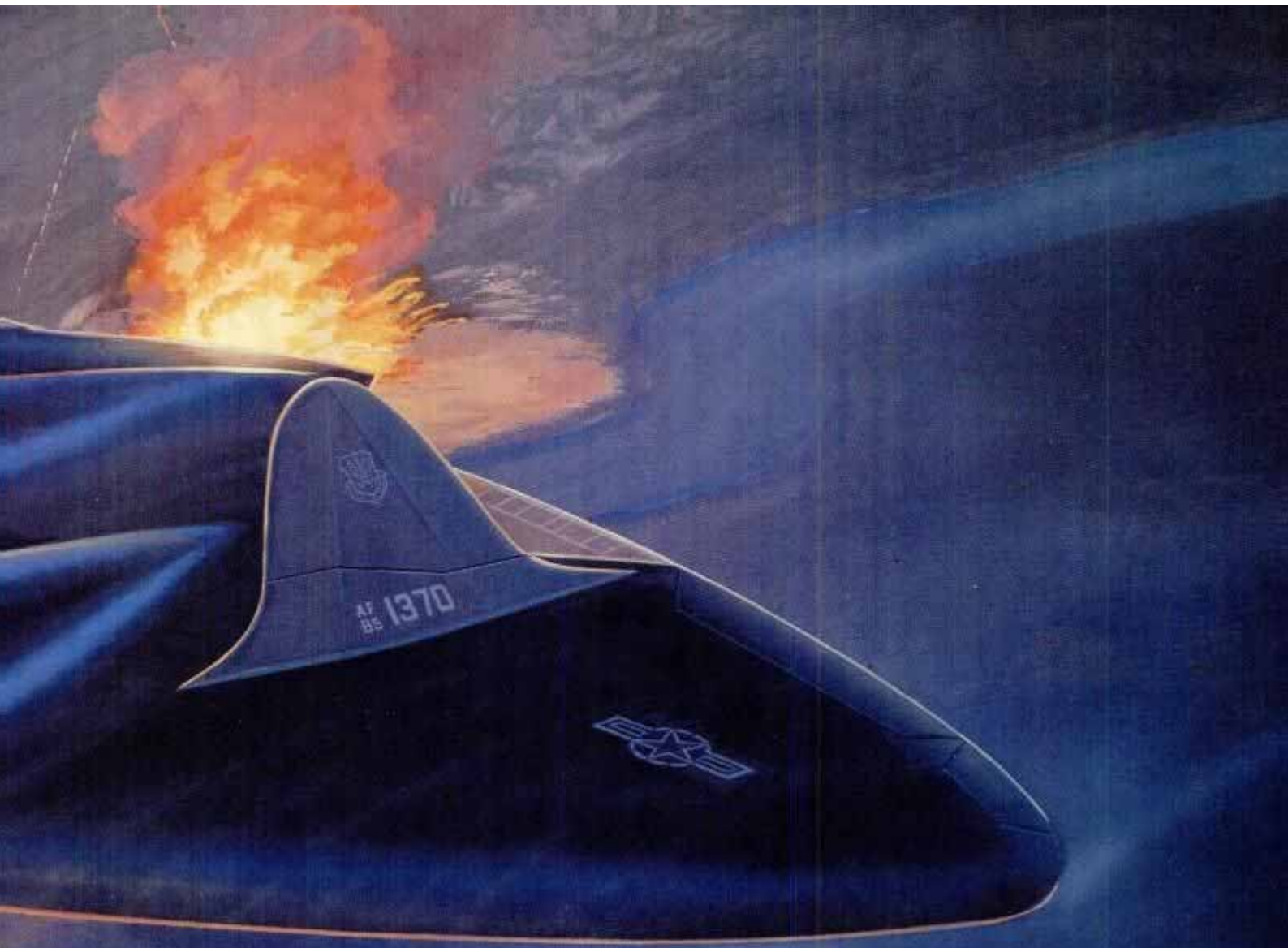
The FBI uses its own age-progression program for adult faces. The system allows artists to do such things as thin hair, add jowls or increase wrinkles while the computer maintains the basic facial proportions. FBI software for aging children's faces allows pictures of parents and older siblings to be fused into photos of missing children to obtain a more accurate image.

Another set of FBI image-processing techniques can be applied to the obscurities created by poor photography. Bank security cameras or other sources of photographic evidence often produce pictures in which vital details are blurred, out of focus or poorly lit. Technology developed by NASA to recover and enhance images from space probes has been adapted to correct many of these problems.

As computers and other advanced tools have worked their way into our criminal justice system, there have been gains not only in our ability to crack difficult cases, but increases in efficiency, which have made laboratory techniques practical in more and more investigations. Along with the advantages, however, has come new potential for abuse. For example, the same computer databases that make AFIS possible could also be used for random searches that might focus suspicion on people because they have stayed in a homeless shelter, or because they fall into certain categories based on age, race or other discriminatory criteria. Thus, the task of ensuring that upholding the law does not interfere with the privacy and freedom of those it is meant to protect grows simultaneously more difficult and more important. **PM**



Air Force's highly classified TR-3A tactical reconnaissance plane may have supported F-117A raids in Persian Gulf.



AMERICA'S NEW SECRET AIRCRAFT

Bizarre aircraft glimpsed in California's desert skies may herald a new generation of American air power.

BY GREGORY T. POPE; PM Illustrations by Mark McCandlish

● At midnight, traffic along Highway 138 has all but died. The Moon has yet to emerge, but stars shed enough light to silhouette the Joshua trees that dot the desert and the Tehachapi Mountains that rise to the north. Twenty miles to the southeast, the city lights of Lancaster throw a faint orange tint on a corner of the sky. Grasshoppers wheeze, pocket mice scuffle in the sand, a faded ranch sign creaks in the wind—otherwise, it is silent.

On nights like this, men and women have stood here and stared at the sky, looking for aircraft that officially don't exist. Some watchers spend the night and leave unrewarded. But others tell stories of lights that streak and maneuver across the heavens at impossible speeds, or triangular shapes that prowl silently overhead.

This corner of California's high desert, known as An-

telope Valley, has long served as a testing ground for ultraclassified, or "black," aircraft—from the P-59 Airacomet, America's first jet, to the F-117A Stealth fighter. Not only does the valley host Edwards Air Force Base, Air Force Plant #42 and associated contractor facilities, but test-flight paths from nearby China Lake Naval Weapon Center and the Air Force's Nellis Air Range in Nevada bring aircraft through restricted airspace into Antelope Valley.

But secrets stay closely held here. Those who know won't break their security vows. Those who think they've glimpsed the truth in the dark skies spoke anonymously to **POPULAR MECHANICS**, fearing reprisal in an area where the aerospace industry dominates employment. In the words of one local journalist, chasing secret activity "is like trying to catch smoke in a bottle."

AMERICA'S NEW SECRET AIRCRAFT

It's no secret, however, that in the past decade the Department of Defense has poured money into "black" programs. The Air Force alone has spent nearly \$46 billion on classified weapons procurement over the past five years, and another \$20.3 billion in classified research and development, according to an analysis by the Defense Budget Project, a nonprofit organization in Washington, D.C.

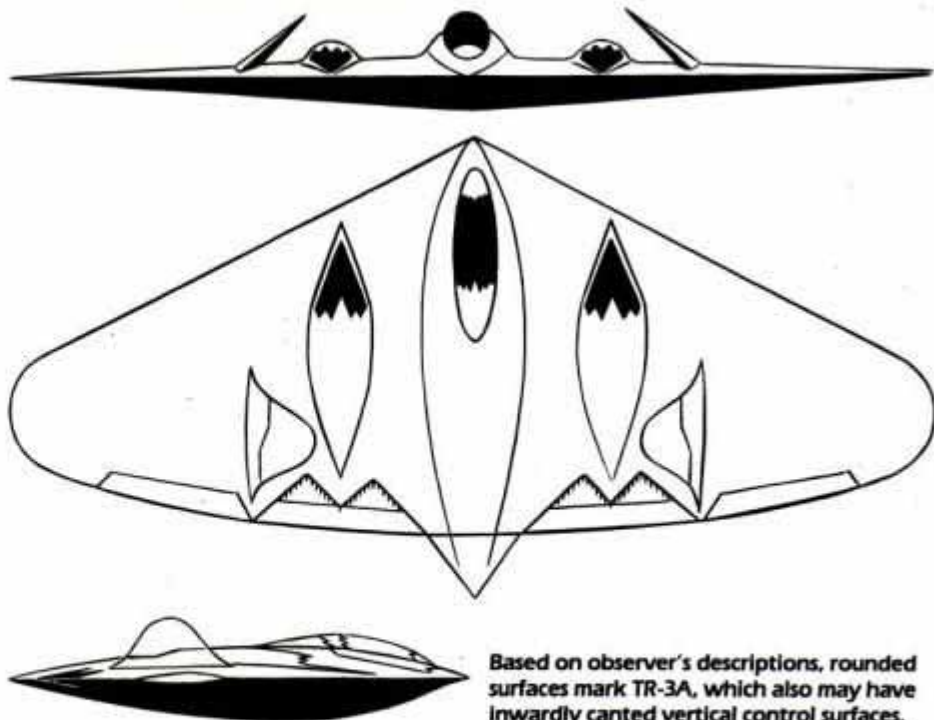
But tracing the flow of classified funds from the Pentagon to contractors reveals little about hardware. Eyewitness reports, even from unqualified observers, tell more. And a nagging consistency ties together accounts from individual eyewitnesses and lends credibility to their claims.

The vehicles in such anecdotes fall into three categories. First, observers have reported several different triangular aircraft with wingspans ranging from roughly 60 to 160 ft. Second, witnesses have described a high-speed, high-altitude vehicle, seen only as a yellow or orange light with a related pulsing engine roar. Finally, a black, silent, boomerang-shaped vehicle that stretches between 600 and 800 ft. across and performs circus-pony maneuvers at airspeeds as low as 20 knots. Asked to comment, Air Force Systems Command referred the inquiry to a Pentagon-based public affairs officer, Capt. Betsy Freeman, who issued this statement: "We have no aircraft matching these descriptions."

Black wings

Reports of the triangular planes come from the best-qualified eyewitnesses. Indeed, the journal *Aviation Week & Space Technology* asserts that one of these aircraft is the Northrop TR-3A, a classified tactical reconnaissance vehicle.

This plane, about 42 ft. long and 60 to 65 ft. in wingspan, appears to fly



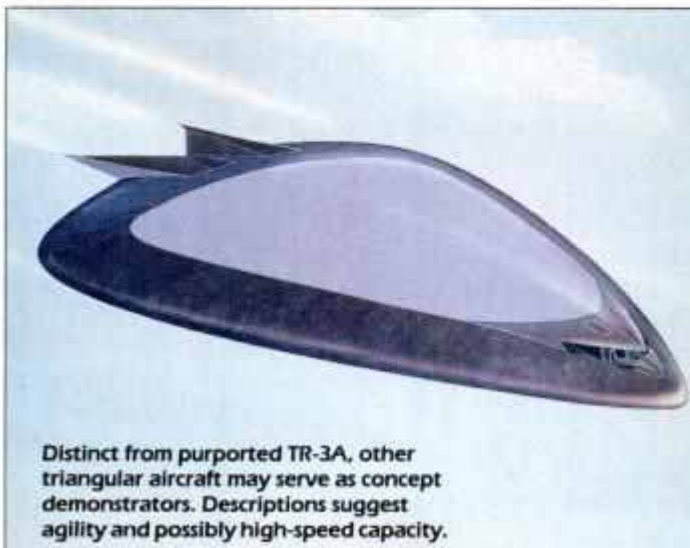
Based on observer's descriptions, rounded surfaces mark TR-3A, which also may have inwardly canted vertical control surfaces.

with the F-117As that pass one by one over Antelope Valley. Its engines reportedly run more quietly than the muffled General Electric F-404 powerplants on the Stealth fighter. Ground observations are inconclusive on whether any vertical control surfaces jut from the aircraft's back. Descriptions suggest the plane evolved from a top-secret Northrop prototype concocted under the Air Force's original Stealth program in the mid-1970s.

According to the *Aviation Week* report, the vehicle has a range of 3000 miles. Its mission: to collect tactical photographic reconnaissance data and relay target information directly to F-117As in near-real time. Apparently dedicated to Stealth fighter support, the TR-3A would supplant the RF-4C in carrying out low-level recon runs if it came into wider use. But if it's capable of high-altitude missions, as *Aviation Week* suggests, the plane

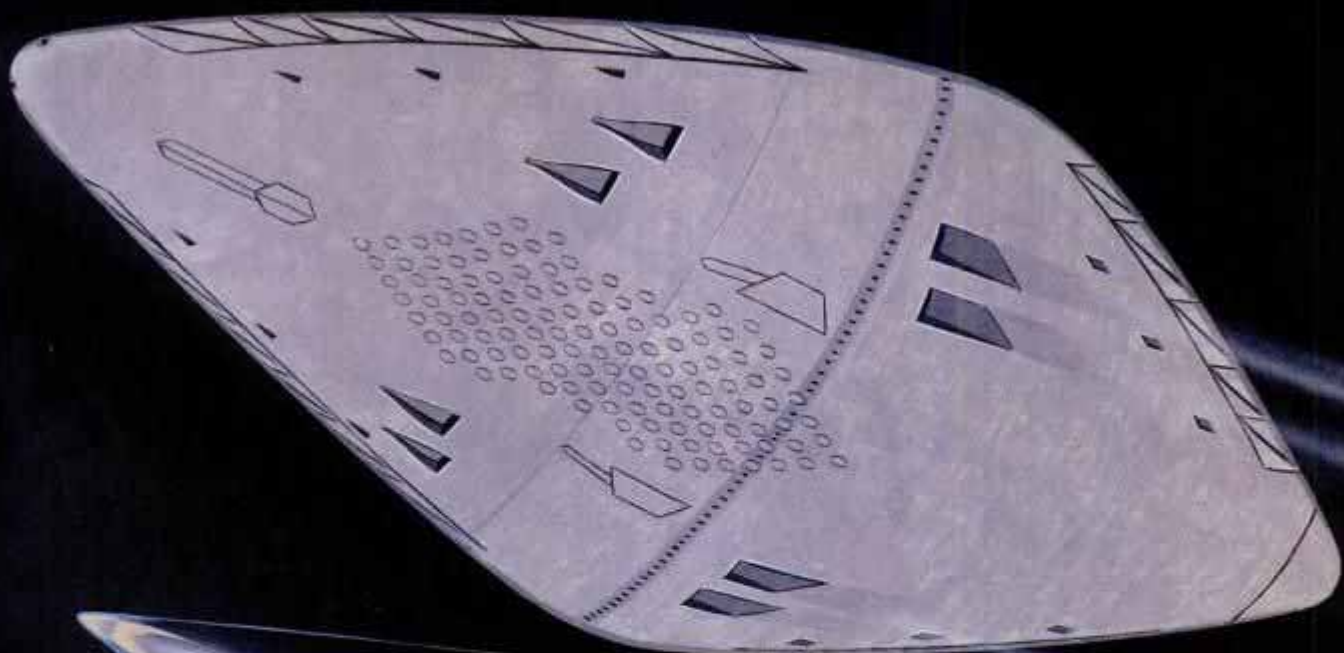
could also be a follow-on to the TR-1, a modernized version of the U-2 spyplane. Given the frequency of sightings and the association with F-117As, it's likely that the secret planes are operational and may have seen action during Operation Desert Storm.

Other reports of flying-wing triangles do not match the TR-3A descriptions. An aircraft with a wingspan close to 150 ft.—roughly that of the B-2 bomber—has been sighted by observers who insist that they can distinguish the B-2 at night. Unlike the purported TR-3A, this vehicle appears highly maneuverable. One is said to have turned 90° on its wingtip. Not spotted as often as the purported TR-3A, the craft may be a proof-of-concept vehicle for the Navy's now-canceled A-12 attack plane, an older technology demonstrator for the B-2 or a one-off experimental prototype.



Distinct from purported TR-3A, other triangular aircraft may serve as concept demonstrators. Descriptions suggest agility and possibly high-speed capacity.



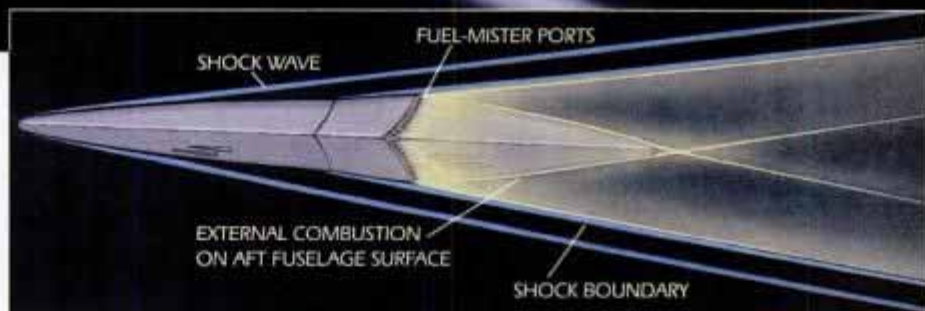


Blackbird's progeny

A separate species of air vehicle has been heard more often than seen. Several times in the past three years, a window-shaking din has awakened Antelope Valley residents between 3 and 5 am. They describe the sound as a "low-frequency buffeting," or a "pulsing roar"—"like the sky itself is tearing"—and distinct from the noise emitted by rocket engines.

Observers standing beyond the cast of streetlights tell of a swift, high-altitude light that accompanies the pulsing noise. "This object did a racetrack turn at high speed," one witness told *POPULAR MECHANICS*, "then shot straight up with tremendous acceleration." Another said the light moved from horizon to horizon—well over 100 miles—in under a minute. The descriptions correlate with reports from Nevada residents and other accounts in *Aviation Week*.

A high-flying, hypersonic vehicle has been the subject of speculation ever since a line item tagged "Aurora" appeared under a strategic-reconnaissance heading in a 1986 Pentagon procurement document. Thought to be a follow-on to the SR-71 Blackbird, analysts have placed Aurora at both Edwards Air Force Base and Nellis Air Range.



External-combustion ports [top] at mid-fuselage release fuel that burns in cone bounded by shock wave. Conventional jets [above] take over at low Mach numbers.

Whether an aircraft code-named Aurora is operational, experimental or simply a red herring, an air-breathing vehicle that flies above Mach 6 would probably rely on a novel propulsion method that might explain the pulsing sound. During the 1950s and 1960s, engineers researched external-combustion systems, whereby a hypersonic aircraft pumps fuel from its midsection into a cone of air bounded by its shock wave.

Ignited externally, combustion

gases expand against a nozzle surface shaped by the inner face of the shock wave and the aircraft's tapered aft fuselage. Such a system ensures that fuel and air stay in contact long enough to burn at high Mach numbers, says Gerald Gregorek, aeronautical engineering professor at Ohio State University. Even the scramjet, under development for the National Aerospace Plane, may function partially by external combustion.

(Please turn to page 109)

There's a passion that drives the more quality into

Six years ago, the people of General Motors embarked on a mission to build quality cars and trucks that rival the best in the world.

And we're doing it with a *passion*.

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That's how Chevrolet broke a 14-year-old Mercedes endurance record by pushing a stock GM engine for 28 straight hours and averaging over 173 miles an hour.

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MARK OF EXCELLENCE

PUTTING QUALITY ON THE ROAD

BUICK

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GMC TRUCK

ADVENTURE

TO THE YUKON

Glaciers, a thousand miles of dirt roads and the land of the midnight sun in GMC's new full-size sport/utility.

BY JOE SKORUPA, Boating/Outdoors Editor
PM Photos by Roy Attaway



● Sixty-six degrees, thirty-three minutes latitude north. The Arctic Circle. We officially enter the land of the midnight sun on a ribbon of dirt built above the permafrost. The recently graded road is in perfect condition. We haven't seen another vehicle for hours. Our tires spin at several clicks above the suggested speed limit, but we aren't in danger of being clocked by radar. "There's no highway patrol up here. All the police do is go back and pick up the pieces," explains a 10-year veteran of the Arctic, who we meet at the only gas station within 500 miles.

What are we doing here at the end of the Earth? Quite a few puzzled residents of the Yukon ask us this very question. We begin asking it ourselves after five



IN A YUKON

14-hour days of rugged driving. The answer is that Associate Auto Editor Mike Allen, photographer Roy Attaway and I are testing GMC's new full-size sport/ute, the Yukon. How do you test a Yukon? By driving it nearly 3000 miles from Banff, Alberta, to Inuvik, in the Northwest Territories. Face it, somebody has to drive the Yukon to the Yukon. It might as well be us.

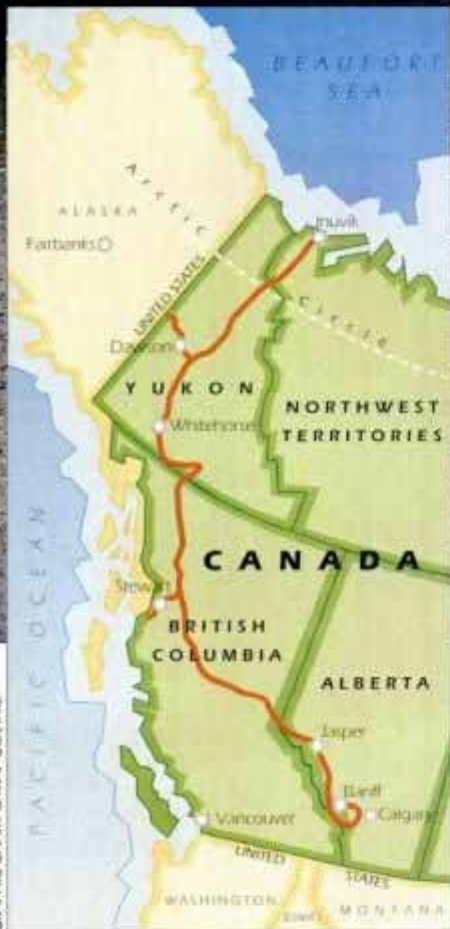
Northern exposure

We've come a long way since our first night in Banff, where we apply decals to the Yukon in the courtyard of a Scottish-style castle. We've come 2740.9 miles, to be exact, averaging 548.2 miles per day. This may not seem like a killing pace to marathon drivers, but consid-

er the route: only 250 miles on 4-lane highways, 1000 miles on unpaved roads and the remainder, about 1500 miles, on 2-lane blacktop that crisscrosses the Continental Divide. This isn't exactly cruise-control country.

It isn't country where you want to find unexpected trouble, either. After leaving Jasper, Alberta, on the second morning, we are generally more than 100 miles between gas stations and other outposts of civilization. On two occasions, on the Stewart-Cassair Highway, in British Columbia, and on the Dempster Highway, which links Dawson to Inuvik, we are more than 250 miles between fuel stops. In wilderness like this, you rely heavily on self-sufficiency and the dependability of your vehicle.

TO THE YUKON IN A YUKON



This page: Sunrise departure from the Banff Springs Hotel (top right), crossing the Yukon's Peel River to fish from a gravel bar (top left), the Athabasca Glacier in the Columbia Icefield (above), and a map of the 2740.9-mile adventure (left). Facing page: Spray Lake in Kananaskis Country south of Banff (top), blasting through mud on the Dempster Highway (far right), and a high five at the Eskimo Inn in Inuvik.

cope with heavy cargo, withstand off-road pounding and absorb whatever punishment the Arctic throws at us.

We spec out a Yukon that has a 350-cu.-in. V8 engine, 4-wheel drive, a 4-speed automatic transmission with overdrive, a 3.42 rear-axle ratio, Goodyear Wrangler GT off-road tires, a skid plate, gas shocks, a roof rack and a trailer package with heavy-duty cooling systems for engine oil, transmission fluid and the radiator.

Although we plan an early August departure, we think it wise to order a cold-climate package, which includes an engine-block heater, special insulation and antifreeze protection to -32° F. For appointments, we choose the upscale SLE trim level.

Looking down at the spec sheet, Pennell says, "This is going to make one hell of a back-country vehicle." He adds that a package similar to the PM vehicle will probably be offered as an option when the Yukon debuts. In fact, our torture test will be part of the vehicle's official post-production analysis, and our input will figure into what emerges as the ultimate off-road Yukon.

(Please turn to page 71)

The prospect of 1000 miles of dirt-road driving convinces us that the first item on our equipment list should be a heavy-duty winch. We request a Warn XD9000, which is powerful enough to pull us out of axle-deep mud. Other gear includes a toolkit, fuses, rope, two spare tires, a serpentine belt, oil, transmission fluid, extra fuel, camping gear, Columbia Sportswear team jackets and food for a couple of days.

Our most important piece of equipment, naturally, is the GMC Yukon, which we pick up in Calgary. It's one of the first pilot-production vehicles off the line, and we're among the first civilians to get a look at it.

Initial impression? It's a beautiful brute in brilliant red with a wide silver band extending across the lower

quarter panels and wheel flares. Body styling is clean and muscular, with a front end that features smoothly sculpted grillwork. But we're not here to judge a beauty contest. While the Yukon clearly takes its place among the best-looking sport/utes on the market, we're more concerned with how it will handle a 14-hour-a-day thrashing.

Call of the wild

For a shake-down trip to the far North, we want the Yukon outfitted for rugged duty. A couple of months before departure, we sit down with Dick Pennell, product line manager of GMC trucks, and comb through an early version of the specifications sheet. We set about outfitting a vehicle that can conquer high elevations,



Mush, You Huskies!



● After a generation of GMC trucks came off production lines alongside Chevrolets identical in every respect but the name badges, GMC's product planners decided it was time to inject some upscale differentiation in their lineup of vehicles.

They started with the new K-series Chevy Blazer (based on the current C/K Chevy pickups) and kept the stuff they liked, which included the dashboard. One welcome note in this respect is the excellent white-on-black instrument

package, replacing last year's rotating half-moons. On the other hand, the Yukon development team for some reason chose not to offer Chevy's in-dash CD option.

Mechanically, the Yukon is no lightweight at nearly 5000 pounds, and really does need the 5.7-liter V8's 210 hp and 300 ft.-lb. of torque. The new K-Blazer is almost half-a-foot longer than last year's, much to the delight of rear-seat passengers.

In spite of being a preproduction vehi-

Specifications	
Layout	Front-engine, rear-drive
Body style	2-door sport/utility
Engine	5.7L TBI V8
Tires	LT265/75R-16/C
Transmission	4A, part-time 4wd
Wheelbase	111.5 in.
Length	187.7 in.
Width	76.4 in.
Height	71.0 in.
Min. ground clearance	6.9 in.
Curb weight	4750 pounds (est.)
Fuel capacity	31 gal.
Brakes, f/r	Disc/drum, 4-wheel ABS

cle, built on a pilot assembly line, our Yukon remained delightfully squeak-and-rattle-free throughout this torture test. Exterior styling is the Yukon's strong point, and it attracted compliments from passersby everywhere we went—even on the tundra.

Although we needed 4-wheel drive only briefly during our odyssey, GM's repositioning of the transfer case shifter was welcome, as were the autolocking front hubs.

—Mike Allen



LOADED LINCOLN

Ford packs a Lincoln with the latest in communications and entertainment electronics. Come along for a ride.

BY FRANK VIZARD, Electronics Editor, and MIKE ALLEN, Associate Automotive Editor

● We were driving west on Interstate 96 toward Lansing, Michigan, when the fax machine began to spit paper. It was a message from the New York office reminding us of an appointment the following day.

We sent a fax back, thanking New York for the reminder and noting that we would be in Lansing for lunch. We also told them to check their computer since we were sending a text file via modem. Business done for the moment, we shut down the laptop computer, cranked up the compact disc player and settled back to enjoy the music and the ride—bumping the speed limit only a little.

If there'd been any back-seat passengers, now would have been a good time to watch a movie. The only difficulty would have been deciding upon which of the three television screens

to watch. With two videocassette recorders mounted below the screens in each of the headrests, a passenger could have watched two movies at once. Or he could make his own phone calls using the cellular phone installed for rear passenger use.

This car, as you might have guessed, is not your typical Lincoln Continental. Ford actually calls it the CCV, which stands for Communications Concept Vehicle. Best suited for those with near-gypsy lifestyles, the CCV is a vehicle for both work and play. While you can't get all these options today, the CCV does reflect the type of offerings Ford may present in the near future.

The major issue for Ford is how well this ancillary equipment fits into the automobile. For example, you'll notice that the cellular phone slides

out of the armrest for easy dialing, yet this is actually the backup system. Voice communication is hands-free, thanks to a remotely installed microphone. You hear callers through the stereo system's speakers. You don't even need to dial since the phone is voice-activated. Just ask the phone to turn itself on and say the name of the person to be called. The recognition system in the phone recognizes two voices and remembers up to 20 phone numbers. Talking to the disembodied voice of our secretary was initially disconcerting—it's as if you're talking to a ghost. You quickly get used to the idea, though, and it's safer than driving with a phone pressed to your ear.

Another good fit is the fax machine, which slides snugly under the dash when not in use. Likewise, a neatly installed infrared transmitter mounted



The Lincoln's front seat means business, while the back seat emphasizes entertainment. Steering-wheel controls (top) operate the radio, and rear passengers have their own remote (above). The teardrop antenna on the roof (below) is a distinguishing feature.

on the steering wheel sends basic commands to the radio via a tiny receiver attached to the dash. Rear-seat passengers can also control the radio with their own wireless remote control. This second remote is stored in a slot between the front seats.

Less cosmetically appealing are the armrest controls for the trunk-mounted compact disc changer and the digital sound processing (DSP) component. The DSP unit allows you to seemingly alter the acoustic environment so that it sounds like you're somewhere else other than in a car. The six DSP modes include stadium, hall and jazz club, plus three others. A second rocker switch allows you to "move" your seat farther away or closer to the performance. It's as if you had your pick of seats at a concert. DSP is a feature that will debut in the 1992 Ford Thunderbird, Mercury Cougar and Lincoln Mark VII with the optional JBL sound system.

If you want to do some private listening, hop into the back seat and plug the headphones into the audio-cassette recorder located beneath each VCR. You can also listen to either the VHS or 8mm VCRs, of course. Ford hasn't

quite settled on which of the three televisions is placed in the optimum location. The two televisions in the headrest are made by Sony, while the third is made by Hitachi. In any event, we wished the window glass had been tinted since the Sun tended to wash out the picture. The rooftop liner location does seem to be the more practical and economical spot since only one TV is then required. This TV, however, reduces your line of sight through the rearview mirror and leads one to reconsider the headrest locations. TV reception on the move is generally poor, so the VCRs are your prime video sources.

Perhaps the most remarkable feature of this Lincoln is the

cleverly disguised antenna array. The teardrop-shaped antenna on the roof is for a cellular phone and is the only indicator of the car's special features that a passerby might notice. A second cellular phone antenna is hidden in the rear door glass.

Antennas for the televisions are concealed in the rear windshield and rear bumper. The radio antenna is wired into the rear windshield and the front bumper. Both the TV and the radio use the better of the two signals being received.

Lunch in Lansing, by the way, was splendid even though we had to get out of the car.

PM



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Dodge Dakota Club Cab V-6

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Dodge Ram Club Cab Cummins Diesel



70
36

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The logo for the 1992 U.S. Olympic Team, featuring the letters "USA" in a bold, sans-serif font above the five Olympic rings.

IMPORTS '92



LAMBORGHINI DIABLO

POWER MODE

Improved performance distinguishes the 1992 import car crop.

BY TONY SWAN, Automotive Editor

● The bad news is that the number of makes in the American import car market for 1992 is diminished by two. After years of disappointing sales, both Peugeot and Sterling have folded up their U.S. operations.

The good news is that even with these departures, there are more and better cars to choose from than ever before. More power. More all-around performance. More style. More variety.

What all this adds up to is a very tempting range of choices for car shoppers, sweetened by the knowledge that it's still very much a buyer's market.

Here's what's new for '92.

Acura

Designed and priced to fit between the Integra and Legend lines, Acura's new **Vigor** sedan is aimed at younger, affluent buyers with a taste for performance.

Thanks to an all-new sohc 20-valve 2.5-liter 5-cylinder engine, that's what the Vigor delivers. With 176 hp

(and 170 ft.-lb. of torque), it's as quick as the bigger Legend and a little more agile, too.

As with the Legend, the Vigor's engine is mounted longitudinally, for better (60/40) weight distribution. Suspension is Honda's double wishbone, also like the Legend, with gas shocks and antiroll bars. Braking is a Vigor strength, with 4-wheel discs and 4-channel ABS.

Although the Vigor is a bit larger than the Honda Accord, it's clear that this car isn't intended for the basic family market, something that's underscored by the price, ranging from just over \$23,000 for the basic LS to \$26,000 for a Vigor GS with moonroof, CD player and leather upholstery.

Audi

Still on the comeback trail, Audi has an all-new **100** line-up for 1992.

With bigger interiors and a little more curb weight, the 100 series comes in three trim levels: 100, 100 S and



ACURA VIGOR GS

and 100 CS. The 100 has an attractive list of standard features—4-wheel-disc brakes with ABS, driver's air-bag, an alarm, central locking, power mirrors, cruise control, 8-speaker sound system, air conditioning—and the S and CS models add more.

A smooth new 172-hp normally aspirated 2.8-liter V6 is the only engine option for the time being (see Audi 100 CS First Drive), and Audi's all-wheel-drive Quattro system won't be

offered until spring. The price range is expected to run from just under \$30,000 to just over \$36,000.

In other Audi news, the Audi V8 gets a bump in displacement, from 3.6 liters to 4.2, raising output to 276 hp.

BMW

Just in at your local showroom, the new 325i is a pretty bold styling departure for BMW.

The new sedans are also bigger,

which translates as roomier. The wheelbase has been stretched, and the short 29.4-in. front overhang, working in league with suspension upgrades, produces exhilarating handling. Power comes from BMW's 189-hp dohc 24-valve 2.5-liter straight-Six, which produces sub-8-second 0-to-60 mph runs.

However, the 325's revitalization doesn't extend immediately to all members of the 3-series. The convert-

FIRST DRIVE

Audi 100 CS

● Aimed at Acura's Legend series, the new Audi 100 takes a big step forward in all-around agility versus its predecessor. And that's saying something, because the old 100 was a very good handling car.

The keys to this improvement are revised front suspension, stiffer components and a 30% increase in torsional rigidity. The new 100 seems even more Teutonic than the old, with a taut, athletic feel that most of the Japanese luxury sedans never quite achieve. It goes where it's pointed, it changes directions quickly and precisely, and it's devoid of surprises.

Pushed to its limits, the 100 CS responds pretty much like most front-wheel-drive cars, with progressive understeer. In this respect, it still gives something away to its sport sedan rivals from Bavaria. However, those limits are higher, thanks to a significant improvement in roll stiffness, limiting weight transfer and consequent mushy response. And this, in turn, inspires increased driver confidence.

It's also significant that Au-



di's chassis engineers managed to tighten up the new 100's handling without sacrificing anything in the way of ride quality. It's firm, but supple enough to keep small bumps and dips from disturbing the car's occupants. The new Audi's excellent seating helps in this department as well.

Audi has a new engine to go with

these improvements. The trademark Audi 5-cylinder has been replaced by an all-new 2.8-liter sohc V6, mounted longitudinally and driving the front wheels through either a 5-speed manual transmission or an electronically controlled 4-speed automatic.

Although 172 hp doesn't exactly produce nosebleeds, it was

enough to tow our 5-speed test CS to 60 miles per hour in less than 9 seconds. With the 100's superb road manners, it's also enough to make this car fun to drive on a fast stretch of back road.

Subtle but sweeping revisions to the sheetmetal give the whole 100 series a more contemporary appearance, and the redesigned interior is simple yet elegant in the Germanic style, particularly in the top-of-the-line 100 CS.

—Tony Swan

Specifications

Layout	Front-engine, fwd
Body style	4-door
Engine	2.8L sohc V6
Horsepower	172 @ 5500 rpm
Torque	184 ft.-lb. @ 3000 rpm
Transmission	5-speed man.
Track, f/r	60.1 in./59.8 in.
Wheelbase	105.8 in.
Length	192.6 in.
Width	70.0 in.
Height	56.3 in.
Curb weight	3407 pounds
Mpg (EPA) city/hwy.	19/26
Cargo capacity	16.4 cu. ft.
Steering	Rack and pinion
Turns lock-to-lock	3.1
Brakes, f/r	Disc/disc, ABS
Tires	195/65HR-15



LEXUS SC400

ible will continue in the old body style until spring before it gets a new skin, and Coupe versions will be along sometime next spring. Look for 325i pricing to start at about \$28,000, topping out just over \$30,000.

Geo

Besides more power from a new 1.8-liter dohc 16-valve Four—140 hp—look for minor cosmetic changes fore and aft in the **Geo Storm** lineup.



MAZDA MX-3

Honda

Just about the time the rest of the world is catching up, Honda redefines the subcompact car with another update on its pace-setting Civic series. The latest Civics are longer, wider, roomier, more aerodynamically efficient, with more power available for those who want it and greater economy available to those who value mpg.

There's also more differentiation between the Civic Hatchback and Civic Sedan, which rides on a longer wheelbase than the 3-door cars.

Engine options range from the CX's miserly 70-hp sohc 1.5-liter Four to a 125-hp 1.6-liter dohc 16-valve Four, and there are fuel-economy improvements across the board.

Chassis rigidity has also been improved, and the Civic EX Sedan includes antilock brakes.

With seven different models in two body styles, Civic pricing will cover a broad range, starting at about \$7500 and ranging upward of \$13,500.

Honda is also offering a brand-new **Prelude** for 1992. The new Preludes ride a shorter wheelbase, have a wider stance and are shorter overall, but there's also big news under the hood.

Although length has been reduced, the new Prelude is roomier inside. Prices are expected to begin at about \$15,500 for the Prelude S and top out as high as \$24,000 for a loaded Si.

Hyundai

While we still tend to think of Hyundai in terms of basic transportation, Korea's No. 1 carmaker has four different nameplates, ranging from the facelifted **Excel** right on up to the compact segment, where a redesigned **Sonata** awaits '92. Besides its stylish new snoot and interior trim changes, the Sonata gets a new 128-hp dohc 16-valve Four as its basic powerplant.

However, Hyundai's biggest news is the **Elentra**, an all-new subcompact sedan conceived to slot in between the Excel and Sonata, with impressive standard features and peppy performance from a 113-hp dohc 16-valve Four. Elentra pricing is between \$10,000 and \$12,500.



MAZDA 929

The new Si engine, an undersquare dohc 2.3-liter 16-valve Four, makes 160 hp, compared to 140 for the previous Si, giving the Prelude a new lease on life (see Prelude First Drive on page 48). A 135-hp 2.2-liter sohc 16-valve Four powers the basic Prelude S.

Infiniti

Although Nissan's luxury-car division is standing pat this fall, watch for an all-new car—the **J30**—later in the year. The Jaguaresque sedan will slide between Infiniti's G20 and M30 in size and price.



HONDA CIVIC HATCHBACK



HONDA CIVIC SEDAN

PHOTOS BY HUMPHREY SUTTON

ISUZU

We're one month away from Isuzu's biggest news for 1992—the new Trooper II. Meanwhile, Isuzu's sporty Impulse coupe—known to Chevy as the Geo Storm—and Stylus sedan get a new 140-hp dohc 16-valve 1.8-liter 4-cylinder (XS models only).

Lamborghini

You probably thought that the 492-hp 205-mph \$240,000 Diablo was fine just

the way it was. Nevertheless, you may have the option of a semiautomatic transmission and all-wheel drive in late '92.

Lexus

It's been a busy year at Lexus. Although the flagship LS 400 is unchanged, there's a new coupe version to go with it—the SC 400—and a new cast of supporting players in the ES 300 sedan and SC 300 coupe.

While the SC 400 shares the sedan's basic platform and smooth 250-hp dohc 32-valve V8 engine, it's been massaged for livelier handling response. It also has its own distinctive look, thanks to Toyota's California-based Calty Design Research center.

Price range: \$32,000 to \$40,000.

As in the first Lexus ES series, the ES 300 and its coupe counterpart share a good many mechanical pieces with the Toyota Camry, including the potent new 185-hp dohc 24-valve 3.0-liter V6. However, these two newcomers are much more distinct from the new Camry range, with luxury appointments commensurate with a \$25,000 to \$30,000 price range.

Lotus

The 2-car Lotus family—Esprit and Elan—are largely unchanged for 1992, although revisions to the Esprit improve interior volume. A remov-

FIRST DRIVE

Honda Prelude Si

● The one consistent rap on previous generations of the Prelude has been tepid power. Well, they've fixed that in the new Prelude Si. With a brand-new 2.3-liter 16-valve Four pumping 160 hp to the front wheels, things happen a lot quicker—0-to-60 in about 8 seconds, for example, which is at least a full second quicker than the old 2.1 Si. In a class that's crowded with several attractively priced rip-snortin' turbocars, that's an important improvement.

Honda's Prelude engineering team has been busy underneath the car, too, tweaking the double wishbone suspension to help it keep up with the power increase. Combined with a shorter wheelbase and wider track, it gives the Prelude Si a much different feel—more aggressive and more precise than the previous car.

It still falls a bit short of having sports car response, but it should measure up quite well in comparison tests. Honda's engineers have also redesigned the Prelude's optional 4-wheel steering (see "Engineering The '92s" on page 51), though we're still not sure if we prefer 4ws to the standard kind.

We're sure about the Si's new looks, though. Preludes have been pretty conservative compared to the rest of their competition, but the new 'lude is loaded to the windowsills with sex appeal and individuality. It's a look that lays down a challenge—and with that new 2.3-liter engine it's got the muscle to back it up.



As we expect from Honda, there are improvements inside the car, too. Besides shortening the wheelbase, Honda also reduced overall length, but even so, the new Prelude feels roomier than the old one. Not to mention the fact that it's more comfortable and ergonomically up-to-the-minute.

It feels like a winner. —Rick Titus

Specifications

Layout	Front-engine, front-drive
Body style	2-door 2+2 coupe
Engine	2.3L dohc 16-valve L4
Horsepower	160 @ 5800 rpm
Torque	156 ft.-lb. @ 4500 rpm
Transmission	5-speed manual
Track, f/r	60.0 in./59.6 in.
Wheelbase	100.4 in.
Length	174.8 in.
Width	69.5 in.
Height	50.8 in.
Curb weight	2866 pounds
Mpg (EPA) city/hwy.	22/26
Steering	Power rack and pinion
Turns lock-to-lock	2.9
Brakes, f/r	Vented disc/disc
Tires	205/55R-15

PHOTOS BY HUMPHREY SUTTON

able hardtop and ABS will appear on Elan order blanks at midyear.

Mazda

After years of solid but unexciting cars, Mazda is suddenly making show-stealers. The first, of course, was the Miata roadster, which is unchanged for 1992. But new describes just about everything else in Mazda's arsenal.

First in this category is the nifty little MX-3 sports coupe. Targeted on Honda CRX territory, the MX-3 offers a back seat and the smallest V6 engine in autodom—a 130-hp 1.8-liter dohc 24-valve smoothie. Base engine for the MX-3 is an 88-hp 1.6-liter dohc 16-valve Four. Pricing ranges from \$10,500 to \$15,500.

At the top of the Mazda spectrum is the stylish new 929. Besides its good looks, it offers ride refinements and a much-revised 3.0-liter dohc 24-valve V6 that's a bit more potent (195 hp versus 190) and much smoother. Price range: \$28,000 to \$32,000.

Mercedes-Benz

After a run of 11 years, there's a new line of Mercedes S-Class Sedans, automobiles that make a compelling claim as best-on-the-planet. Bigger, roomier, heavier, slicker (0.31 Cd) and totally reengineered, the cars



MERCEDES 600 SEL

stress safety and environmentalism.

For example: Plastic body parts are coded to promote recyclability. The a/c system is the first to avoid ozone-eating refrigerants. The ABS system is double-acting, optimizing, among other things, rear-brake effect.

Five models will be available initially—the 300SE and SD, 400SE, 500SEL and 600SEL. The engine family includes a 228-hp dohc 24-valve 3.2-liter inline-Six, a 148-hp sohc 3.5-liter 6-cylinder turbodiesel, a 282-hp dohc 32-valve 4.2-liter V8, a 322-hp dohc 32-valve 5.0-liter V8, and for the 600SEL, a 402-hp dohc 48-valve 6.0-liter V12. Pricing will range between \$66,000 and \$125,000.

Mercedes will also broaden its mid-size 300-series with the addition of the 400E, powered by a 282-hp V8.



SUBARU SVX

Mitsubishi

Introduced earlier this year, the new Diamante is Mitsubishi's first venture into the luxury market. Available in two trim levels, with two engine options—a 175-hp sohc 3.0-liter V6 and a 202-hp dohc 24-valve version of the same engine—the Diamante offers distinctive styling, smooth operation and a host of high-tech goodies.

Conceived as a Legend/929/Lexus ES 300 competitor, the Diamante rates as a bargain at the bottom of its range—just under \$20,000—and a value at the \$30,000 top.

Mitsubishi's recently introduced (see *New Cars*, page 88, Aug. '90) Expo and Expo LRV lend new confusion to the minivan/station wagon bat-

Engines are a 113-hp sohc 16-valve 1.8-liter Four for the LRV, and a 116-hp 2.4-liter sohc Four that's much quieter. All-wheel drive is available, as is ABS. Prices range from \$11,169 for a basic LRV to \$16,539 for the Expo.

Nissan

Nissan's major '92 news—the NX coupe—came along in early 1991. It's available with a 110-hp dohc 16-valve 1.6-liter Four or the NX 2000's potent 140-hp dohc 2.0-liter 16-valve Four.

Elsewhere, the Maxima gets a very modest facelift and more power (see "Engineering The '92s" on page 51).

Porsche

New sheetmetal is rare at Porsche, and that alone makes the new 968 interesting. With an all-new 928-style front-end, it's the first major redesign of the 944 line since its introduction.

However, even more interesting is the 968's 3.0-liter dohc 16-valve Four. Thanks to Porsche's new VarioCam variable-cam timing system (see "Engineering The '92s"), the engine produces 236 hp, compared to its previous 208, and 225 ft.-lb. of torque.

Braking is as impressive as the go-power, with 4-piston calipers, bolstered by ABS, squeezing vented rotors at all four corners.

Inside, the 968's layout is reminiscent of the 911 series, and there are airbags for driver and passenger. Look for pricing to start at about \$45,000 and top out above \$50,000.

tleground. Smaller than most minivans but taller than station wagons, the Expo and smaller Expo LRV (light recreational vehicle) are versatile and well designed inside.



PORSCHE 968

Subaru

Making a determined effort to shake off its sensible-shoes image once and for all, Subaru is entering the 1992 sport-coupe derby with a truly new 2+2, the SVX.

The new 230-hp dohc 24-valve SVX flat-Six is covered on page 51. Suffice to say it can propel this big (3525 pounds) coupe to 60 mph in less than 7.5 seconds.

The powertrain is a cornucopia of high tech, with microprocessor-controlled awd offering variable front/rear torque split and a limited-slip rear differential. A 4-speed automatic is the only transmission available. Brakes are 4-wheel discs with ABS.

Pricing ranges from \$25,000 to \$28,000.

Toyota

Anyone who thinks competition doesn't improve consumer products should take a look at Toyota's new Camry series. Longer, wider, sexier and more refined, these new midsize sedans are for the first time bigger than the Honda Accord and are some of the roomiest cars in the class.

They're also more powerful, with

130 hp available in the standard 2.2-liter dohc 16-valve Four, and 185 hp from the new 3.0-liter dohc 24-valve V6 (see Camry SE First Drive).

Safety features include driver's airbags in all models, and across-the-



VOLKSWAGEN GOLF GTI

board availability of antilock braking.

The new Camry will be available in four trim levels—DX, LE, XLE and SE—with prices expected to range from about \$12,000 to over \$20,000.

Introduced in mid-'91 as an early '92, Toyota's all-new Paseo is a nifty little 2+2 coupe based on the Tercel platform, with suspension tweaks to

improve handling response.

The 100-hp 1.5-liter dohc 16-valve 4-cylinder engine isn't in the same league as the tigers of this class (CRX Si, Nissan NX 2000, Mazda MX-3). But 100 hp in a good-handling 2000-pound car that's also cute adds up to a lot of fun—especially when the base price is under \$10,000.

Volkswagen

Just introduced in Europe and due in U.S. showrooms in late '92, the new VW Golf follows the trend of most new small cars—it's bigger, roomier and more powerful.

While the new car is filled with interesting technical and safety features, one of the most intriguing is its premium engine, VW's long-awaited narrow angle (15°) V6. Watch for our preview

report next month.

Volvo

Volvo's 9-series sedan lineup gets a new flagship for '92—the 960. The distinguishing feature is a 201-hp dohc 24-valve straight-Six. Pricing for the 9-series starts at \$28,500 and soars to almost \$36,000. **PM**

FIRST DRIVE

Toyota Camry SE

● Honda's Accord may hold the high ground in the midsize family sedan market, but Toyota is poised for yet another assault with its bigger, better and much more potent new Camry. And the hottest weapon in the new Camry battle plan is the SE.

Abandoning the conservative look of previous Camrys, the SE has all the go-fast aesthetic touches: deck spoiler, blackout moldings and V-rated tires on 15-in. alloy wheels. Transmission options—5-speed manual or 4-speed automatic—are familiar, but performance of the 3.0-liter dohc 24-valve V6 is a distinct step forward from the previous car. Even though the Camry has gained a couple hundred pounds, the V6 has gained almost 30 horsepower, reducing the car's power-to-weight ratio from 19 pounds/hp to 17.

Bolt that gain to a close-ratio 5-speed and 3.93:1 final drive (lower than the automatic) and—zingo!—the SE will run with anything in its class.

Although the Camry chassis has also had a few tweaks—longer wheelbase, wider track—it's not quite as sporty as the powertrain. The SE has a quicker steering ratio than other Camry models (15.9:1 versus 17.4:1) and stiffer spring, shock absorber and antiroll bar rates, but it still leans more toward pleasant ride quality than hot slalom runs.

On the other hand, like the rest of the new Camry clan it's exceptionally good to look



at, extremely quiet, quite a bit roomier than its predecessor, gratifyingly quick out of the blocks and totally predictable in its handling. When the SE hits Toyota showrooms in January, we think a lot of buyers will find the combination irresistible.

—Don Chaikin

Specifications

Layout	Front-engine, front-drive
Body style	4-door
Engine	3.0L dohc 24-valve V6
Horsepower	185 @ 5200 rpm
Torque	195 ft.-lb. @ 4400 rpm
Transmission	5-speed manual
Track, f/r	61.0 in./59.0 in.
Wheelbase	103.1 in.
Length	187.8 in.
Width	69.7 in.
Height	55.1 in.
Curb weight	3153 pounds
Mpg (EPA) city/hwy.	19/25
Cargo capacity	14.9 cu. ft.
Steering power	Power rack and pinion
Turns lock-to-lock	3.0
Brakes, f/r	Vented disc/disc, ABS
Tires	205/65VR-15

ENGINEERING THE '92s

Refining and retuning for comfort and performance.

BY PAUL WEISSLER

● Powertrain refinements, particularly refinements to the engine itself, dominate the import-car tech news for 1992. And while most of these refinements are aimed at improving power output, they're strongly influenced by packaging considerations. Even though displacements tend to be modest, dohc valvetrains and complex induction systems usually mean there's quite a bit of engine to squeeze into quite a small space.

Subaru's answer to this packaging problem has been a long series of horizontally opposed engines. The latest of them, powering the sporty new SVX, is among the performance leaders in its class, with 230 hp and 228 ft.-lb. of torque from 3.3 liters. GM's Twin Dual Cam V6, by way of contrast, makes less hp (210) and less torque (215 ft.-lb.) with more displacement (3.4 liters).

The dohc 24-valve SVX flat Six is just over 20 in. long, about 7 in. shorter than similar V6s. It's about 32 in. wide, roughly the same as a typical dohc V6. And it's less than 24 in. high, which works in nicely with a short, sloping hoodline.

Length, however, was the critical dimension, since Subaru's engineers wanted to get a longitudinal front-drive system into the SVX's compact engine bay. One of the keys to this tidy package was the use of extremely narrow crankshaft counterweights. The north-south mounting helps to quell the low-speed vibrations that seem inherent in transverse-engine setups, and silicone-filled engine mounts damp out the rest.

Although the new Six has only 50% more displacement than the Legacy's flat Four, it produces about 80% more horsepower. Here's how: The four cams act directly on the valves, promoting optimum size and location in

the high-compression (10:1) pentroof combustion chamber.

The crossflow heads are fed from a tuned intake manifold with a divided plenum for sonic wave air-ramming. The divider is a motorized flap valve controlled by the engine computer,



SUBARU SVX FLAT SIX

Subaru SVX flat Six sports 24 valves, 230 hp in an extremely compact package.

opening at 4200 rpm to change the manifold's resonant frequency for high-end performance.

Chain, chain, chain

As with Subaru's flat Six, Nissan had to do some redesign work to shoehorn more muscle into the '92 Maxima. Nissan wanted to substitute the dohc 24-valve version of its 3.0-liter V6 engine

for the 2-cam, 2-valve edition.

However, a belt-driven 4-cam engine would have been at least 32 in. wide, leaving no room for the tuned air-induction system. Even a standard chain-drive setup was too bulky. Instead, Nissan came up with a 3-chain system. Two of the chains connect the camshaft sprockets (one per pair) with idler sprockets halfway between the cams and the crankshaft. A third chain wraps around both idler sprockets and the crank sprocket to complete the drive.

Result: The 4-cam engine is only 28.5 in. wide, just 1.7 in. wider than the 2-valve engine, and it makes 30 hp more—190 versus 160.

Variable valve timing

Variable valve timing gains wider acceptance in '92, as both the Honda Civic and Nissan Sentra help bring this refinement to the less expensive end of the market. In

fact, the Civic has two systems, and like the one introduced on the \$60,000 Acura NSX, each changes a cam profile, too. The attention-getter is on the 92-hp 1.5-liter Four, because it's part of a lean-burn fuel system, where the air-fuel ratio is an average of 24:1, compared to the more customary, chemically correct 14.7:1 ratio.

Although there are two intake valves, only the primary one operates at low speed, where it promotes good mixture swirl for maximum fuel economy (the other is virtually closed). Above 2500 rpm, a solenoid valve feeds pressurized oil to the primary rocker, where it pushes a plunger that slides into the second intake rocker, locking the two together so both open

and close according to the camshaft profile of the primary rocker.

With the aid of a special sensor, the engine runs super-lean, although the spark-plug tip is in an area locally rich in fuel to promote good combustion. The system boosts fuel economy about 10%, but doesn't meet California emissions standards.

Lean burn is not used on the optional 125-hp 1.6-liter Civic engine, which has a variable valve-timing system more like the NSX. With this system, two intake valves operate on their own cam and rocker at low speed. At higher rpm, the plunger locks the two rockers to a third, which has a more aggressive, high-speed profile.

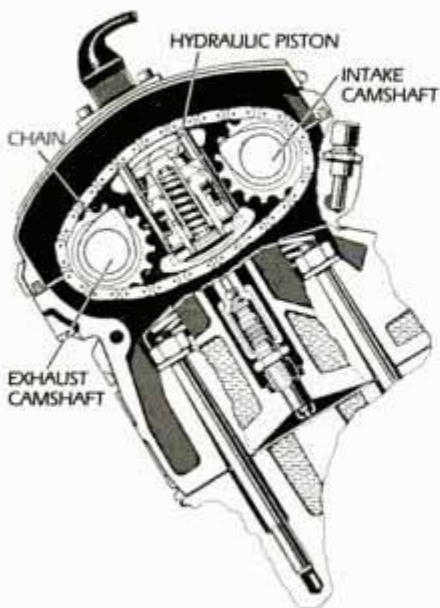
Porsche variation

Still another approach to variable timing has been taken by Porsche on the new 968. A hydraulic plunger, controlled by the engine computer, operates against the guides for the chain that drives the intake camshaft from the exhaust cam. By changing the path of the chain between the sprockets, the intake cam is advanced $7\frac{1}{2}^\circ$, from 1500 rpm to 5500 rpm.

Hydraulic fan control

Precise control of radiator fan speed is a key to more efficient engine operation, but it's complicated to offer more than two speeds. The '92 Toyota Camry has a novel answer: a fan operated by a hydraulic motor that's infinitely variable.

Between the pump and the hydraulic motor is a solenoid, controlled by

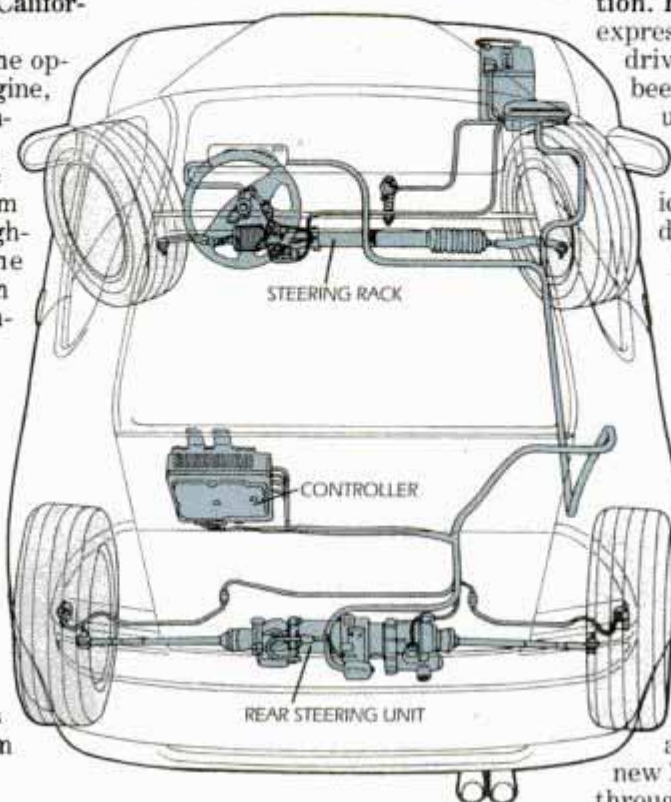


Porsche 968 uses novel approach to variable cam timing by moving chain between cams.

the engine computer, that operates a hydraulic valve. The computer pulses the solenoid to set the fan speed.

Honda Prelude 4ws

Although the '92 Prelude has a lot more power, its new 4-wheel-steering



Prelude 4-wheel steering uses electric motor to drive recirculating-ball rear steering.

option is the engineering centerpiece. The all-mechanical system is gone, replaced by a computer-controlled electric motor operating a recirculating-ball gearbox to steer the rear wheels.

With the computer in control, the system not only responds to vehicle speed, but also to how much and how quickly you turn the steering wheel.

At parking-lot speeds (up to 18.6 mph), the rear wheels turn opposite the front wheels. At higher speeds, the system has the ability to turn the rear wheels either in the same direction as the front—which is generally the case—or opposite, depending on different sets of variables.

Double windows

One of the many subtle touches in the new Mercedes-Benz S-Class sedans is double-pane windows in all the doors. The door glass is insulated double-pane, which is highly resistant to fogging in cool, damp weather, and provides the same thermal effect as in a house, keeping the interior of the car warmer in winter, cooler in summer.

Double glass is also particularly effective at keeping out noise.

The panes are 3mm thick and separated by a 3mm gap. The inner pane is

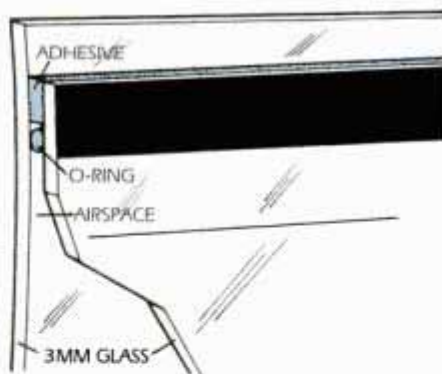
the one that actually rides in the door channel. It's larger than the outer, which is flush with the body for good aerodynamics.

All four power windows have an express-up, as well as express-down, feature, in addition to normal operation. Except for Subaru, which has express-down and -up on the Legacy driver's window, carmakers have been reluctant to provide express-up for fear of some mishap, such as trapping a hand. Mercedes has adapted the stop-automatic reversing switch of the garage door opener—so if the window makes contact with an obstacle, it stops and lowers the window about an inch.

The S-Class also proves that Mercedes can provide bells-and-whistles with the best of the Japanese. When the transmission is shifted into Reverse, two parking guide rods project about 3 in. from the tops of the fenders. The rods, pushed by pressure from an air pump, retract after shifting out of Reverse.

Audi underfoot

Audi has a new V6—2.8 liters and 172 horses—to power its new 100 series, but there's high-tech throughout the car. One particularly nifty touch is the carpet, a huge, single piece with an insulating foam



Mercedes S-Class sedans use double-pane glass for insulation, reduced wind noise.

back, to keep out floor pan buzzes. Besides making the 100's interior quieter, the new carpeting makes it tidier, too—no more irregularly cut seams or unraveled loops.

Solar ventilation

Although solar cars are experimental, the '92 Mazda 929 sedan offers a practical use for solar energy—operating a fan that vents hot air from the interior of a parked car. Power comes from solar electric cells in the optional moonroof. When it's cold, the current goes to recharge the car battery. **PM**

JOURNAL



SHOP PROJECT

TREASURED CHEST

Build this classic, reproduction cherry chest of drawers.

BY NEAL BARRETT

● This chest, a reproduction of the style known as American Chippendale, has its origins in England. Furniture design in Colonial America was strongly influenced by the styles popular in England, where the work of Thomas Chippendale had become extremely important. People were

struck by Chippendale's unusual and graceful designs, which proved to be so durable, they are widely reproduced today, 200 years after he lived.

This chest combines the best of traditional features, such as dovetailed drawers with state-of-the-art construction methods, like plate joinery

to form the panels. While this approach might not appeal to the purist, it yields a first-class piece of furniture. Lacking a plate joiner, you can also use dowels to join the panels or carefully glue them together without any alignment device.

In keeping with traditional tastes, our choice of lumber was cherry with maple for drawer sides and backs. If, however, you wish to substitute maple, birch, walnut or pine for the case and drawer parts, the results would be equally appealing.

Color photo: J.R. Rost
Black-and-white photos: Neal Barrett
Technical art: Gene Thompson
Photo stylist: Gabe Herrick

Building The Case

Rip $\frac{3}{4}$ -in.-thick stock, slightly over width for edge-gluing to form the case panels. Lay out the joining plates 6 to 8 in. on center along each piece to be edge glued. To cut the plate slots, hold both the workpiece and the joiner flat against the table saw top (Photo 1). Apply glue to the plate grooves and edges to be joined. Install the plates (Photo 2), and clamp the panel.

Rip and crosscut the panels to finished size for the case top, bottom and sides. Allow for a slight amount of wood to be removed in jointing off the saw marks. If you use a table saw, use a sliding table crosscut jig (Photo 3) to achieve maximum accuracy.

Rip and crosscut the parts for the drawer support frames and top stretchers. Lay out and bore the mortises with a $\frac{1}{4}$ -in.-dia. bit, making a series of overlapping holes. Pare each mortise square with a chisel (Photos 4 and 5).

Using dado blades in the table saw, cut the tenons on the frame members (Photo 6). Clamp a stopblock to the saw table to ensure the tenons are the same length. Readjust the blade height, and cut the tenon shoulders.

Glue and clamp the drawer frames, and check each frame for square by measuring the diagonals. Readjust the clamps if necessary to bring the assembly into square, then let the glue set.

With a $\frac{1}{2}$ -in.-dia. dovetail bit in the router table, cut the dovetail along both sides of the drawer support frames (Photo 7). Use a piece of scrap lumber to test the cuts before proceeding with the frames.

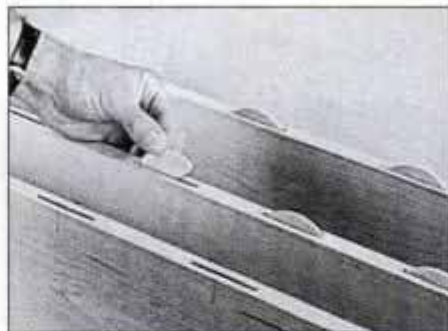
Lay out and cut the dovetails on the stretchers (Photo 8), and trace the dovetails to lay out their mortises on the top edge of the case sides. Cut the mortises with a dovetail bit in the router (Photo 9). Finish each mortise with a sharp chisel.

Next, mark and cut the sliding dovetail grooves in the case sides. Each groove requires two passes of the router (Photo 10). Clamp a straightedge guide to the work on each side of the router and clamp a wood strip on both sides of the panel to prevent splintering where the router bit exits. The dovetails should fit snugly in the grooves but should not require force to fit.

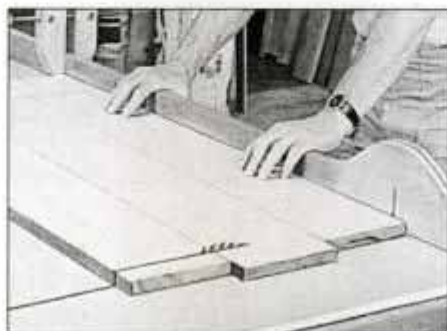
Cut the rabbet along the back of the case sides with a router, straight bit and an edge guide. Next, mark the location of the dowel holes on the bottom edge of the case sides, and use a doweling jig to bore the holes.



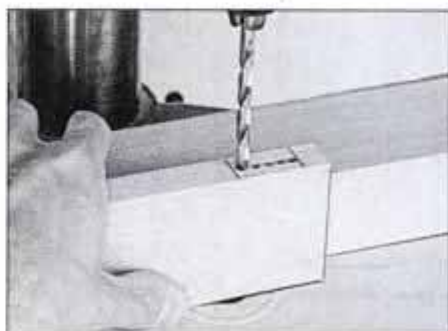
1 Place the sawn and jointed strips for the case body on the table saw. Cut the plate slots in the strips with a plate joiner.



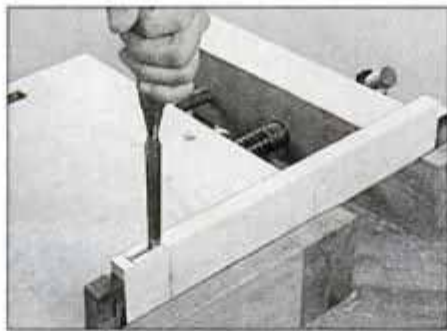
2 Apply glue to the plates and slot edges. Clamp the panels for about 30 minutes, then pare off the glue squeeze-out.



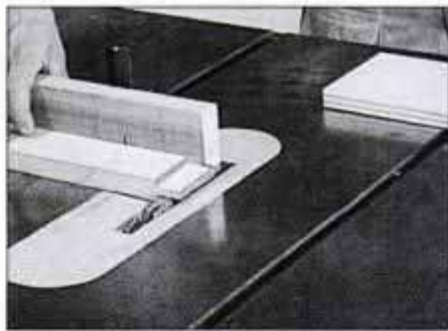
3 Use a sliding table jig to crosscut the case panels. Note the parallel jaw clamp at the left that acts as a stop.



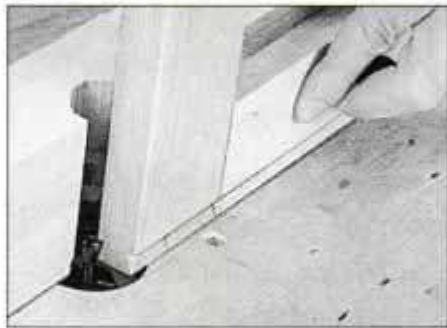
4 Lay out the mortises in the drawer support frames, and bore overlapping $\frac{1}{4}$ -in.-dia. holes to remove the bulk of the waste.



5 Hold a drawer support frame between bench dogs, use a sharp chisel to square the ends and smooth the mortise walls.



6 Cut the tenons on the drawer support frames with a dado blade on the table saw. Use a miter gauge and a stopblock.



7 Use a dovetail bit in the router table to cut the sliding dovetails on the sides of the drawer support frames.



8 Lay out the large dovetails on the stretcher ends. Tip the stretcher at an angle and make the cuts with a dovetail saw.

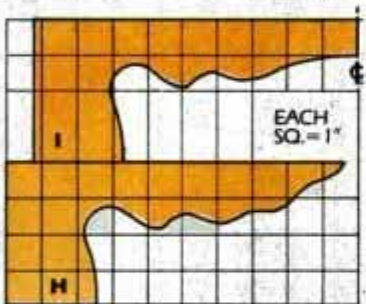
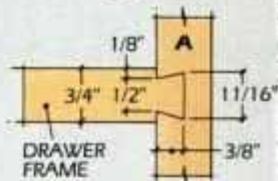
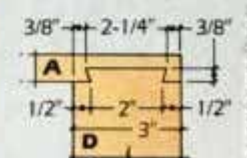
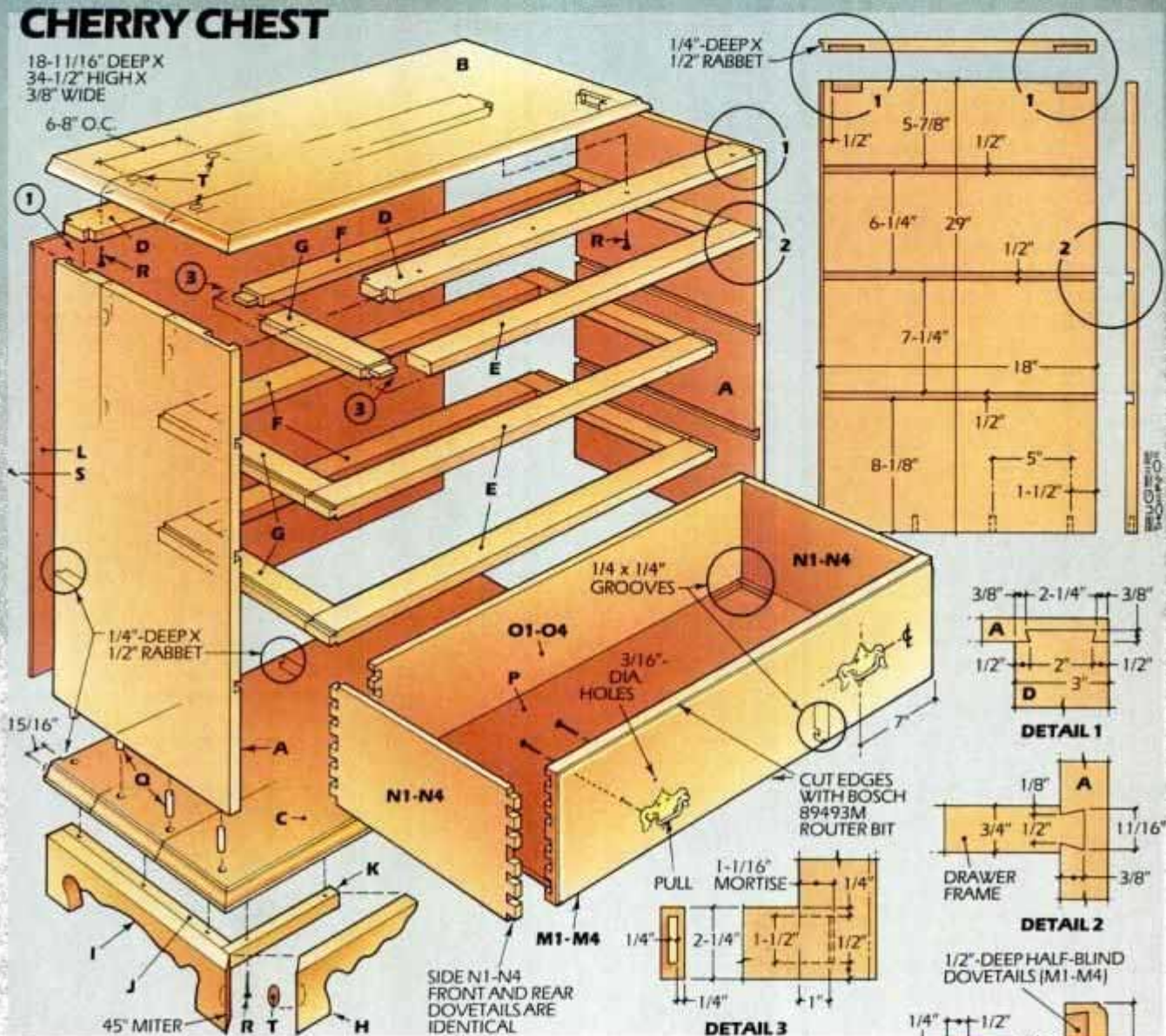
Pre-sand the inside surfaces of the case sides and drawer support frames with 120- and 220-grit sandpaper. Apply glue sparingly to the front of the dovetail mortises and the sliding dovetails on the frames, and assemble

the drawer frames and the case sides (Photo 11). If necessary, use clamps to pull the frames into place. Now apply glue to the dovetail mortises for the stretchers and to the dovetails on the stretcher ends. Install the

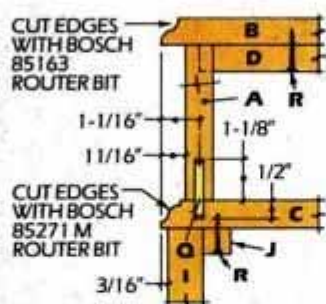
CHERRY CHEST

18-11/16" DEEP X
34-1/2" HIGH X
3/8" WIDE

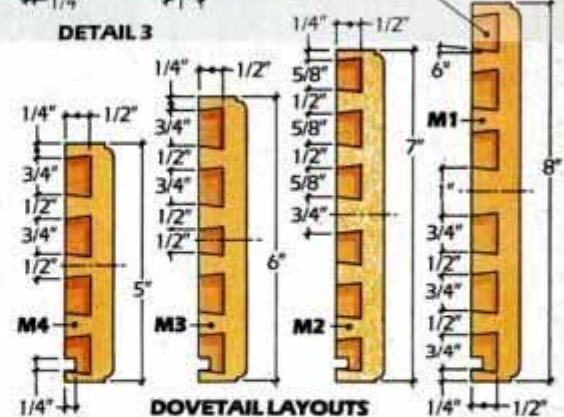
6-8" O.C.



FOOT PATTERNS



SECTION AT SIDE



MATERIALS LIST—CHERRY CHEST

Key	No.	Size and description (use)
A	2	3/4 x 18 x 29" cherry (side)
B	1	3/4 x 18 11/16 x 38" cherry (top)
C	1	3/4 x 18 11/16 x 38" cherry (bottom)
D	2	3/4 x 3 x 35 3/8" cherry (stretcher)
E	3	3/4 x 2 1/4 x 35 3/8" cherry (rail)
F	3	3/4 x 2 1/4 x 33 3/8" cherry (rail)
G	6	3/4 x 2 1/4 x 16 1/4" cherry (rail)
H	2	1 x 4 x 9 9/16" cherry (front foot)
I	2	1 x 4 x 18 1/2" cherry (side foot)
J	2	3/4 x 3/4 x 16 1/4" cherry (cleat)

K	2	3/4 x 3/4 x 8" cherry (cleat)
L	1	1/4 x 29 1/4 x 36 1/8" plywood (back)
M1	1	1 x 8 x 35 3/8" cherry (drawer face)
M2	1	1 x 7 x 35 3/8" cherry (drawer face)
M3	1	1 x 6 x 35 3/8" cherry (drawer face)
M4	1	1 x 5 x 35 3/8" cherry (drawer face)
N1	2	1/2 x 8 x 16 15/16" maple (drawer side)
N2	2	1/2 x 7 x 16 15/16" maple (drawer side)
N3	2	1/2 x 6 x 16 15/16" maple (drawer side)
N4	2	1/2 x 5 x 16 15/16" maple (drawer side)
O1	1	1/2 x 8 x 35 3/8" maple (drawer back)
O2	1	1/2 x 7 x 35 3/8" maple (drawer back)

O3	1	1/2 x 6 x 35 3/8" maple (drawer back)
O4	1	1/2 x 5 x 35 3/8" maple (drawer back)
P	4	1/4 x 16 7/16 x 34 3/8" plywood (drawer bottom)
Q	8	1/4" dia. x 1 1/2" dowel

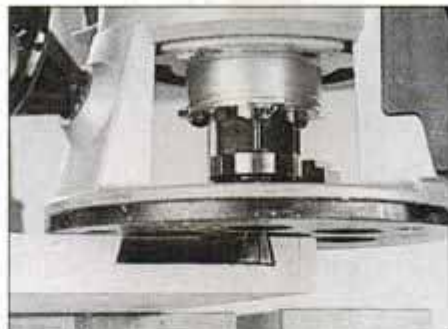
Misc.: 1 1/4" No. 8 fh screws; 3/4" No. 6 fh screws; No. 20 joining plates (wood biscuits); 8 No. 822 Chippendale drawer pulls, 3" centers, Paxton Hardware Ltd., 7818 Bradshaw Rd., Upper Falls, MD 21156; 120- and 220-grit sandpaper, glue; Watco (cherry) Danish Oil.

stretchers, and check the case assembly for square.

While the glue is drying, use a router with an ogee bit (Bosch No. 85271 M) to cut the molding on the front and sides of the case bottom. Rout the stopped rabbet at the back edge of the bottom using a straight bit and edge guide. Chisel the ends of the rabbet square. Lay out the dowel holes in the case bottom, and bore the holes with a 1/4-in.-dia. bit in the drill press, or use a drill guide. Pre-sand the bottom with 120- and 220-grit sandpaper.

Crosscut and chamfer the ends of the 1/4-in.-dia. dowels for joining the bottom to the case sides. Apply glue to the dowel holes in the case sides and bottom. Tap the dowels into the bottom, then clamp the bottom to the inverted case assembly (Photo 12). Let it set until the glue dries.

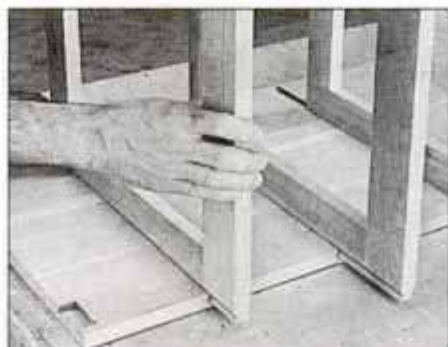
Mold the front and side edges of the case top using a router and an ogee bit (Bosch No. 85163) with the edge guide. Bore countersunk pilot holes through the top stretchers. Place the top upside down on a padded surface, then invert the case over it with proper overhang. Bore pilot holes into top, and screw the top to the stretchers.



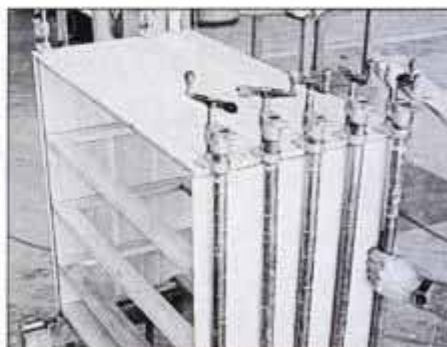
9 Cut the dovetail mortises at the top of the case sides, and use a dovetail bit in the router to remove most of the waste.



10 Clamp two straightedges across the case sides and rout the dovetail slot, making two passes with the router.



11 Apply glue to the front of the dovetail slots and the drawer frames. If necessary, assemble the pieces with clamps.



12 Invert the case sides and frames, and glue and clamp the bottom to the sides. Check for square by measuring diagonals.

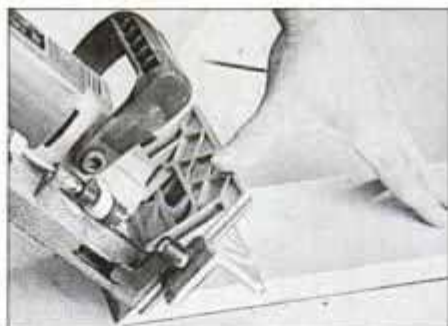
Making The Feet

Rip and crosscut the blanks for the bracket feet slightly oversize, and transfer the foot outline to each blank. Cut the miters on the front feet, and the front corner of the side feet, using the table saw and the miter gauge. Use the plate joiner with miter fence to cut a groove in the mitered surfaces (Photo 13).

Cut the foot profile on the band saw, or use a jigsaw. Smooth off the saw marks with fine-toothed rasps. Apply glue to the mitered edges of the feet and to the joining plate grooves. Install a joining plate at each joint, and clamp the assembly together until the glue sets (Photo 14).

Rip and crosscut the strips to attach the feet to the case, and bore the pilot holes in them. Elongate the holes slightly as you bore them in the strips along the side feet (part I). This ensures that screws holding it to the case bottom will move slightly as the bottom expands and contracts with fluctuating humidity. This prevents cracking the case bottom.

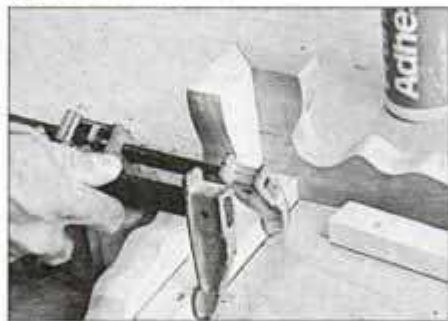
Glue and clamp these strips to the feet (Photo 15). When the glue has dried, sand the feet with 120- and 220-grit sandpaper. Lay the case on its back, and use spring clamps to hold the feet to the case. Bore the pilot holes into the case bottom, and screw



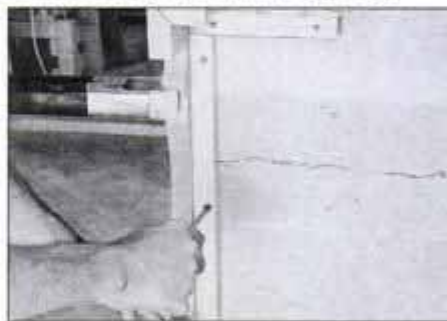
13 Hold blanks for feet firmly to bench, and cut the plate slots. Use the plate joiner tipped on its miter fence.



14 Apply glue to miter faces and plate groove. Install the joining plate, and clamp feet together until the glue sets.



15 Glue and clamp the strips to the inside surface of the feet. Bore slightly elongated pilot holes through the strips.



16 Rest case on its back, and hold feet in place with spring clamps. Bore pilot holes into case bottom, and screw feet in place.

the feet in place (Photo 16).

Cut the case back from 1/4-in. plywood, and attach it to the top, bottom and frames with countersunk screws.

Do not finish the case back with the

oil finish used on the outside of the case and the drawers. The back doesn't need any finish, and it will also impart an oily odor to the inside of the case that's impossible to get rid of.

Drawer Making

Cut all drawer parts to dimension. Use a marking gauge set with the pin $\frac{1}{2}$ in. from the sliding block to scribe a line around both ends of the drawer sides and the backs (Photo 17). Scribe the line only on the back of the front and on its edges.

Mark the dovetail spacing on the drawer sides using a dovetail marker (Photo 18) or a sliding bevel gauge. Mark two sides at a time, using a sharp knife to make the lines. Pencil an X between each dovetail to indicate the scrap. Saw the dovetails on both sides at once, stopping the cut on the scribed line (Photo 19).

Clamp each side to the workbench, over a scrap board, and use a chisel to chop out the waste between the tails, alternating vertical and horizontal cuts. When you reach the center, turn the workpiece around and chop in from the other side.

Hold the chisel slightly in front of the scribed line when chopping. Finish each cut by holding the chisel in the scribed line. Angle the chisel to the front slightly as you pare down from each side of the workpiece. This slight undercutting ensures a tight joint (Photo 20).

Clamp a drawer face vertically in a vise, place a drawer side over it (supported on blocks) and trace the side's dovetails on the front with a sharp knife (Photo 21). Mark the drawer back the same way.

Next, use a square to extend the lines down the inside of the face to the scribed baseline. Mark the waste between the pins with an X and number the parts to indicate mating joints.

To cut the pins in the drawer backs, first cut down to the baseline using the dovetail saw. Next, chisel the waste from between the pins.

The face is joined to the drawer sides with half-blind dovetail joints, so named because the dovetails are not visible from the front. Holding the drawer face in a vise, cut with the saw held diagonally as you follow the scribed lines. Next, remove the waste between the saw cuts with alternating vertical and horizontal cuts with a chisel. After all the joints are cut, test fit the parts. If any parts are too tight, pare away high spots with a chisel (Photos 22 and 23).

Cut the groove for the drawer bottom with a dado blade in the table saw. Cut the bead around the drawer faces using a Bosch router bit, No. 89493M. Sand inside drawer surfaces with 120- and 220-grit sandpaper.

To assemble a drawer, apply glue

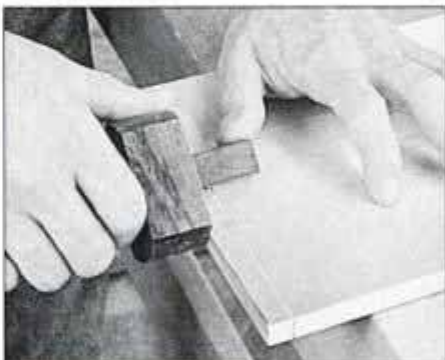
sparingly to the pins and tails. Assemble one drawer side to both the drawer face and back, slide the bottom into its groove, then attach the other drawer side. If the dovetails fit properly, no clamping is necessary, but check that the drawer is square. If not, clamp it into a square position and hold it there until the glue sets.

Next, fit the drawers to the case. Try each in its opening, noting any spot that is too tight. Plane or sand these spots until the resistance is eliminated. It may require several adjustments before the drawer fits.

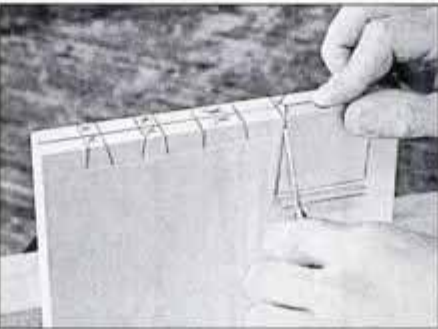
Bore $\frac{3}{16}$ -in.-dia. holes for drawer pulls as shown. Sand the case and drawer exteriors with 120- and 220-grit sandpaper, and dust them off.

Finish only the outside of the case and drawer fronts with cherry-col-

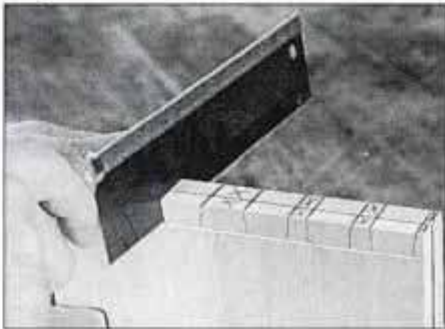
ored Watco Danish Oil. To ease drawer operation, apply a little wax to their sides, bottom and top edges, as well as the inside of the drawers and the case sides. **PM**



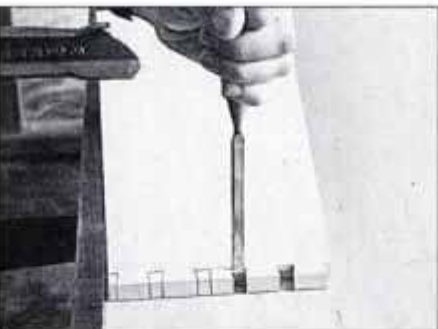
17 Scribe a line $\frac{1}{2}$ in. from the end, on all four faces of drawer sides and back. Scribe only the back face on the drawer fronts.



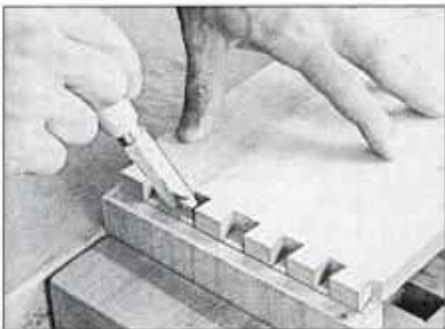
18 Use either a dovetail layout marker or a sliding bevel gauge to mark the dovetail angles on the drawer sides.



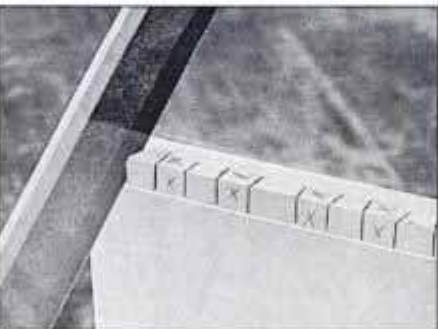
19 With a sharp dovetail saw, cut on the waste side of the layout lines. Stop at the baseline, and saw two sides at one time.



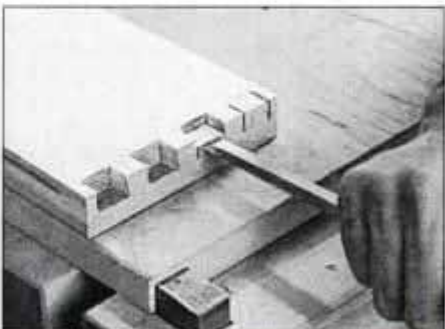
20 Clamp each side to the workbench over a piece of scrap. Use a sharp chisel to remove waste from between dovetails.



21 Stand front up in a vise, and lay side on top of it. To mark the pins, scribe the outline of the dovetails on the front's edge.



22 To cut the pins, angle the dovetail saw sharply between the scribed lines on the edge and inside surface.



23 The pins are completed with a chisel. Clamp the front firmly to the bench, and alternate vertical and horizontal cuts.

HOW IT WORKS

ELECTRIC MOTOR

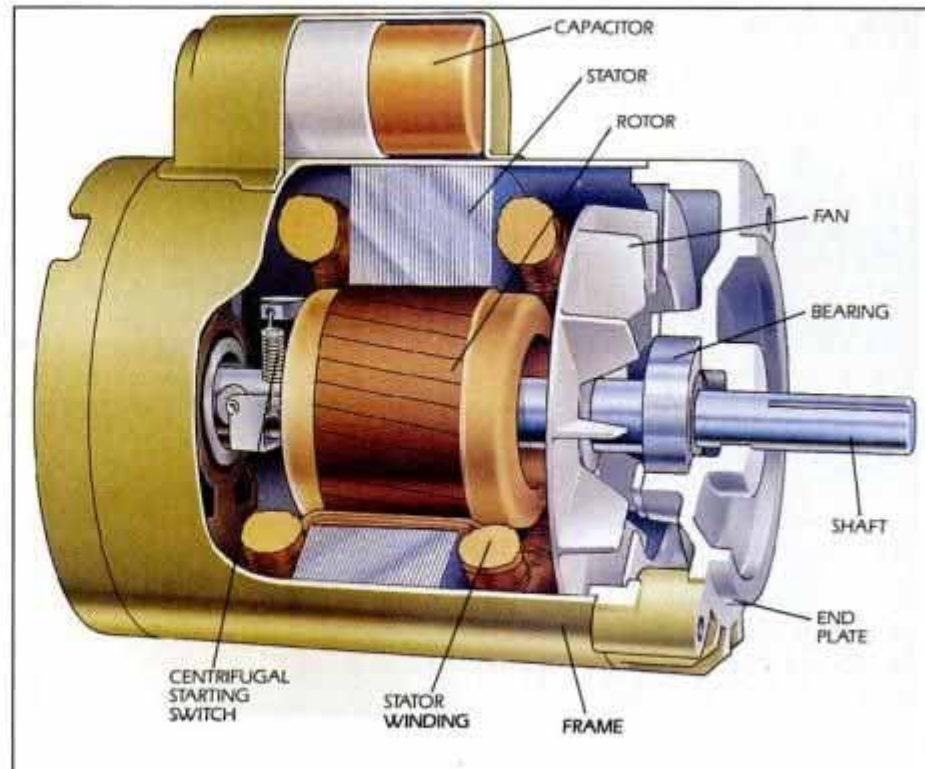
BY MERLE HENKENIUS
PM Illustrations by Eugene Thompson

● Many of the labor-saving devices that we take for granted are driven by electric motors. The obvious ones—things like electric drills, food processors, fans and vacuum cleaners—are no surprise. You can hear the motor start as soon as you flip the switch or press the trigger. Other applications, such as refrigerators, dishwashers and furnaces, are less obvious. Here, the motor takes a support role, providing the necessary power to keep a complex appliance functioning. In both cases, the motor supplies mechanical energy. The unique thing about an electric motor is that it generates this mechanical energy from electrical current.

Although there are many types of electric motors, they all utilize a common phenomenon that links electrical and mechanical energy—magnetism.

Magnets and electricity

Every magnet is surrounded by a field of force that moves through and around it to create a north and south polarity. And, as we all learned in school, the similar poles of two mag-



Typical single-phase induction motor is used to convert electrical energy into mechanical energy for household appliances, such as washing machines, dryers, refrigerators and furnaces.

nets repel each other and the dissimilar poles attract each other. Using one magnet to move another is the essence of a motor.

All electrical current is accompanied by a magnetic field. A copper wire, normally unaffected by a magnetic field, becomes magnetic when current is sent through the wire. Wrapping the wire in a coil, concentrates the magnetic field, and filling

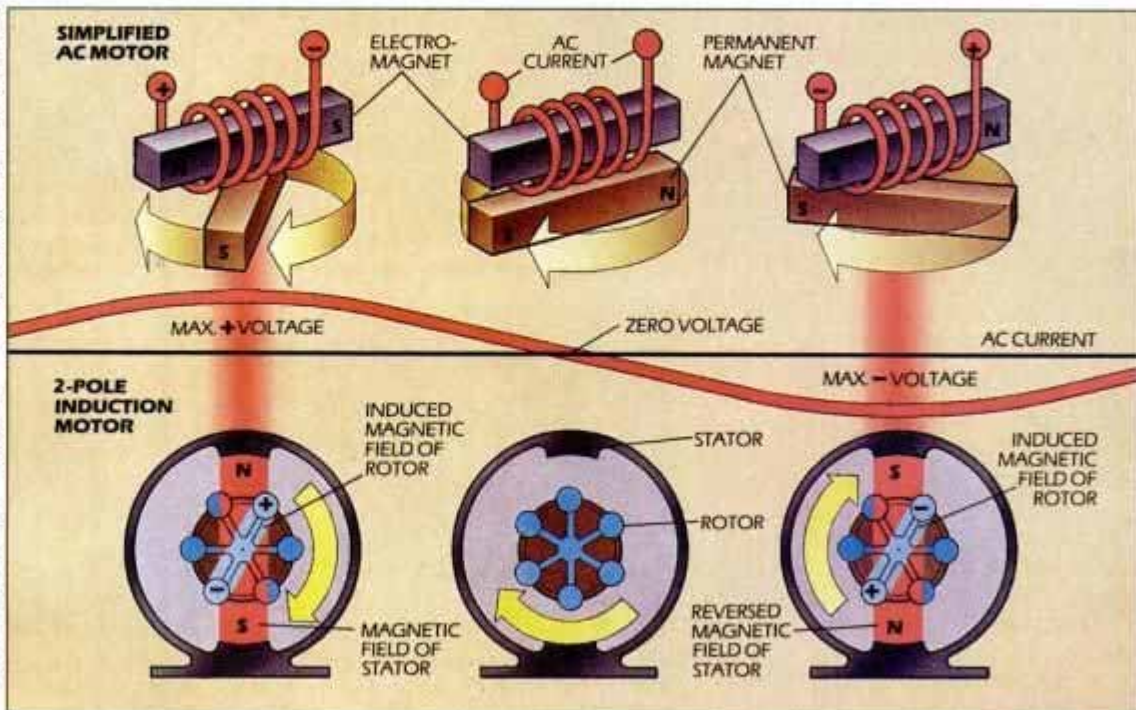
the coil with an iron bar amplifies the effect. The result is an electromagnet. One end of the bar is the positive pole, and the other is the negative pole. Switching the direction of the current changes the polarity.

A simple motor

If you mount a permanent magnet on a pivot next to an electromagnet and turn on the current, the permanent

1 Simplified AC motor (right top) is comprised of an electromagnet positioned above a permanent magnet that is mounted on a pivot. When current is sent through the coil, the permanent magnet rotates so that opposite poles align. As the AC current switches direction, the permanent magnet continues rotation to align with reversed poles.

Two-pole induction motor (right bottom) has stator that generates magnetic field across rotor. Electrical current induced in rotor creates magnetic field that spins rotor to align it with poles of stator. With each cycle of AC current, rotor spins 360°. Speed is determined by the number of cycles per second.



magnet will align itself with the electromagnet, as its positive pole is drawn to the negative pole of the electromagnet (Fig. 1). If you switch the direction of the current at the right time, the electromagnet poles will reverse, causing the magnet to rotate 180°. If you keep switching the current at the proper interval, the permanent magnet will spin.

While there are several ways to switch the current direction, alternating current handles the job automatically. Here, the voltage cycles from zero to a positive peak, back to zero and then repeats the process with the current flowing in the opposite direction. Normal household current repeats this back-and-forth switching 60 times a second.

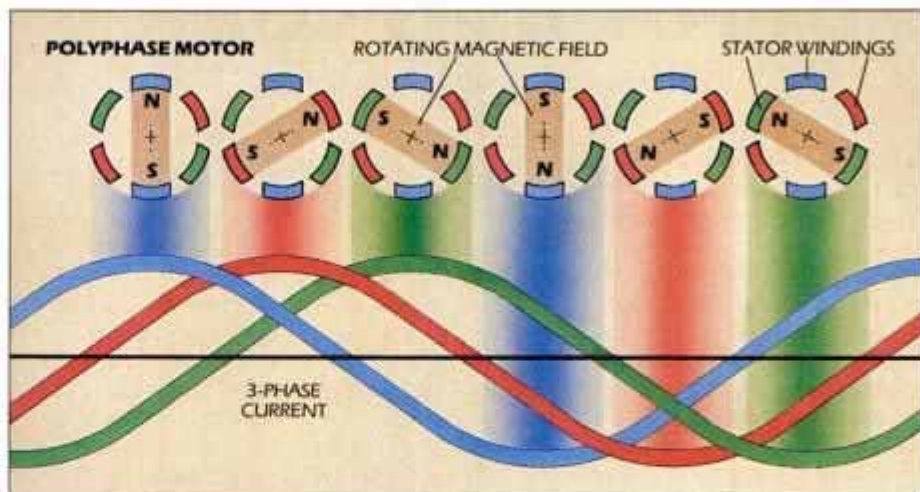
Induction motors

The most common motor found in household appliances such as your refrigerator or furnace is an induction motor. Electromagnetic induction occurs when a conductor cuts through a magnetic field. The magnetic field generates a flow of current in the conductor without physical contact.

An induction motor has a rotating core, or rotor, that's made up of a ring of nonmagnetic conductors, connected at the ends and held in a laminated steel cylinder. The rotor is surrounded by a stationary field winding, or stator. In its simplest form, the stator has two poles (north and south) that create an electromagnetic field across the rotor. This field induces a current in the rotor that, in turn, generates a magnetic field. The interplay between the magnetic field induced in the rotor and the magnetic field of the stator, which varies with the AC current, forces the rotor to spin.

The number of poles in the stator, along with the frequency of the AC current (60 cycles per second), determines the speed at which the magnetic field attempts to spin the rotor (synchronous speed). In theory, a 2-pole motor rotates one complete revolution each AC cycle, or 3600 rpm. Switch to four poles, and the magnetic field only rotates 180° each cycle for a speed of 1800 rpm. However, the actual speed of a typical induction motor lags behind the synchronous speed. Called slip, this accounts for the usual speeds of 3450 and 1725 rpm.

Of course, this theoretical motor will only run if it's brought to operating speed by some other source. In practice, there are several ways to get things moving. In a 3-phase system, the current is comprised of three



2 Diagrammatic polyphase motor uses three AC currents with uniformly spaced voltage cycles. Consecutive phases are wired to poles on stator to create a rotating magnetic field.

equally spaced voltage cycles running concurrently. When each of these cycles feeds a respective winding in the stator, a rotating magnetic field is produced that the rotor immediately follows (Fig. 2). Single-phase motors often utilize a separate starter winding in the stator. Along with a capacitor, this starter winding generates a magnetic field that's out of phase with the primary winding field. This results in a rotating field that spins the rotor. When the rotor reaches speed, a centrifugal switch disconnects the starter winding from the power source.

Motors that utilize induction are made in a variety of designs with running characteristics tailored to the job at hand. Split-phase motors come in fractional-horsepower sizes for light-duty appliance and tool operation. Capacitor-start motors are commonly used in machinery and range up to about 10 horsepower.

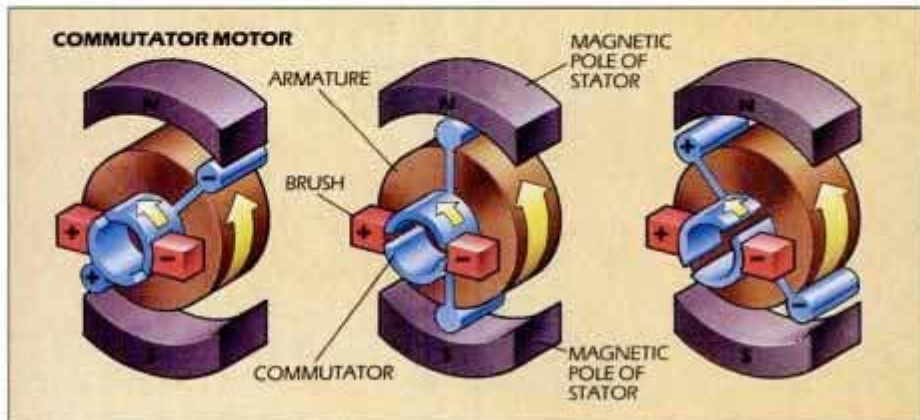
DC and universal motors

Your electric drill uses a different kind of motor. Where an induction

motor induces current—and its accompanying magnetic field—in the rotor, DC and universal motors deliver current to the rotor, usually called the armature, through direct physical contact. The current is sent to the armature through carbon blocks, or brushes, that bear on a component called the commutator. The commutator routes the current through the armature coils where its magnetic field interacts with the field of the stationary winding.

In its basic DC form, a 2-segment commutator is simply a switch that reverses the polarity of the current flowing through the armature (Fig. 3). As such, it converts direct current to a form of alternating current, and the armature is impelled to spin as described for AC motors.

In practice, the commutator has many insulated segments—each connected to a coil on the armature—to produce the rotating magnetic field that spins the armature. Universal motors are similar to DC motors but have modifications so they can run under AC as well as DC current. **PM**



3 Simplified DC motor sends current to armature through contact between brushes and commutator. Spinning commutator acts as a reversing switch that alternates magnetic field.

HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

Roof Valleys

Our 16-year-old asphalt strip shingle roof will soon need replacement.

What is the preferred way to handle roof valleys? In this area of New Jersey, roofing contractors do not use valley flashing, but shingle continuously into and out of the valley. However, in the Midwest (St. Paul, Minnesota, area), contractors continue to use valley flashing (usually metal).

Is there a preferred construction in treating roof valleys?

ROBERT HLAVACEK
BERKELEY HEIGHTS, NJ

Without sounding facetious, the preferred way is the way the local roofers do it. There is no technical superiority between the styles. There are three basic types of valleys: open, closed-cut and woven. The decision on the type of valley is usually the roofer's. That decision is based on past experience and aesthetics. If the valleys on all the roofs in the neighborhood are woven, most homeowners would be reluctant to have a roof installed with an open valley.

One reason for selecting one valley style may be due to how the local building department interprets national building codes. A roof with Class A (fire rated) shingles with an open valley may not be given a Class A rating. Whereas, it would be given a Class A fire rating with a woven valley.

Rumbling Water Heater

I have a gas-fired, tank-type water heater. Lately, it has been making a rumbling noise when it fires. That's

the only time it makes this noise. Should it be replaced?

ANTHONY SCALIA
WHITTIER, CA

The water heater does not have to be replaced. Over the years, sediment, scale and mineral deposits accumulate on the bottom of the heater tank. Manufacturers suggest that a few quarts of water be periodically drained from the heater to help remove these deposits. However, this practice is not always effective, and, if sufficient deposits accumulate, a rumbling sound can be heard when the unit is firing. It is not a dangerous condition, although it can be annoying. Also, the deposits act as an insulator between the water and the flame, and decrease the heater's efficiency.

Roof Shake

In a recent issue, you discussed weathering new shake shingles. Please give us some advice on maintaining our 10-year-old shake roof.

EDITH THACK
IVY, VA

The most important aspect of maintaining a shake roof is keeping it clean. Sweep and rinse out the slots between the shakes to keep leaves and debris from accumulating. These organic substances decay and trap moisture, contributing to the premature deterioration of the shakes. They can also prevent water from flowing off the roof, trapping it at the eaves, where it can back up and leak under the shakes.

Fortunately, cedar shakes resist rot because they contain natural

preservative oils, called extractives. However, shakes are not immune to rot. Homeowners in humid climates, or whose house is in a heavily wooded area, should treat the shakes with a preservative containing a fungicide.

More On Sweaty Windows

In a recent Homeowners Clinic, we discussed several causes of excessive humidity in a home (a dirt crawl-space or improperly vented bathrooms). As several readers reminded us, we inadvertently left out that a damaged furnace heat exchanger or a clogged furnace flue can push excessive water vapor into the house.

Water vapor is a byproduct of combustion. A cracked heat exchanger in a forced-air furnace will release water vapor into the air being heated for distribution. A blocked furnace flue will cause water vapor and fumes to back into the house.

Either kind of failure can be dangerous. Carbon monoxide is produced along with the water vapor, and this would permeate the house as well. In a tightly sealed house, this odorless gas could prove deadly.

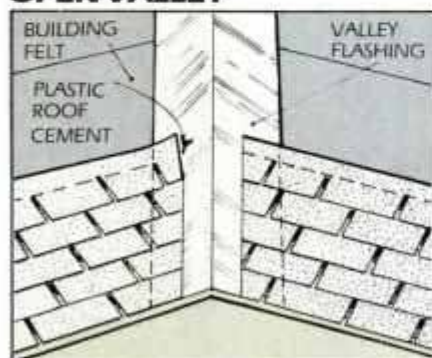
Play it safe. Should you have excessive moisture in your house, first make sure your chimney flue is clear and that the combustion gases from your heating system (including your water heater) are vented to the outside. Have a heating contractor or your local utility check your heating/ventilation system.

PM

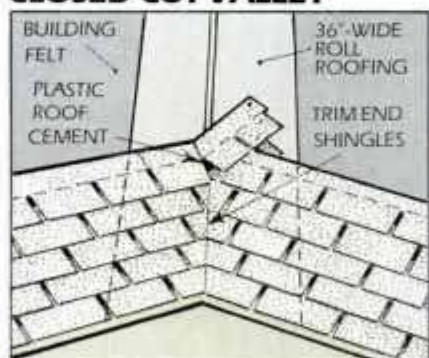
DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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. For more home-repair and maintenance help, get PM's Home Care Guide, \$5.95 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

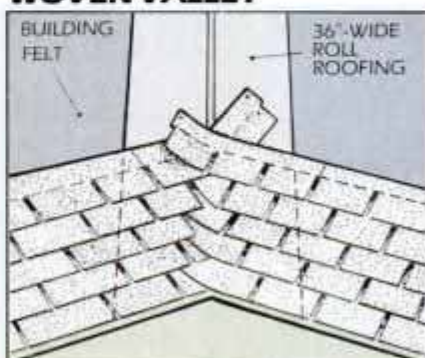
OPEN VALLEY



CLOSED-CUT VALLEY



WOVEN VALLEY



There are three ways to shingle a valley. In an open valley, flashing or roll roofing forms a gutter where the two roofs intersect. In a closed-cut valley, one layer of shingles is laid over the other and the top is trimmed. In a woven valley, the shingles are woven together.

PM ILLUSTRATIONS BY ED LIPINSKI

Now! Cash in on emergency shortages of qualified people in 4 fast-growing fields. FREE OPPORTUNITY KITS tell you how...

There's no obligation or cost to find out how to start your own profitable full—or part-time business—with little investment and zero risk! What do small-engine repair technicians, upholsterers, locksmiths and saw-and-tool sharpeners have in common? There are not nearly enough of them to keep up with the demand!

Take locksmiths, for example. Did you know that there is only one qualified locksmith for every 17,000 people in

America? The shortage of qualified practitioners in these four trades is creating inflated prices and big profits for those few who have the skills to take on these kinds of work.

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Upholstery

It is estimated that there are more than 401,950,000 pieces of furniture in America that need re-covering and repair every five to ten years. Take this course and you can become one of the few craftsmen that individuals and companies seek out to restyle and upholster these pieces. In no time you'll be making big profits upholstering, rebuilding and restyling chairs, sofas, love seats, automobile seat covers...any piece of furniture!



Locksmithing



a Pro Key Machine at no extra cost! The work's easy, the money's good and the demand is skyrocketing.

Never before have opportunities been so great for qualified locksmiths. With crime zooming, the lock and key business has multiplied a thousandfold. This Foley-Belsaw course gives you everything you need to start your own locksmith business — including

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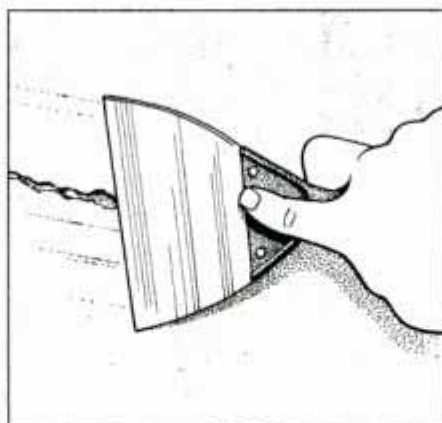
HOME IMPROVEMENT

FIVE HOME HINTS

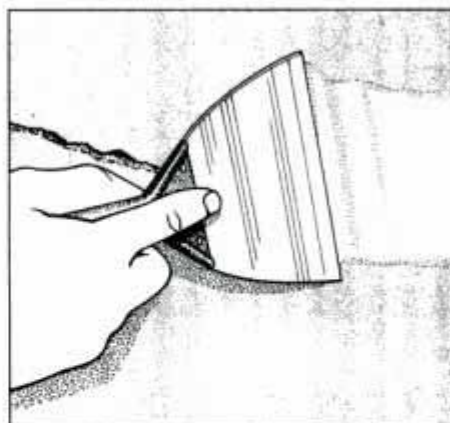
BY GARY BRANSON
PM Illustrations by
George Retseck

1 Patching Plaster

Most cracks in plaster are caused by movement in the building's structure. If you simply fill the cracks, it's likely that they'll open again within a short time. Also, the usual advice to undercut a crack so the patch will hold better is unwise. The patch may not fall out, but there's nothing to keep the crack from reappearing. To do the job right, reinforce the patch with paper drywall tape. First, scrape away any loose plaster from the area. Then, cover the crack with drywall compound, imbed the tape and wipe away the excess compound with a taping knife. When the compound is dry, apply a thin cover coat of compound. After this coat is dry, add a second, very thin coat and, when dry, smooth by wet sanding.



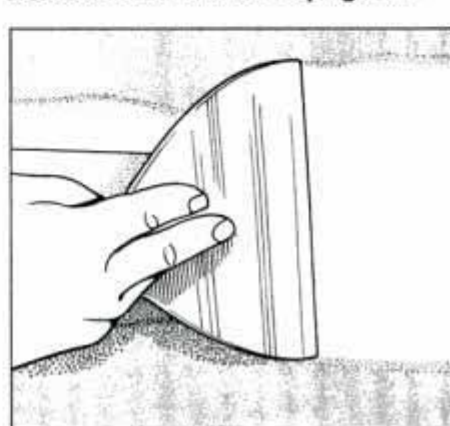
1A Use a taping knife to clean away loose particles or projecting plaster chips from the crack and the surrounding area.



1B Next, apply a coat of premixed drywall taping compound over the repair area. Use a 4- or 6-in.-wide taping knife.



1C Imbed paper drywall tape into the compound, centering the tape over the crack. Wipe away excess and let dry.



1D Apply a very thin coat of compound to cover the tape. After it's dry, apply a second thin coat and sand smooth.

2 Garage Door Tips

Keeping your home in shape through preventive maintenance is the best method for keeping those big, expensive jobs at bay. One area that benefits from periodic attention is your overhead garage door. With a quick inspection and a little cleaning and lubricating, you can keep your garage door working properly day after day

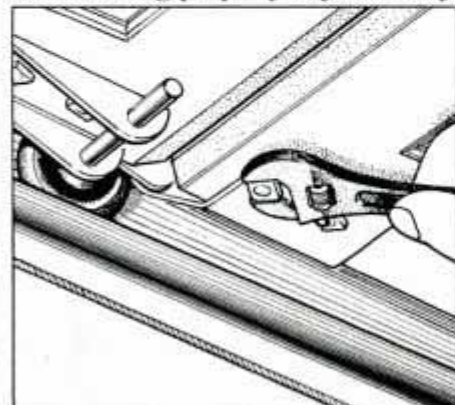
—plus extend the life of the door's hardware and components.

The first step in maintenance is to check the hardware. Tracks, brackets and rollers can loosen under the load of constant use. Tighten any loose screws or nuts on the door hardware.

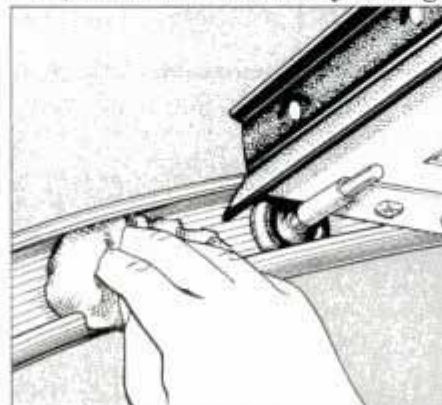
Next, clean the door track regularly to avoid a buildup of dirt and oil. The residue that develops when dirt and oil combine can cause the door to bind, which can eventually damage

other components or the door itself. Use a cloth or sponge soaked in a solvent such as mineral spirits to scrub the track until it's clean.

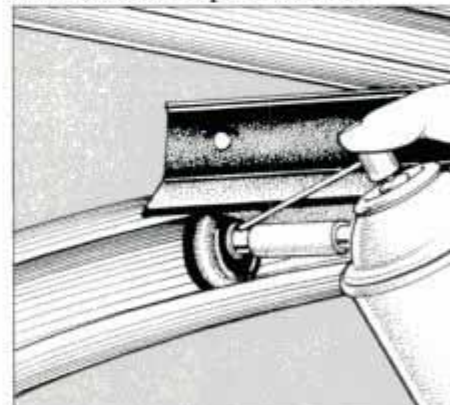
The final step is to lubricate every piece of hardware that moves, such as locks, tracks and hinges. If you have a garage door opener, lubricate the mechanism that raises and lowers the door. Also check that the components are adjusted properly according to manufacturer's specifications.



2A Inspect hardware to make sure it's secure and in good condition. Tighten any component that's loose.



2B Use a clean cloth or sponge soaked in a solvent such as mineral spirits to wipe away all dirt and grime from the door track.



2C Lubricate all moving parts. Use a convenient aerosol spray lubricant to reach track rollers, locks and door hinges.

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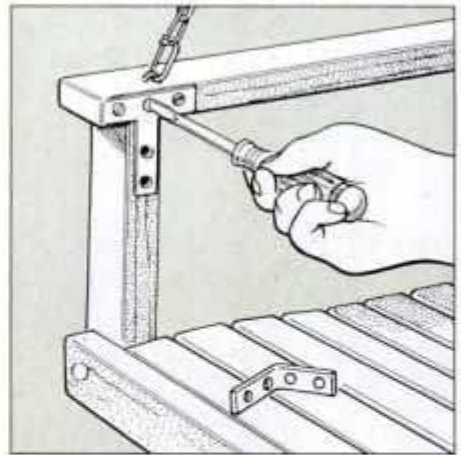
3 Fixing Lawn Furniture

Last year's wooden garden furniture may have looked pretty good when you picked it out in the store. Now that it's been through a season, you may have found that poor construction, or simple heavy-duty relaxing, has taken its toll. What once seemed like a sturdy piece of outdoor equipment now greets you with a wobble and a groan. Upon close inspection, you may find that the wooden joints are simply held together with staples or small nails. However, you can make your wooden furniture last for several more seasons with this tip.

Stop by the hardware store and

check out the wide assortment of steel reinforcing brackets. These come in T and L shapes and are secured with flathead woodscrews. Pick out the brackets that are suitable for reinforcing the joints on your wooden lawn furniture.

Install the metal brackets at all key stress points. Use them to strengthen crossbraces, where the arms meet the back and on parts that are suspended by chains or ropes. Be sure to use galvanized screws that are sized for the stock you're fastening and that have heads that fit neatly in the metal reinforcing brackets. If you're beefing up a new piece of unfinished wooden lawn furniture, install the brackets before you apply the finish.



3A If your wooden lawn furniture isn't sturdily built, reinforce the joints at all key stress points with metal brackets.

4 Cutting Patches

If you've ever had to cut multiples of the same shape from cloth or paper, you know that the easy way to do the job is to double up the material and cut two or more pieces simultaneously. Called double cutting, this method can also be used to cut repair patches for wallcoverings or vinyl floors, so they fit precisely and the patterns are exactly aligned.

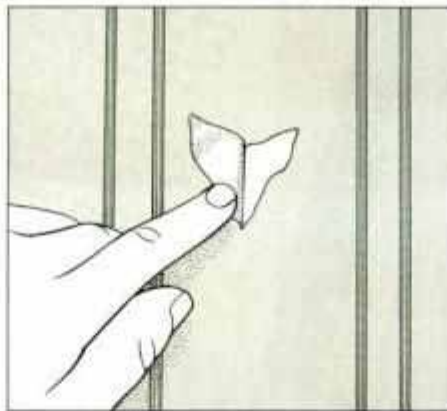
To repair a small damaged section, first position a scrap piece of matching material over the affected area. Align the patch material so its pattern lines up perfectly with that on the original material. Then, tape the repair piece in place with masking tape so it won't shift while it's being cut.

Next, use a razor knife to cut a shape through both the patch and the original material. Always use a sharp, new blade so you can cut through both layers without forcing the tool or slipping. Keep the blade held at right angles to the surface so the patch and repair cutout will be exactly the same

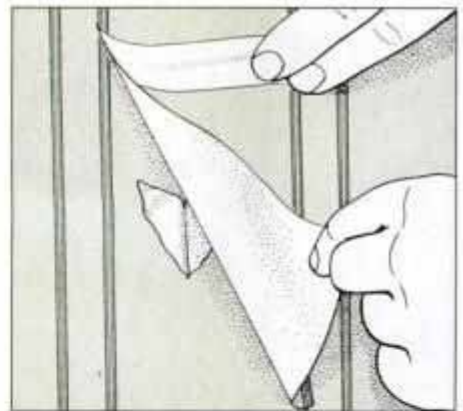
size. If there are lines in the pattern, make your cuts on these lines to better conceal the patch. If there are no pattern lines, make an irregular cut-out with wavy lines so the cutline will be less visible.

Remove the patch and use water, solvent or heat—depending on the adhesive used—to soften the glue under the damaged section, and then remove it. If you're working with thick

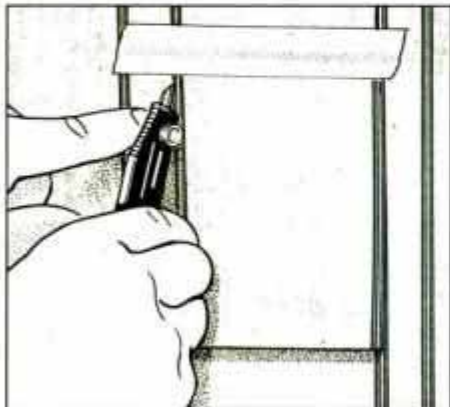
material, pry up the section slowly and check that you've cut all the way through. If necessary, carefully deepen the cut. Apply adhesive to the back of the patch, insert it into the hole and carefully adjust its position so it fits exactly. Press the patch firmly in place, and use a sponge dampened with the appropriate solvent to wipe away excess adhesive from the patch and surrounding area.



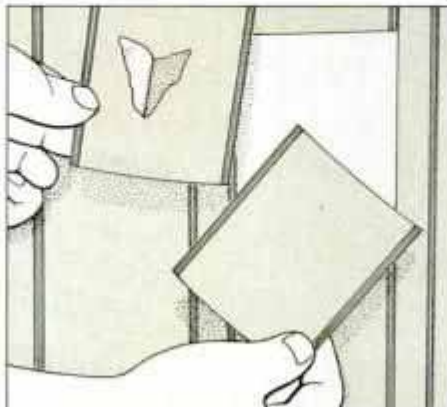
4A Damage to most any material that can be cut with a razor knife, such as torn wallpaper, can be repaired by double cutting.



4B Cut a patch from scrap material so it's slightly larger than the damaged area. Tape it in place so its pattern is aligned.



4C Use a sharp razor knife to cut both layers at once. Align cut with pattern lines, or use a wavy cutline if there's no pattern.



4D Use water to loosen glue under wallpaper. Carefully remove damaged section and check that your patch fits.



4E Apply glue to patch back and carefully locate in hole. Use a sponge to smooth patch and remove any excess adhesive.

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5 Repairing Carpet

If you have a small stain or burn in your carpet, you can repair it with a special carpet patch cutting tool that professional carpet installers call a cookie cutter. This tool cuts away the damaged area and cuts a matching plug to fill the hole. You can buy the tool and adhesive discs for securing



5A To remove a small damaged area of carpet, use a carpet repair cutter. Press cutter gently and turn until cut is completed.

the patch at carpet supply dealers.

The cutter has a pair of razor blades at its perimeter. Just position the cutter over the damaged area of the carpet, press gently and turn. When the damaged section is removed, peel the face off the adhesive-backed disc. Insert the disc into the hole so it's centered and laps under the hole perimeter uniformly. Press the carpet to secure it to the disc. Then, use the cut-



5B Peel off back of adhesive disc and insert into hole, adhesive side up. Center disc and press carpet around hole to secure disc.

ter to make a repair plug from a piece of scrap carpet or from a section of the carpet that's hidden, such as inside a closet. Press the plug in place so it sticks to the disc. If the edges don't quite match, lift the plug, coat the edges with carpet adhesive and replace the plug. You can further blend the patch by running a vacuum cleaner over the area, or by using a comb to blend the carpet fibers together. **PM**



5C Cut replacement plug from hidden carpet and press plug into hole. Brush surface to blend fibers together.

TOOL UPDATE

PORTER-CABLE SABRE SAW AND CORDLESS DRILL

Power tool companies come out with new tool designs all the time. And, while some are indeed improvements, it's refreshing to see a manufacturer refine a design rather than introduce an entire new line. Such is the case with the Model 7549 sabre saw and the Model 9852 cordless drill from Porter-Cable.

We tested the previous incarnations of both of these tools (see

"Sabre Saws," page 79, October '89 and "Anywhere Drills," page 89, March '89). While we found both tools to be leaders, we also thought each needed improvement.

Sabre saws are great for curved and internal cuts. But due to the flex of the blade, they're not good at cutting square. When we reviewed the original P-C model 7548, we were impressed by two bearings mounted near the side of the blade for support. As we found out and wrote about, the system didn't work. Well, Porter-Cable fixed the problem. The new electronic, variable-speed Model 7549 (about \$250) has adjustable blade guides similar to those found on a band saw. And P-C now has a blade clamp that allows you to use all standard blades. If you prefer a barrel-grip over the top-handle shown, choose P-C's Model 7649.

Although the original 3/8-in., 12-volt Model 9850 Magnequench cordless drill was a powerful performer, we noted that the absence of a high-speed range made it less than best at small hole boring. The new dual-speed

range Model 9852 (about \$270) solves the problem with variable speeds up to 1000 rpm versus the maximum 350 rpm of the older tool. And, you can also get this drill with a 3/8-in. keyless chuck (Model 9853) or with a 1/2-in. standard chuck (Model 9854). For more information, write Porter-Cable, Youngs Crossing at Hwy. 45, Box 2468, Jackson, TN 38302.

—Tom Klenck



Adjustable blade guides give the P-C 7549 the edge for square cutting. New blade clamp handles different blade shanks.



Porter-Cable's 9852 Magnequench cordless drill enhances powerful performance with a new dual-speed range.

TOOL TEST

**DREMEL
CORDLESS
TOOL**

TEXT AND PHOTOS BY
ROSARIO CAPOTOSTO,
Contributing Editor

● The Dremel rotary tool, a longtime favorite of home craftsmen and professionals, is now available in a cordless version, the Minimate Model 750.

This compact and lightweight rotary tool is powered with a removable battery that recharges in about 3 hours. For an extra \$20, you can buy a spare battery to use while the other one charges.

The tool is sized and balanced so it can be held like a pencil. The absence of a bulky power cord gives it great maneuverability so it excels at precision detailing, sanding and cutting.

Adding to the tool's convenience is its knurled chuck. To remove a bit, push in the button at the tool's tip, grab the chuck and twist. The knurl-



Cordless Minimate is a maneuverable and well-balanced tool that's gripped like a pen during high-speed shaping.

ing allows you to grab the chuck firmly enough so that you don't need a wrench to loosen the bit (as was needed with earlier cord-type rotary tools).

The 750 has a low- and high-speed switch to deliver 5000 and 10,000 rpm, respectively. It accepts accessories with 1/8-in.-dia. and smaller shafts, and it comes with a high-speed cutter, drill bit, wire brush, sanding sleeve, drum sander and battery recharger. It costs about \$50 at hardware and hobby stores. Contact Dremel, 4915 21st St., Racine, WI 53406. **PM**



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APPLIANCE CLINIC

BY STEVE TOTH,
Contributing Editor

Clothes Come Out Dirty

I have a Maytag washing machine model No. A606, serial No. 313339MW. The machine does not wash the clothes clean and acts as if the agitator is not turning fast enough in the normal wash mode.

I have replaced the drivebelt, pump belt and the electric timer control. I removed the motor and cleaned the plastic rollers that allow the motor to move and tighten the belt. Do you have any ideas?

ROY CHASE
STOW, MA

You may have the pump belt adjusted too tightly, or there may be a transmission problem. To adjust the pump belt, first unplug the machine. Loosen the screws at the bottom of the front panel, and remove the panel by lifting it off the clips that hold it to the top. Tilt back the washer enough to slip a block of wood under the machine's left front leg.

Next, pull the motor ahead so the drivebelt is tight. Reach under the washer and grasp the pump belt in the middle. The belt is separated from the motor and the pump by a sheetmetal panel. Pinch the belt together. There should be about 1/4 in. of space between the belt's inside surfaces before the motor pulley starts to turn.

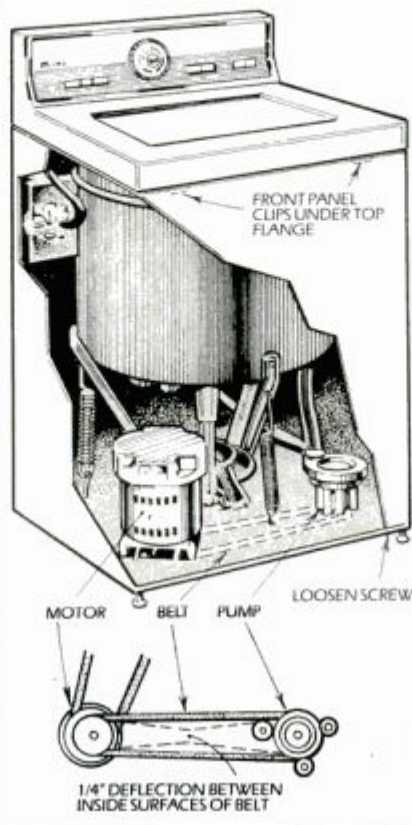
To adjust the belt, loosen the screws holding the pump to the base and then move the pump either to the left or to the right to get the 1/4-in. spacing.

If adjusting the belt doesn't help, your problem is that years of use have thickened the transmission oil. It started out as normal 90-weight oil, but may have become 150- to 200-weight. This prevents the gears from moving properly, causing the slow agitation and perhaps other damage as well.

To correct this, you can either replace the transmission or take the transmission out, disassemble it, take all the gears out, drain the fluid, clean it and replace the fluid. If a service person performs either job, it will cost \$300 to \$350.

If you want to tackle the job yourself, I suggest you get a copy of the

WASHER DRIVEBELT ADJUSTMENT



PM ILLUSTRATION BY EDO LIPINSKI

First, unclip the washer's front panel, then tip the washer up on a block. Pull the motor ahead, and test belt deflection.

service manual from Maytag for your model washing machine and review the procedure.

You can either order the service manual from your local Maytag parts and services company, or write Maytag Appliance Parts and Service Co., 240 Edwards St. SE, Cleveland, TN 37311. The Maytag part number for the manual is 056130. The cost is about \$9 plus postage.

Hoover Washer Needs Parts

I have a Hoover Spin Basket Washer model No. 0517, serial No. 74103. I need parts for it at times, but can't locate any locally. Presently, I need belts for the pump and the basket spinner. Could you help me with this procedure?

JOSEPH SOOS
SOUTH BEND, IN

For parts or service literature for a Hoover washer or dryer, contact the Hoover Co., 101 E. Maple St., North Canton, OH 44720, Attn.: Consumer Affairs Dept.; (216) 499-9200. You're in luck, Hoover has the parts you need in stock.

No Bags Left

I have a GE vacuum Model MV-1, and have been informed by the local GE supplier that this model was discontinued many years ago and the replacement bags are no longer obtainable. If you can tell me where I can get a new cloth bag or disposable bags for this model, my wife will thank you many times over.

ROBERT WHITE
LAS VEGAS, NV

GE discontinued making your model hand cleaner years ago, and a replacement bag is no longer available from GE.

However, stop by your local vacuum cleaner repair shop and pick up a 3-pack of disposable vacuum bags for a Eureka vacuum. Ask for the Style W bags for 160-series vacuums. The Eureka part number is 52332, and it costs about \$3. These bags should fit your vacuum, as well as GE and Premiere models MV-1, MV-2 and MV-3. If you can't locate these bags locally, contact Eureka parts at (800) 438-7352. The bags can be ordered over the phone with a major credit card.

Save The Range

I have a problem in locating a replacement oven temperature control for my Hotpoint electric range. The range shows two model numbers: 108RB715-J and 188RB715-J. The local parts house shows the oven temp control part number as WB21X507. I have been told the part is no longer available. The range is in great shape, but the oven won't work without the control. Will I have to junk it, or can I get new parts?

DAN SCHEPFLIN
ST. ANN, MO

Sounds as if you have two options to keep your range in service. First, you can replace your obsolete control with a replacement control, GE part No. WB21X5116, about \$180. This part is still available and will fit your range, according to the people at GE. Your second option is to try contacting local appliance parts distributors and ask them if they can send your old oven control to a thermostat remanufacturer to have it rebuilt. This may be less expensive than replacing it, though the entire repair would take longer.

PM

DO YOU HAVE AN APPLIANCE PROBLEM?
Just ask Steve about it. Send your question, along with the model and serial numbers, to Appliance 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.

Great White North

A few miles from Dawson, a bald eagle sits on a driftwood branch in the middle of the Klondike River. This is Jack London country. We pull into the old gold-rush town at 8 pm. We check into a hotel, eat a steak dinner, take a stroll along the wooden sidewalks past the restored Victorian buildings, wash a thick layer of dead bugs off the windshield, and still have time for a 100-mile sunset drive on the Top of the World Highway. We never actually see the Sun go down that night.

The unpaved Top of the World Highway, which roughly parallels the Yukon River, ends at the Canada-U.S. border and provides us with our second visit to Alaska. A few days and a thousand miles earlier, we spend the night in the port town of Stewart, British Columbia, located at the base of a glacier-rimmed fjord.

Adjacent to Stewart is Hyder, Alaska, which is so small it's not on our maps. We cross the unmanned international border at 7 in the morning and ride through Hyder's unpaved streets. The only inhabitants at this hour are free-roaming horses and pigs. Welcome to the United States.

By way of contrast, the international border on the Top of the World Highway is marked by a guard house and gate. However, the guard has closed up by the time we arrive. Life is still pretty loose in the Yukon.

Surprises are what road trips are all about, and we experience our share. We come across Indian totem poles on the Skeena River, water-skiers on the delta of the Mackenzie River, the best burger in British Columbia in a gas-station café in Forty Mile Flats, unsightly timber clear cuts along the Yellowhead and Stewart-Cassair highways, milky-white runoff from grit-filled glaciers, an official greeter at the Arctic Circle in top hat and tails, three ferry rides across rivers that are ice-free only three months a year, a stretch of road that crosses the Continental Divide three times in a couple hundred miles, and a dinner check in Inuvik with a bar bill double the cost of the Arctic char and caribou steak entrees. Never mind what we drank.

Law of the Yukon

The GMC Yukon handles all of these surprises flawlessly. It takes us 2740.9 tough miles, while burning 227.8 gallons of fuel. The best gas mileage we record is 15.6 mpg, but most drivers can expect to do this well or better. Our big 350-cu.-in. V8 runs at peak rpm most of the trip due to the advantage of zero highway patrol monitoring. Also, our altitude is high,

typically around 5000 ft., and we are loaded down with 1000 pounds of gear and virtual wind brakes—luggage, spare tire and fuel jugs mounted on the roof.

The Yukon takes the place of the full-size GMC Jimmy and features a number of welcome improvements. Chief among these is a 4-wheel anti-lock brake system and the complete redesign of the dash and instrument panel. Off-roaders will appreciate the 6.9 in. of bottom clearance and the shift-on-the-fly 4wd stick, which is conveniently offset close to the driver on the transmission hump.

After spending 70 hours in the GMC Yukon in five days, our test crew is impressed with its comfort and roominess. Headroom, legroom and overall ergonomics are outstanding in the front captain's seats and in the rear folding bench seat, which is where photographer Roy Attaway spends the entire trip and never complains once. Honest.

The only problems we encounter are with the cruise control and seatbelts. The cruise control hunts excessively between Third and Fourth gears, although the unique characteristics of our trip—high elevation, high speeds and heavy load—may contribute to the problem. As for the seatbelts, they develop slack in the shoulder straps and often fail to wind back into the spool. GMC informs us that both problems have since been corrected. These, of course, are extremely minor annoyances.

Northern lights

Our Arctic journey comes to an end in the small Eskimo town of Inuvik, which is closer to the North Pole than is Iceland. Here we encounter our final surprise. A taxi pulls up next to us at a stop sign, where the driver rolls down his window and hollers out, "You're from POPULAR MECHANICS, eh?"

Mike Allen, who's sitting behind the wheel nearest the taxi driver, answers suspiciously, "Yeah."

"What's your name?"

"Why?"

"Because I read it all the time."

"Mike Allen."

"I know you."

"Huh?"

"I read your Car Clinic column. It's how I learned to speak English after I moved here from Hungary. I love your magazine."

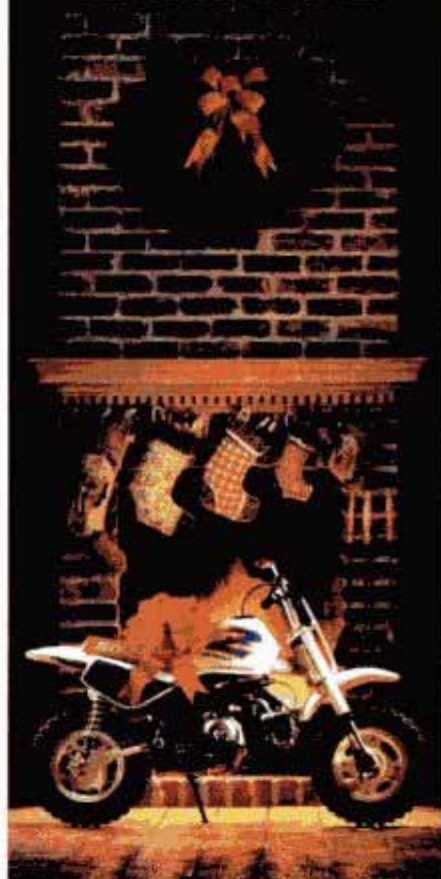
We may have driven to the end of the world, but POPULAR MECHANICS apparently goes everywhere. And, so will the new GMC Yukon, which we have learned fully lives up to its rugged name. **PM**

You'll need

a crowbar to

get the smiles

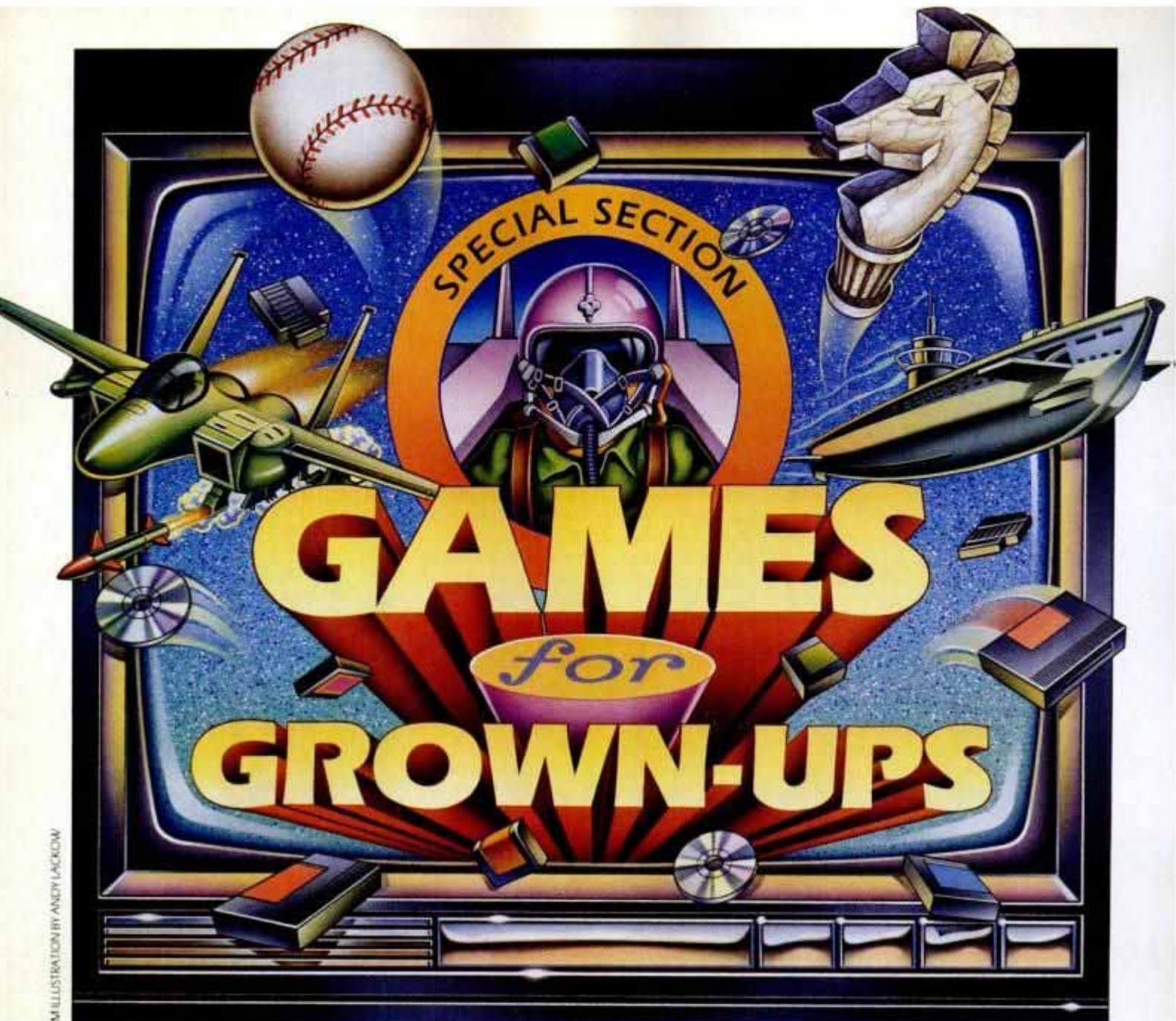
off their faces.



Unrestrained laughter. Hooting and hollering. Even dimples. They come standard with every pint-sized Honda this holiday season. But not just for the little ones. For you. When you see the cozy deals and financing* available on shiny, new Honda motorcycles. So have a Merry Christmas. And if this isn't the happiest new year they've ever had, fine. Keep the bike. Return the kids.

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FM ILLUSTRATION BY ANDY LACKOW

● Television, habitually described as a cool medium due to the passivity of the experience, is warming up. Television is becoming increasingly interactive, offering a give-and-take never before available, thanks to a variety of both new and improved technologies.

Better technology means that the on-screen material is more sophisticated, complex enough to engage the adult mind but entertaining to the child in all of us.

More engaging, for example, are a new crop of videogame systems with twice the entertainment capability of previous systems. Lest you feel like some overgrown Tony the Tiger eating a kid's sugar-coated breakfast cereal when you shouldn't, consider this: Nintendo estimates that its old 8-bit game system is in more than 7 million homes where there are no children present. Let's not even count the adult gamers who play when the children are tucked in bed. If you're an adult videogame player, you're far from alone.

Television is not just for watching. Games aren't only for kids. And thanks to new interactive technologies, you might learn something too.

It's no surprise then that the new 16-bit videogame systems feature a great many titles that adults can enjoy. Sports titles endorsed by athletes like football great Joe Montana are a natural. But while you might like playing

the football hero, playing God, for example, in "Populous" is an even more fanciful experience. In the game "Populous," you create and control a world made in your own image—an intellectual exercise on a very grand scale to be sure.

"Populous" also illustrates a trend that's bound to create confusion. "Populous" is a game for many platforms—that is, it exists on many systems. In this instance, "Populous" exists as a computer game and as a videogame for Nintendo and Sega. The Nintendo version has 989 levels of play on 10 landscapes, while both the Sega and IBM-compatible computer title have less than 500 levels on four landscapes. While the title of the game may be the same, the complexity of the video-

(Please turn to page 74)

CANADA AT ITS BEST

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In this holiday season,
we wish you, as ever, our very best.

LIGHT,
SMOOTH,
MELLOW

GAMES FOR GROWN-UPS

game may differ depending upon the platform.

The newest platform uses an already-familiar medium—the compact disc—to present games, entertainment and instructional material. There's also a choice to be made between Commodore's CDTV approach and Philips' CD-I system. The interactive approach used by these systems promises to make TV the textbook of choice for many subjects. A glance at the initial CDTV catalog shows the breadth of learning material available. One disc holds the complete works of Shakespeare. Another disc holds an encyclopedia. A third contains a dictionary. There's also an illustrated Bible, an atlas, and a disc on weapon systems that will make you sound like an arms dealer.

CD-I is just as educational. Take a stroll around the Smithsonian Museum, play cards like a Las Vegas gambler, or learn photography without the cost of developing film. With either system, a library of information can be stored on a small bookshelf.

Both systems offer games for children and adults. Nintendo will make its games available on CD-I.

Snoopy and Sherlock Holmes are available on CDTV. Adults should favor the board games and simulations like "Sim City" available on CDTV. Perhaps the most realistic round of golf, short of being on the green itself, is a strength of CD-I.

The differences between the two systems are complex (see page 78) and go beyond software. If any first impression has been made, it would be to say that CDTV is more of a reference-oriented format while CD-I is geared more toward simulating experiences.

How well experience is simulated corresponds directly to the amount of data that can be stored on a given platform. One of the best platforms for this purpose, of course, is the computer. Literature suggests war brings experience in a rush. There's also a plethora of skills required for mastering the high-tech task of piloting a Stealth aircraft, for example. Strategic thinking is a major consideration as well. The computer simulations reviewed on page 82 let us learn some of the lessons of war safely and even entertainingly.

—Frank Vizard

TM PHOTO BY BRIAN KOSOFF



VIDEOGAMES POWER UP

New 16-bit game systems are twice as good.

BY JAMES K. WILLCOX

● This Christmas, Nintendo, Sega and NEC will try to convince you it's time to move up to a new generation of videogame systems. The new game systems, they say, will be more than just a little bit better—they'll be 8 bits better, to be exact.

What the new videogame systems offer is a step up from 8-bit to 16-bit game play, thanks to microprocessors once only found in personal computers. Utilizing these new computer chips, home videogame players can now enjoy the fast action and colorful

graphics that were once only available in videogame arcades.

Along the way, however, videogame manufacturers will have to convince you that the improved performance is worth the increase in price.

And while earlier 8-bit game systems, such as the market-leading Nintendo Entertainment System (NES), had been geared toward a target audience of 8- to 14-year-olds, the new game systems are clearly being positioned with an eye toward generally overlooked prospective gamers: teenage boys and men who still have a little bit of the teenager left in them.

While 16-bit game systems have been available from NEC and Sega for nearly two years, this Christmas marks the first appearance of Nintendo's successor to its workhorse NES. Like Sega's Genesis and NEC's TurboGrafx-16 systems, the Super Nintendo Entertainment System—Super NES, for short—uses upgraded computer chips to provide dramatic improvements in game play and sound. But what does that really mean for game players?

First, it's necessary to understand that beneath the plastic exterior and emphasis on entertainment, videogame machines are at heart small, relatively powerful computers. In the same manner that text and graphics are controlled in the PCs we use in our homes or at the office, the on-screen action in videogames is controlled by two tiny but powerful microchips—the Picture Processing Unit (PPU)

—the Picture Processing Unit (PPU)



and Central Processing Unit (CPU).

The CPU acts as the brains of the system, interpreting and directing the steady stream of data it receives from the game cartridges. The PPU, in turn, receives information from the CPU and game cartridges, and transforms it into the graphics and video information you see displayed on-screen. In the NES, for example, it is the PPU that completely redraws the entire screen every 60th of a second or so, a speed sufficiently fast so that on-screen images appear to be moving.

By using faster, more powerful 16-bit chips, game play is markedly improved, primarily because of better graphics and sound. A larger, faster processor allows for better resolution, larger and more colorful characters and graphics, and smoother movement by on-screen objects. In addition, more moving objects can be presented on screen at once, and they can be moved more quickly. Game sound is also greatly enhanced, and most systems can be connected to stereo systems for truly high fidelity.

While NEC's TurboGrafx-16, Sega's Genesis and Nintendo's Super NES systems each represent a technological step up from older videogame systems, each system offers its players merits unique to that system.

A strong sports lineup and a very fast CPU makes Sega's Genesis system a strong rival to Super NES. Genesis has a list price of \$150. About 150 games are available.

Nearly 30 million NES game consoles have found their way into homes in the U.S. And because of this dominance of its NES game machine, Nintendo hasn't been in a hurry to introduce a new system. Presented only recently, Super NES is the newest kid on the block. But the company's deep pockets—it has earmarked \$25 million for advertising for just the first few months—and well-recognized name will almost ensure Super NES high visibility this Christmas.

Technologically, Nintendo's latest stands toe-to-toe with its competition. Super NES sports the widest palette of colors (32,768) of any system, with 256 colors capable of being displayed at one time. Super NES also has the highest maximum screen resolution, which is measured in screen dots called pixels, so that the picture is sharp and detailed. In addition, a custom Sony sound chip, complete with its own 8-bit CPU and digital signal processing, pro-



PHOTO BY BRIAN KOSOFF

vides for impressive digital audio capabilities.

But the Super NES feature that has attracted the most attention among game players is a graphics mode the company calls "Mode 7." This feature allows Super NES superb biaxial rotational and scaling abilities. Scaling refers to the size of one object relative to its proximity to another. The abilities are shown to nice effect on the flight simulation, "Pilot Wings," and the space-age racing game, "F-Zero."

Recognizing the wider appeal of a more sophisticated system, Nintendo will also be offering games such as "Sim City," a popular computer title, which lets you create and run a major city, from housing to sanitation. Similarly, "Populous," a title offered by Nintendo licensee Acclaim, is also a sophisticated game derived from a computer title. "Super Play Action Football" should attract sports fans. Most of Nintendo's Super NES games will sell for about \$50, and a number of its NES licensees have signed on to make games for the new system. However, Nintendo expects to have 18 games ready by the new year.

All that technology, however, comes at a price: Super NES leads the pack with a sticker just pennies shy of \$200, though that price does include



SNK's Neo Geo system also lets you play golf, but course fees are the highest around.

GAMES FOR GROWN-UPS



"Super Mario Land," the latest sequel in its best-selling Super Mario Bros. series.

Unfortunately for those who have significant libraries of NES games, you can't play them on Super NES. Nintendo won't offer an adapter like Sega has for Genesis so you can play 8-bit Sega Master games.

Speedy sprites

As for Sega, its Genesis system can lay claim to having the fastest Central Processing Unit—the same processor as a Macintosh computer. The CPU handles the dizzying flow of data related to the on-screen action. While the maximum number of sprites Genesis can display (80) is less than the 128 of the Super NES, Sega's faster processor (7.6MHz, to 3.58MHz for Super NES) means that Genesis won't slow down as noticeably as Super NES when the action is at its peak.

Like NEC, Sega has been in the 16-bit market since 1989, so it enjoys an advantage in being farther along on the learning curve than Nintendo for developing 16-bit games that utilize its system's capabilities.

Finally, with a price of \$150, Genesis is \$50 cheaper than Nintendo's Super NES, and it comes packed

with its hottest game, "Sonic The Hedgehog"—one of the best-selling videogames of the year. With more than 1.5 million Genesis systems already in game players' homes, Sega can boast the highest installed base of any 16-bit videogame system.

Sega expects to have almost 150 games out by Christmas this year. These will include a strong lineup of recognized, licensed titles, as well as sports games such as "John Madden Football," "Hardball" and "Mario Lemieux Hockey." There will also be games based on popular characters such as Dick Tracy, Spider-Man and Mickey Mouse.

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Like Sega, chip manufacturer and telecommunications giant NEC debuted its 16-bit system, TurboGrafx-16, in late 1989. Early this past summer, the company decided to drop the price on the system to \$100, making it the most affordable 16-bit system available. Unlike Nintendo's and Sega's new machines,

Price buster

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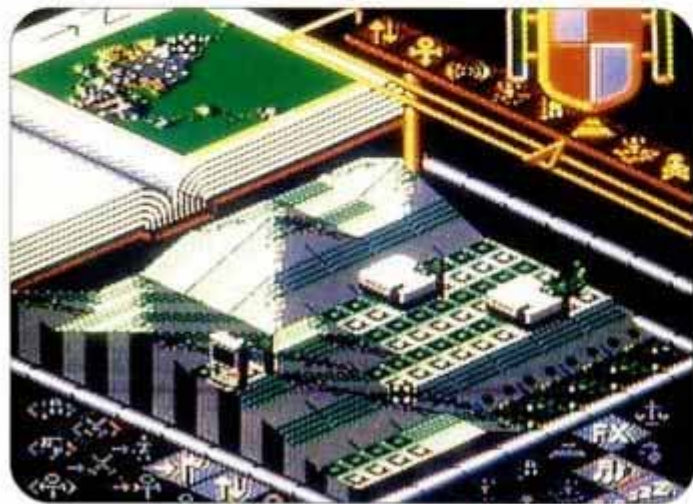
however, NEC's still uses an 8-bit CPU, though graphics are provided courtesy of a 16-bit graphics generator. TurboGrafx-16 can theoretically display more colors (512) than Sega's Genesis (16) or Nintendo's Super NES, although at present NEC's games don't use more than Super NES's 256 colors.

Currently, NEC is the only company offering a CD-ROM accessory—TurboGrafx-CD (\$299)—for its system. Because a compact disc (CD) is able to store 2000 times the amount of data as a conventional game cartridge, better sound, graphics and digitized video are possible. The CD player can also play standard audio CDs, as well as CDs with graphics (CD+G).

While many of its early CD games were merely cartridge games loaded onto discs, NEC has recently introduced several games specifically designed for its CD peripheral. For example, "Sherlock Holmes, Consulting Detective" uses digitized images of live actors, and "Magical Dinosaurs Tour," an entertaining and educational animated encyclopedia, uses digitized video and photo images and human voices. A CD game based on the new Addams Family movie is currently being developed. Most CD games are priced at \$62.

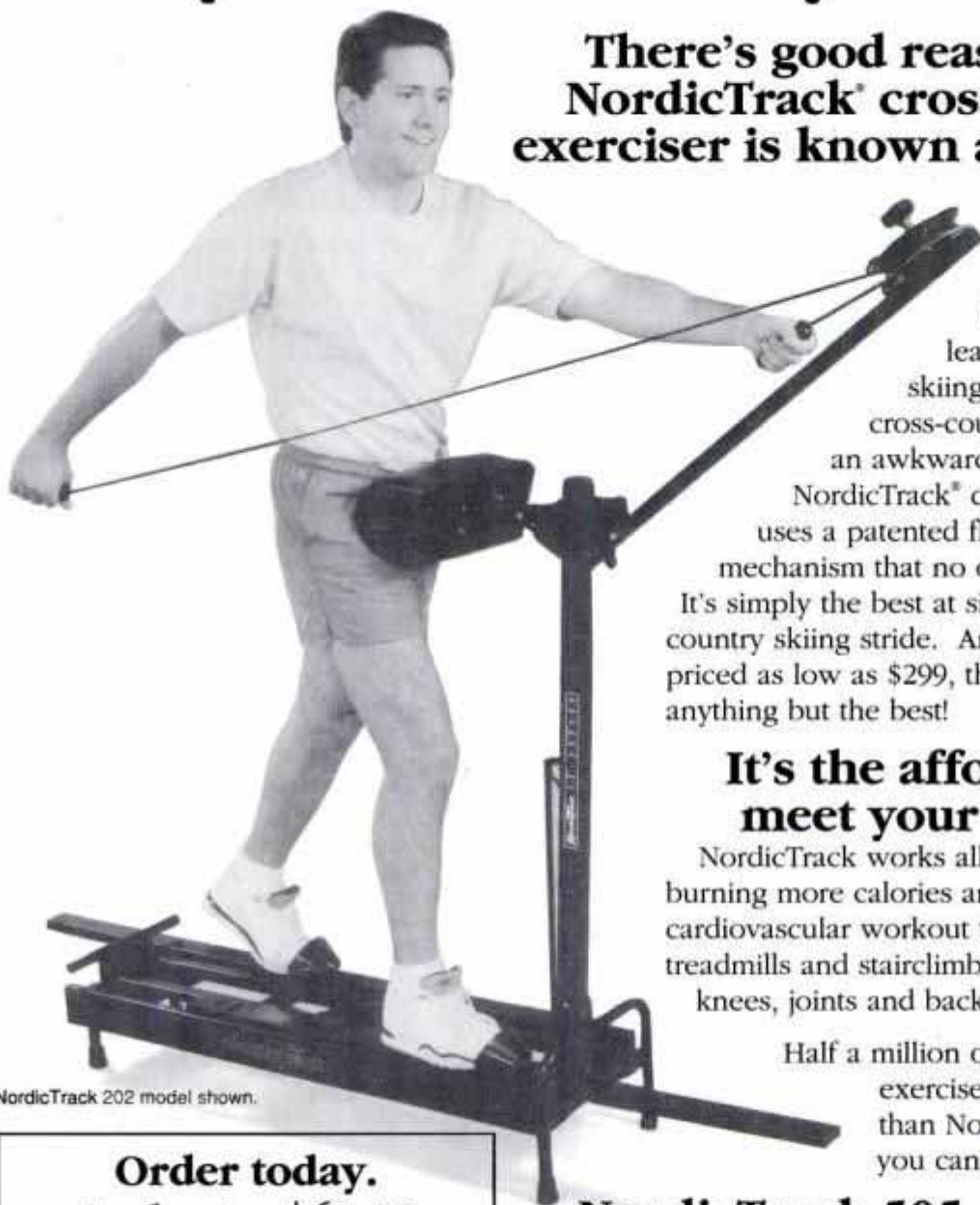
To capitalize on the growing market for sports-related titles, NEC introduced an accessory called TurboTap, which lets as many as five

(Please turn to page 78)



Complex computer games like "Populous" are being adapted for Super NES.

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NordicTrack 202 model shown.

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GAMES FOR GROWN-UPS

players participate simultaneously. A line of cartridge-based TV Sports titles, beginning with "TV Sports Baseball," utilize the 5-player option.

More bits

While new systems from Nintendo, Sega and NEC are providing heightened videogame excitement and expanding interest, other companies are already pushing game parameters beyond 16-bit systems into more advanced technologies.

For example, Neo Geo, a high-tech videogame system from SNK, features two separate processors, three independent background screens, 15 channels of stereo sound and the ability to display more than 4000 colors on-screen simultaneously. Capable of playing games with 330 megabytes of ROM (8 to 10 megs are considered heavy duty on 16-bit systems), Neo Geo—and its price of \$649—obviously isn't for everyone. Game cartridges

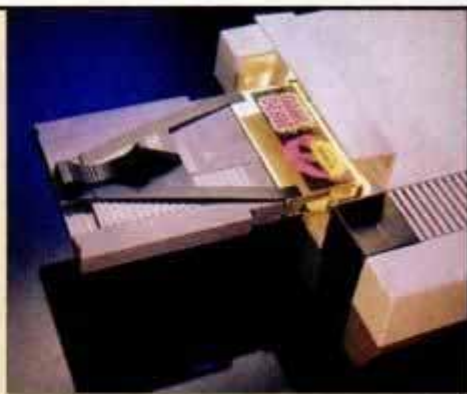
Genie Offers Short Cuts To Highest Level

● Can't get to that last level of Super Mario Bros.? Get some help from Game Genie, an accessory from Galoob Toys that allows you to customize your favorite Nintendo videogames.

Game Genie connects a Nintendo cartridge and the NES deck—you slide a game cartridge into Game Genie, which then plugs into the game slot in the NES console.

By punching in special codes from an included code book, Game Genie lets you modify the play of favorite videogames. For example, your character can gain lives, run faster or jump higher. You can even start on any level

are the size of videocassettes and include titles like "Top Players Golf," "Baseball Stars Pro" and a 3D riding game called "Riding Hero." With each



without playing through previous ones.

Game Genie will work with over 290 popular Nintendo games, and quarterly updates will be provided as newer games hit the market. The price of Game Genie is about \$50. —J.K.W.

game priced at \$200 each, Neo Geo is obviously targeting an older well-heeled crowd. Clearly, videogames are not just for kids anymore. **PM**



VIDEO CD

Play and learn with data-packed compact discs.

BY STEVEN A. BOOTH, Contributing Editor

● Wanna shoot craps at Caesar's Palace like the high-rollers do? Wanna flip through a '50s jukebox like we used to? How about breaking the sound barrier in Chuck Yeager's Bell XI, or pulling high g's in an F-16 Falcon? You can do all this and more right

in your own TV room by spinning some mint-new silvery platters that have the look and feel of digital compact discs.

Fact is, these little saucers that combine video, sound and text for display on your TV are indeed

CDs—sort of. The programs they provide are similar to the feats performed by so-called multimedia computer workstations—but that's a mouthful that would cause many people to stop reading right here. Accordingly, by packing the entertainment possibilities of a complex computer onto the familiar CD and running that disc in a machine that

Commodore's CDTV has an Amiga computer built-in for games and data retrieval. Like a computer, a keyboard and other accessories are available. The CDTV also plays music CDs.

looks just like the familiar CD player, the makers of this new, interactive entertainment technology hope to make an end run around the negative connotations of the work, difficulty

and confusion often associated with computers.

So far, so good. What we've got here is an accessible, user-friendly system for adults to play a simulated game of golf in Palm Springs, or for kids to create their own cartoon animations instead of being spoon-fed by commercial television. Trouble is, we've got two of them. As is so often the case in consumer electronics—videogames, VCRs, camcorders, you name it—the poor "consumer" has to choose among competing systems that aren't compatible with one another.

At press time, your choices in interactive home entertainment are two: CDTV and CD-I. The first stands for Commodore Dynamic Total Vision and is the brainchild of the same Commodore Electronics of Amiga computer fame. CD-I, which should be avail-

able in stores by the time you read this, stands for Compact Disc-Interactive. It's a joint development of electronics giants Philips and Sony, those wonderful people who brought you the CD. Before investigating how the systems differ, let's look at what they have in common.

Both CDTV and CD-I deliver their programming software on the same size compact discs used for music reproduction. For both systems, the "iron" is a sleek, black component that looks just like a music CD player and, in fact, will play conventional music CDs. Each type of player hooks up to your TV, the same way a VCR does, to display the video portion of the programming. You can route the sound through your TV too, but for greater enjoyment of the digital audio quality, each kind of machine provides outputs for hookup to your hi-fi system and loudspeakers.

To navigate your way through the disc programs and make golf strokes or brush strokes, each system comes with a wireless handset that combines the functions of a remote control and videogame controller. Overall, CDTV and CD-I are conceived as products that belong in the family room, alongside the TV and VCR, not in the home office where you'd put a computer. In fact, to distance its

CDTV player from the notion of computing, Commodore does not issue any printed operations manual with the unit. Instead, there's a starter disc that takes you through the machine's functions in learning-by-doing fashion. The cost of the hardware is similar: between \$800 and \$1000 on the street. The disc programs range from \$20 to \$60 for CD-I and \$40 to \$80 for CDTV, with some titles costing more. For example, a 21-volume encyclopedia on a single CDTV disc lists for around \$400, but is available as a promotion for \$50 when you buy the machine.

Different strokes

Despite their outward resemblance and similarity of purpose, the operating systems for CDTV and CD-I are as different as those for VHS and 8mm video or, for that matter, Amiga and Macintosh computers. Functions and performance differ, too.

Both systems put their programming software on a CD, but all CDs are not created equal. There are several formats for compact discs. One (the first) is the familiar music CD. Others include CD-ROM (Read-Only Memory) and CD-I (Interactive)—and these two don't speak the same language. In fact, CD-ROM discs aren't always interchangeable.

CDs have immense storage capacity: 550 megabytes of data in computerese, or about 250,000 typewritten pages. The CD-ROM format was conceived to deliver vast amounts of data to a computer, including sound and still graphics, through a peripheral disc drive. As computer systems differ, so do the CD-ROMs that feed them. There is no universal standard. For example, a Macintosh CD-ROM won't play on an IBM computer, and vice versa.

CDTV is basically a CD-ROM, but endowed with special attributes owing to its association with Commodore's popular Amiga computer. Among these attributes is a wide color-range and motion video, as we'll discuss later. Fact is, there's a full-fledged Amiga 500 computer under the deceptive hood of the CDTV player (and this presents intriguing possibilities for would-be CDTV users). But unless Commodore licenses other companies to sell CDTV machines, the only way you can play a CDTV disc is in a Commodore CDTV player.

CD-I is a totally different format—but it is a standard. Just as a music CD from any label will work in a CD player from any brand, the new interactive compact disc will play in any CD-I player. This is a stipulation of the manufacturing license granted by

Old Board Games Come To Life

● When electronics companies plug into traditional board games, the result is something other than a quiet day at the park.

Chess fans may be interested in the Chesster Phantom made by Fidelity Electronics of Miami, Florida. Chesster Phantom is like having an annoying but instructive coach. The machine's vocabulary includes hundreds of words and phrases that it's able to use in English, French and German.

Mostly, Chesster tries to pass on helpful hints that may give you a chance to win. Chesster can be set for

play on 10 levels of difficulty, but your chances of winning are slim. Fidelity says Chesster Phantom can beat 95% of the world's chess players.

Chesster Phantom's expertise goes hand-in-hand with a rather obnoxious sense of humor. Make a particularly dumb move, and Chesster Phantom asks: "Are you a salesman? Only a salesman would make a dumb move like that!"

Chesster Phantom can also move board pieces for you. Providing the movement is an electromagnetic guidance system underneath the playing board. Chesster also calculates the move time for a player, how many moves ahead Chesster is calculating and current scoring. List price for the machine is \$599.

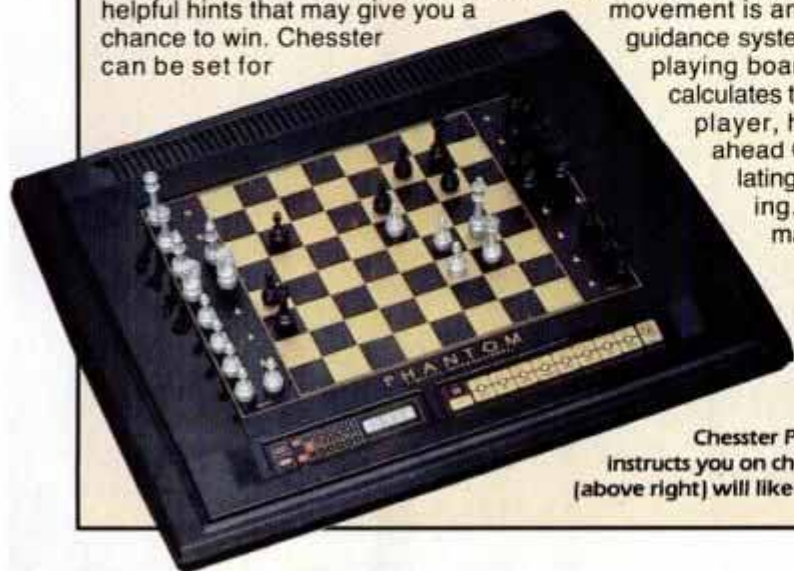
For those who like their games to have an Oriental twist, consider a portable, electronic ver-

Chesster Phantom (left) rudely instructs you on chess, while fans of Go (above right) will like the portable model.



sion of Go. Extremely popular in Japan, Go is a complex, 4000-year-old game of Chinese origin said to have been played by samurai. It's most popular today with Japanese businessmen who appreciate the game for its strategic and tactical lessons.

In the portable electronic game, you play against the computer. While working on a 19 x 19 grid board, you place black stones on vacant intersections. Your opponent does the same with white stones. The winner is the player who owns the most unoccupied intersections. List price for the Nemesis Igo Dojo, as the portable is called, is \$695. The machine is made by Toyogo, Inc., of Kaneohe, Hawaii. —Frank Vizard



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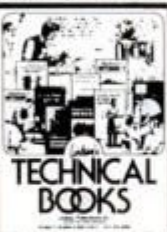
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GAMES FOR GROWN-UPS

Philips and Sony, the developers. Although the Philips CDI910 will be the first CD-I player on the street, subsequent entries from Magnavox, Sony, Panasonic or whomever will play any CD-I title.

Although CDTV and CD-I are not compatible, there is one possible point of confusion. Commodore calls CDTV "interactive" despite its use of the CD-ROM. Here, the company is describing CDTV's character, not its CD format. By interactive, Commodore means the programs provide more than passive entertainment—they're designed for user participation. The degree to which either system is interactive, that is to say instantaneously and intelligently responsive to the user's input, seems upon first impression to depend more on the software programming than the CD format.

We use the term "first impression" purposely. We suspect that each system has potential and capabilities that will evolve, or be added to it, over time. For example, a reading of Commodore's literature would lead you to believe that the system can display only 32 colors from its palette of 4096. In fact, by using a special function of the Amiga

computer called Hold And Modify, CDTV can display all 4096 colors simultaneously. Although the initial software programs didn't use HAM, later disc titles probably will.

Disc-ography

The initial software libraries for CDTV and CD-I comprise about 50 discs for each system. The programs address both adults' and children's interests, and can be categorized broadly as entertainment, simulation, education and reference titles.

At first blush, reference works appear to be CDTV's strong suit while CD-I holds the cards in simulations. Reference titles under the CDTV umbrella include the *American Heritage Dictionary*, *Grolier Electronic Encyclopedia*, *Illustrated Holy Bible*,



A jukebox of classical music and an ABC golf simulation are just two of the titles available for CD-I players like this one from Magnavox. Like CDTV, CD-I machines play music, too.



Complete Works Of Shakespeare, and four Gardenfax discs. Simulations for the CD-I system include *Caesar's World Of Gambling*, *ABC Sports Golf: Palm Springs Open*, *Time-Life Photography* and *Treasures Of The Smithsonian*.

Any of the CDTV reference works makes research a breeze. But let's say you're planning a vegetable garden and need to know what works best in your location. The disc titled *Gardenfax: Fruits, Vegetables & Herbs* lets you select from 170 edible plants according to climate, planting time, harvest time, soil and light conditions, and other criteria. Just use the remote control to select the conditions that apply to your location, and the disc generates lists of what you should grow—along with copious information on each plant. On another tack, most kids hate library work. But the *Grolier Electronic Encyclopedia* on CDTV brings research alive. Because it combines video with sound and text, you not only get to see and read the difference between a piano and harpsichord, but you get to hear the difference too, with CD-quality sound. (For the record, the quality of the digital audio varies on all CDTV and CD-I discs—from CD level to AM-radio sound, according to the demands of the program material.)

The CD-I simulations offer a different level of experience. Let's say you're playing blackjack in *Caesar's World*—and you are, because the screen action is live, on-location video. You're dealt two sevens, and the dealer asks you if you want to "double down." Don't know what this means? Ask the dealer through your remote control, and you'll get an explanation. The *Smithsonian* CD-I is more than the type of tour you'd get on TV—or even at the venerable museum. You won't just see the African thumb-piano that's kept under glass. You'll get to play and hear it, too. Short of paying for lessons, *Time-Life Photography* is the neatest way yet to learn picture-taking. It's based on the 10-volume book series, but you get to practice and see your results on TV. In the chapter on shutter speeds, for example, you'll change shutter settings when shooting a fast-moving boat, and see how a fast shutter freezes action while a slow setting captures the feeling of motion through an intentionally blurred image.

There's more to CDTV and CD-I than just work. Both formats offer programs that are a lot better for the kids than gazing at the boob tube. Titles include the *All Dogs Go To Heaven Talking Electric Crayon* coloring book for CDTV and the *A Visit To*

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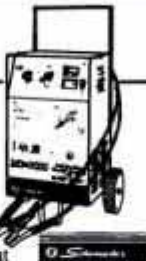
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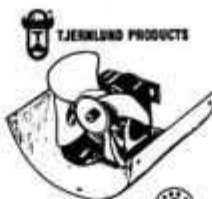


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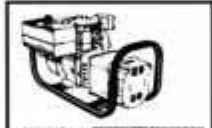
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Traditional board games like chess take on new life when played on CDTV.

song and artist. CDTV's *Music Maker* disc lets you get into the action. If you hook up an electronic musical instrument (drum pad, keyboard and so on) to the CDTV player's MIDI (Musical Instrument Digital

Sesame Street: Letters reading program for CD-I.

For grown-ups, the CD-I *Jukebox* series is fun. Whether it's golden oldies or classical music, the screen display resembles an oldtime jukebox and complements the digital-audio tunes with lyrics, photos and all sorts of background information on the

Interface) port, you can play along or just take lessons.

This last example raises an important point about the CDTV player. It is in fact an Amiga 500 computer, and by adding an optional keyboard or other accessories, it will do everything the Amiga will. This is a key benefit for musicians (the MIDI port

and for video buffs. If you're into making video home movies with a camcorder, an optional genlock board for the CDTV player will let you generate all sorts of computer special effects for overdubbing on your tapes. CD-I, while having other attributes (such as crisper video rendering of photographs), is a closed system and does not offer CDTV's computing ability.

While we're on the subject of video, let's note that at this writing, neither system offers full-screen, full-motion video. This will come in the near future, in the form of an add-on board that you'll be able to install in your player. For now, they both deliver only still-video and varying degrees of partial-screen, partial-motion video. This is not a limitation, though, for the types of programs now available. When the systems get up to speed, their makers claim they'll deliver about an hour of full-screen, full-motion video (about VHS-tape quality) with digital audio. **FM**

WAR GAMES

Computer simulations take you to the modern battlefield. Here's a look at the best.

BY FRANK VIZARD, Electronics Editor, and GREGORY T. POPE



FM PHOTO BY BRIAN KOSOFF

● Modern warfare is a high-tech business requiring specialized skills that most of us, thankfully, never get a chance to learn. Still, if you want to get a sense of what it's all about, you might investigate the large number of war simulations available for running on a personal computer.

While some of these games are nothing more than shoot-'em-ups, a surprising number are amazingly accurate in their representations. Game designers cull performance details from a variety of nonclassified sources. The result is something that operates very much like the real military machine. Computer games are generally a lot harder to play than videogames. Manuals run as long as 100 pages in some cases. The price is higher too—between \$40 and \$80 each. To make playing the game as simple as possible, it makes sense to invest in a joystick like those made by Advanced Gravis (around \$50). Joysticks are fairly easy to install and companies like Gravis include testing procedures to ensure proper calibration. However, all games can be played using the keyboard.

War plane simulations like "F-117A Nighthawk" put you in the cockpit of a Stealth fighter. Experience combat in nine theaters of operation. This game features topnotch graphics.

M1 TANK PLATOON MicroProse

Among armored combat simulations, the heavyweight title goes to this offering from MicroProse. The game



puts you in command of a 4-tank platoon, each vehicle operated by a motley crew of four. You direct the action by doling out orders through the keyboard, but since your 16 subordinates vary wildly in skill, you must often step into their shoes.

Despite a formidable learning curve, "M1 Tank Platoon" delivers a realistic punch, rewarding graphics and endless variety of action.

TANK Spectrum Holobyte

Based on the U.S. Army's SIMNET land-combat simulation system, "Tank" allows you to play the battle-planning colonel, the order-snapping lieutenant and the fight-or-die soldier in a single experience.

This choice of approaches eases you into the game without force-feeding you dozens of keyboard commands. But the graphics have a stripped-down, EGA look.

"Gunboat" (left) sends you up the river to raise hell, while "M1 Tank Platoon" puts you in the driver's seat of a formidable land vehicle and in command of three other tanks.

SILENT SERVICE II MicroProse

If modern-day submarine warfare seems too distant and clinical for you, step

back in time to World War II. You're a sub commander patrolling the Pacific Ocean and preying on Japanese ships.

"Silent Service II" is an easy game to get into, perhaps because submarines were simpler back then. Thankfully, "Silent Service II" doesn't get you bogged down in procedural details. The graphics are quite good, and the game seems to have a great deal of longevity. You also can't help but learn a little history.

GUNBOAT Accolade

River patrol boats came into their own during the Vietnam War, and it's here "Gunboat" begins. There are two other scenarios with more modern-day implications. One takes place in the Panama Canal Zone and the second in Columbia.

"Gunboat" is basically a shooting gallery although some piloting skills are necessary. Graphically, "Gunboat" varies in quality from the primitive to fair.

688 ATTACK SUB Electronic Arts

If this game is any indication, there's a lot to do on a modern submarine. And this game makes you do it all.

This game does have a lot of nice

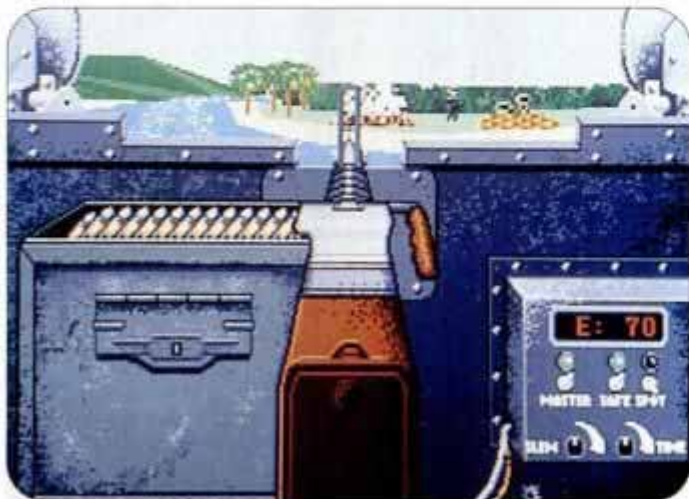
features. One is a side-scanning sonar that produces a contour image of the ocean floor. You can also opt to command a Russian submarine for a different point of view. Nothing is easy in this game. Master it, and you'll be ready to teach sub school.

"Silent Service II" (left) simulates World War II submarine action in the Pacific. "Stormovik: Su-25" gives you a sense of the challenges facing Soviet airmen.

STORMOVIK: SU-25 Electronic Arts

"Stormovik" offers a rare glimpse at the pride of the Soviet Air Army: the Su-25 ground-attack jet that NATO has unkindly dubbed Frogfoot. Packed with ordnance, this aircraft hugs the ground at low speeds in search-and-destroy missions. The game pits you, a Russian pilot, against unrepentant Cold War terrorists seeking to scuttle perestroika and revive flagging defense industries.

Players used to the helpful cockpit electronics in American combat-jet simulations will find the mechanical switches and dials a bit of a throwback. Once you've mastered the controls, the plane is very responsive. The graphics are smooth and detailed.



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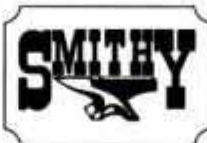
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GAMES FOR GROWN-UPS

F-117A STEALTH FIGHTER 2.0 MicroProse

Remember Desert Storm and how big a role the Stealth fighter played? Remember those great videos on CNN showing missiles blasting targets?

Yes, this game is like seeing all that footage all over again. The difference is that you're the pilot. The graphics on this game are superb.

Remarkably, the learning curve on this game is not steep, even though the manual is long. This game lets you get into the cockpit right away.

LHX ATTACK CHOPPER Electronic Arts

Even if you find realistic high-performance fighter games a dream, a realistic combat-helicopter simulation could be your worst nightmare. Mercifully, the designers have blended cyclic, collective and tail-rotor control into intuitive one-handed action, so that controlling your whirlybird won't make your head spin.

Gripping battle graphics make up for sparse scenery, and the aerodynamic complexities of a rotary wing come through with verisimilitude.

F-15 STRIKE EAGLE II MicroProse

The skies are dark, the landscape bathed in shadow. Soviet-made SA-6 surface-to-air missiles streak into the air, lighting up your tactical radar screen like a Christmas tree. Laden with AA-10 air-to-air missiles, three Iraqi MiG-29s are converging on you.

But with a few joystick wiggles and some keyboard pepper, you skip through the danger, down the MiGs and blaze a trail toward your primary target: a chemical weapons plant north of Baghdad. A quick "pitch-up-and-drop" maneuver, and you've knocked out the plant.

The game's chief appeal is its gentle learning curve. Unlike other combat simulations, it strips away the tough training and tedium and turns you loose on the enemy right away.

COMMAND H.Q. MicroProse

Most combat-simulation games revolve around tactics—outflanking enemy armor, ambushing hostile aircraft and the like. That's fine if you like the role of the one-man fighting machine. But if you'd rather play Colin Powell than Rambo, sealing the fates of nations with sweeping strategic decisions, then "Command H.Q." may be the game for you.

What this game lets you do is direct

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a World War of your own devising. "Command H.Q." has little of the action graphics in other simulation games—only canned animations in a corner of the screen showing the denouement of battles. But what the game lacks in visual bang it makes up in psychological tension. The clock runs constantly. Your decisions must come quickly and irrevocably.

GUNSHIP 2000 MicroProse

This is the helicopter version of "F-117A Stealth Fighter." The visuals are outstanding and approximate real-motion video at times.

While seemingly complex at first glance, the learning curve is fairly easy, thanks to a good manual that walks you through. There's also a lot of action since you are in a low-flying aircraft. Take out buildings, armored vehicles, infantry and so on. No points are awarded for shooting trees. This is an outstanding game.

HARPOON Three Sixty Pacific

You're suddenly transplanted into the uniform of a NATO naval commander. You're deluged with data on ships, subs, sonar and search radar. You have dozens of menus, hidden screens and dialog boxes to slog through while the enemy closes its net around your convoy.

If this is your idea of a good time, then "Harpoon" will push your buttons. But if you've never encountered a realistic modern naval simulation game, then forget about playing without Tom Clancy or the Chief of Naval Operations watching over you.

True, "Harpoon" covers all the bases, and its graphics are crisp and intelligent. But don't expect swash-buckling sea action or *Red October* suspense: The war unfolds verbally, the action limited to shifting icons on maps. And the manual offers no patience for raw recruits. **PM**

"LHX Attack Chopper" (above left) lets you scour the hills for enemies in an experimental helicopter. "Command H.Q." (above right) is war on a global scale, and you're giving the orders. Dogfights, good graphics and an easy learning curve characterize "F-15 Strike Eagle II" (right).



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CAR CARE

MAINTENANCE BASICS

LOCKS AND HINGES

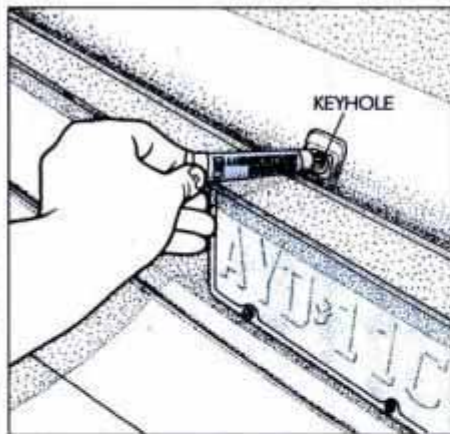
BY DON CHAIKIN

● A groaning car door irritates you each time you open it. And a hinge or lock that freezes can leave you stranded. Fortunately, it's easy to keep all doors and locks working smoothly and quietly. A twice-a-year maintenance regimen is all that's needed.

Different areas require different lubricants. The ones to use are:

- Waterproof white grease. Do not use multipurpose lithium grease, which is too thick. Nonstaining grease protects upholstery and clothing.
- Clean engine oil.
- Graphite-based lock lubricant. This can be a powder, a squeeze tube or an aerosol.

Before you apply any new lubricant, clean off the old, caked-on, dirt-laden lube. Use a grease-removing solvent such as mineral spirits on a clean rag or an aerosol degreaser with



Use a small amount of graphite-based lube on all of the lock cylinders.

a finely adjustable spray nozzle. Read any cautions on the label. Dry all the parts before lubricating.

Generally, more closely assembled parts, such as hinge pivot pins, should be oiled. Parts with larger clearances, such as latches and sliding metal pieces, should be greased.

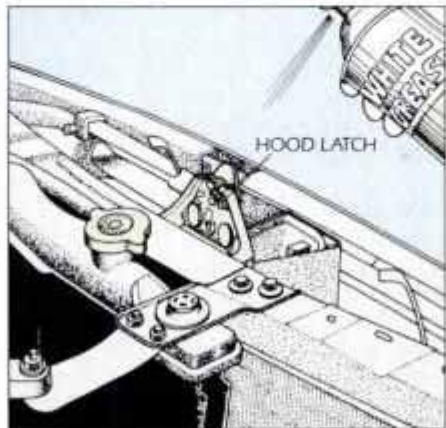
- Squirt a small amount of oil onto the pin that goes through the door hinge.
- Oil each hinge on each door, as well



Poorly aligned, ill-closing doors may need to have their striker plates adjusted.

as the hinge pins of the trunk lid (or rear hatch) and hood.

- Don't forget the pivot pins of the fuel-filler door.
- Open and close the doors, trunk and hood several times to work in the oil. Wipe off any excess oil.



White grease is best for hood and trunk latches. Be sure to wipe off any excess.

If a door, trunk lid or hatch does not close smoothly, or if it does not properly line up with the rest of the car, its latching mechanism, or striker, may need to be adjusted.

With the door, trunk lid or hatch closed, see if it has to be moved in or out to align with the adjacent body panels. Partially loosen the striker's mounting screws on the car body. Move the striker *slightly* in the direction needed—either in or out—and snug down the mounting screws. Recheck the alignment.

- Grease the hood latch and the hood hinge springs.
- Open and close the hood and trunk lid several times. Wipe away excess.

Since even the thinnest oil holds dirt and grit which can jam a lock, use graphite to lubricate all locks. Hold the lock open with the tip of a key to spray into the lock. Insert, twist and remove the key a few times. Then wipe it clean.

PM

CAR CLINIC

BY MIKE ALLEN
Associate Automotive Editor

Blowin' In The Wind

I used to have a compression test done periodically on my cars to keep tabs on the health of the engine.

I just asked a mechanic to do one last week, and he tried to convince me to get a "leakdown" test, which he told me was better, of course. Somehow I was not surprised when he also told me that it was more expensive than a compression test.

Is a leakdown test better? Is it harder to do? And how much more expensive should it be?

EMERY DUELL
SHREVEPORT, LA

I bought a leakdown tester about 10 years ago. The next day I gave away my compression tester to a friend. It's definitely better.

A compression tester relies on the pumping action of the engine to build up pressure in the cylinder. A gauge with a check valve measures the pressure, giving you an indication of how good the engine's internal sealing is. A low cylinder may have a burned valve, blown gasket or a scored cylinder wall. An engine with low compression on all cylinders probably has worn-out rings.

Problem is, it's difficult to get an accurate reading, because the amount of pressure you see on the gauge is dependent on a number of variables, such as the engine's cranking speed (which is dependent on the state of the battery and starter), the mechanic remembering to prop the throttle wide open and even the barometric pressure on the day the test is done.

A leakdown tester measures basically the same thing—but it uses a continuous supply of high-pressure air from the shop's compressor.

The air is regulated to a standard pressure—typically 80 to 100 psi. From there, it goes through a calibrated orifice in the leakdown tester, past a second gauge and then to an adapter in the spark-plug hole. The higher the leakage in the engine, the lower the second gauge will read. Typically, a well-broken-in engine will show a leakdown rate between 2% and 5%. An engine with a 10% leakdown is okay, and anything over 20% is pretty bad.

Unlike a compression test, you can



PM ILLUSTRATION BY DON MANNES

use a leakdown test to diagnose a problem. If there's a burned exhaust valve, then there will be a hissing noise from the tailpipe. Leaky rings will hiss through the oil filler cap. A blown head gasket will gurgle air back up through the radiator.

A good mechanic will be able to do a leakdown test on most cars in an hour or two, depending on how accessible the spark plugs are.

His Cup Runneth Over

I have a 1988 Hyundai. At 28,000 miles, the two rear tires are showing a strange wear pattern—I'd call it "cupping." The little rubber tread blocks come to a raised sort of point on the forward edge, especially on the inner edge of the tread.

I haven't rotated them at all, as I want to know the reason for this. I have been told all kinds of stories

—shocks, alignment, turnpike driving and so on.

ROBERT GRAY
GROVE CITY, PA

There's a technical term for the type of wear that's clearly visible in the photo you sent of your tire—it is in fact called cupping.

What causes it? It's fairly common on many fwd cars with lightly loaded rear wheels. The alignment settings that give the best handling and wear also seem to exaggerate cupping.

How do you prevent it? You can rotate your tires every 10,000 miles or so, more often if the cupping seems to be getting ahead. My personal preference for fwd cars calls for skipping the rotation sequence entirely—the rear tires will probably last the life of the vehicle if they are never moved, and you can simply buy new tires, two at a time for the front, as they wear.

CAR CARE

Should you do this? Maybe. The advanced cupping you have will have little effect if you leave it alone. But if you rotate the tires now, you might have some problem with whining noise from the rubber blocks slamming into the pavement until they wear off in a few thousand miles.

Fluid Debate

I was recently told by one trusted mechanic that automatic transmission fluid and power-steering fluid were the same. Another equally trusted mechanic said the opposite.

Could you please clear the air on this matter?

R. D. GIBBONS
HOT SPRINGS, AZ

ATF is not the same thing as power-steering fluid. There are about four kinds of ATF nowadays. It's important to use the appropriate type of ATF in your transmission, or shift quality and reliability may be compromised.

Power-steering fluid is basically just a hydraulic oil and really doesn't need many of the additives in ATF. Does this mean you can use ATF in your steering, but not use power-steering fluid in your transmission? The answer is no.

Confounding the issue is the fact that some vehicles specify ATF for the power steering—this may be what your first mechanic had in mind. For that matter, some modern manual transmissions specify ATF or even motor oil lube instead of gear lube.

Sigh. Read the owner's manual, and always use what the manufacturer specifies.

Getting The Lead Out

I have a 1977 Dodge-engine motor-home with an Onan generator. Both engines specify regular gas. As you know, regular, leaded gas is a thing of the past. Will unleaded gas harm the engine, or should I use a lead-substitute additive?

FLOYD FREDRICK
MULBERRY, TN

If your vehicle uses an engine built after 1972 or so—depending on the particular manufacturer—the valves and valve seats are probably rated for unleaded gas service.

Earlier vehicles that see light-duty service, like passenger cars driven back and forth to work or on the freeway at legal speeds, probably can live a normal life on unleaded.

(Please turn to page 90)



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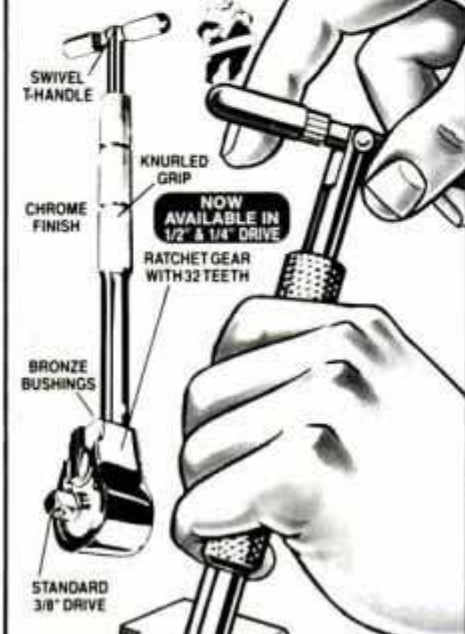
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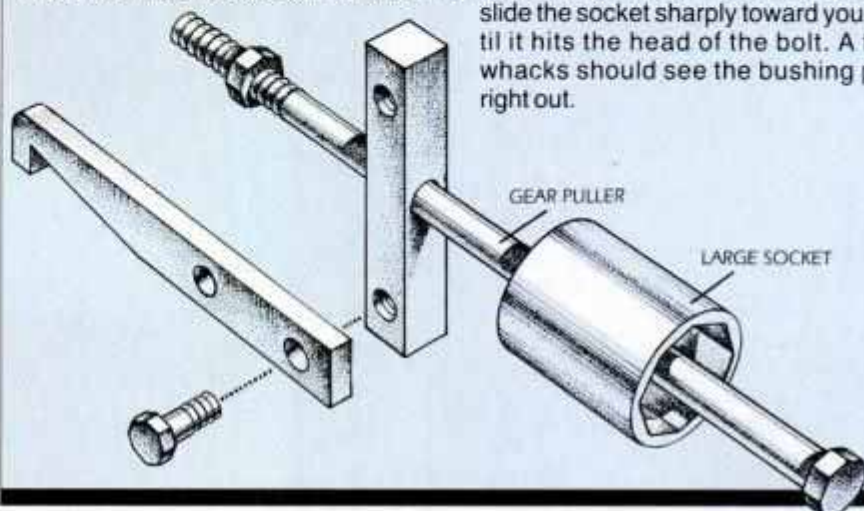
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Hammer Lite

● I've got a really nice slide hammer outfit—it's great for pulling steering wheels, brake drums and an assortment of bearing races. But it's too big for a lot of smaller parts, like pilot shaft bushings or Volkswagen clutch pivots.

Reader G.E. Rip Linger, of Kent, Washington, uses a small gear puller to make a pint-size puller. Install just one of the puller arms, and slide a long bolt first through a large 1/2-in. socket and then into the center bar.

Now insert the puller arm into the bushing of your choice, hooking the backside of the bushing. Hold just a little tension on the puller assembly with one hand, and slide the socket sharply toward you until it hits the head of the bolt. A few whacks should see the bushing pop right out.



Trucks, motorhomes, boats or generators—anything that runs at or near wide-open throttle for extended periods of time—are another story.

If your vehicle is much older than Mr. Fredrick's, you have several options: Use a commercial lead-substitute additive. Be wary that some of these are not very good, and often need to be used in substantially higher concentrations than called for on the bottle to be effective. They are also not particularly cheap and sometimes inconvenient, too.

Do not use diesel fuel, motor oil, automatic transmission fluid or any other kind of lubricant. They won't help even a little, and may well cause serious engine damage.

I wouldn't put up with that for very long. I'd simply start using unleaded with a high-enough octane to run properly, and live with the consequences: burned valves at some point in the future.

You could have the heads pulled, and the valves and seats replaced with unleaded-rated components immediately.

DO YOU HAVE A CAR PROBLEM?

Just ask Mike about it. Mail your question to Car Clinic, Popular Mechanics, 224 W. 57th St., New York, NY 10019. While letters, faxes or phone calls cannot be answered individually, problems of general interest will be discussed in the column.

Or you can simply drive the vehicle until it needs valve work anyway—which may be a very long time down the road.

PM

SERVICE TIPS

- 1990 Cadillac Broughams that exhibit a clunking noise over road dips may have an interference problem between the trans crossmember and the U-joint. TSB T-90-104 says to replace the trans mount with PN 22111684, and shim for a 2° U-joint angle. It may be necessary to use longer bolts.
- Ford TSB 90-10-3 describes the engine throttle-position sensor recalibration procedure for '87 to '90 Escorts, EXPs and Lynxes that repeatedly stall after a lengthy deceleration to a stop when the engine is cold.
- 1991 Camaros and Caprices with 5.0-liter engines may have a SERVICE ENGINE SOON indication and a trouble code 22, accompanied by rough idle or idle surging, caused by plastic mold flash in the throttle-position sensor. TSB 91-60-6E says to replace the TPS with PN 177112404.
- If the cooling fan on your 1984-'90 Buick Century, Electra, Park Avenue or LeSabre stays on until the battery goes dead, TSB 90-6D-4 suggests that the fan relay may have welded its contacts shut. This can be caused by one of two things: a malfunction in the air conditioning that cycles the fan repeatedly or a failed fan temp switch rapidly switching the fan on and off until the contacts fail.

SATURDAY MECHANIC

TROUBLESHOOTING ANTILOCK BRAKES

BY DON CHAIKIN

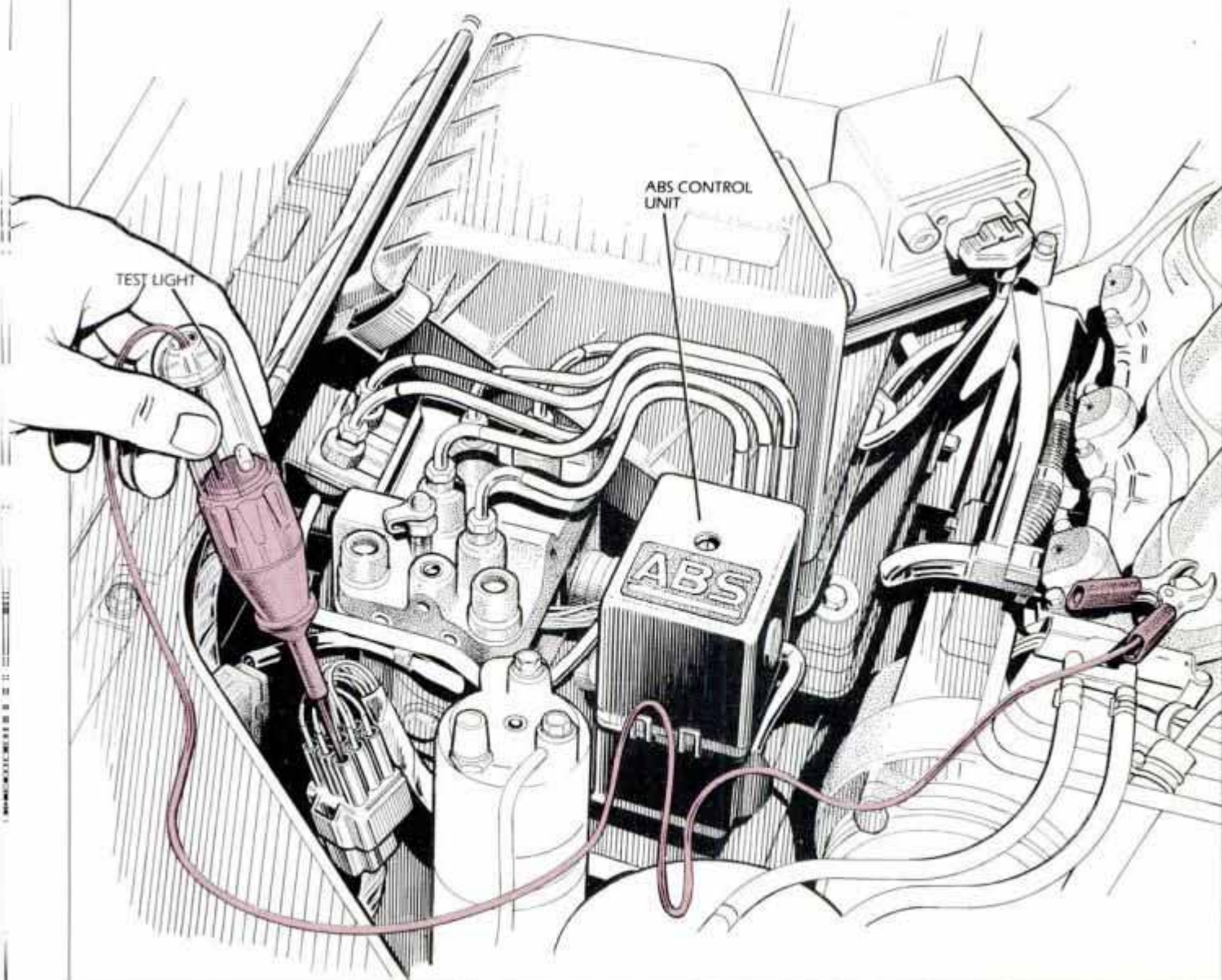
● You're winding your way home from the rained-out Little League game through a frog-choking thundershower, depending on your new car's antilock braking system to keep you and the entire infield safely on the road. Suddenly, the ABS WARNING

Check the 12V connections to the ABS controller with a test light or voltmeter. You'll need a service manual for this.

light on the dashboard winks at you. After a moment's panic, you realize that the normal service brakes should still be fine, capable of stopping your car normally. But since you've come to rely on the extra margin of safety of ABS—you'll be extra careful until you've found the source of the ABS problem.

Despite the proliferation of air-

bags, rear-seat 3-point seatbelts and improved passenger accident protection, the most important safety devices your car comes with are still those things that help it avoid an accident in the first place: its acceleration, steering and braking. And the most important safety innovation of the last decade is the development of anti-lock brakes (ABS).



Why you need ABS

Antilock braking systems do exactly that—they prevent the controlled wheels from locking, even if you push down on the brake pedal with all of your might and with both feet.

You might ask: How can this be good? Won't this make my car take longer to stop? Shouldn't the brakes lock in a panic stop?

Not necessarily. Under almost every circumstance, a wheel should continue to roll to maintain the maximum deceleration. A tire that's being scrubbed along the pavement at speed without rotating actually has a few percent less deceleration than a tire that rotates at about 95% of the road speed. In practice, this doesn't amount to much difference, and braking distances on dry or wet pavement are within 1 to 3 ft., with or without antilock brakes.

But there's a much more important consideration than the raw stopping power, and it's a side-effect of the ABS-braked tire's continued rotation. The tire will maintain its ability to steer the car.

A locked tire will have no directional stability. Lock the tire with the brakes, and you can turn the steering wheel any which way with no effect on the car's direction of travel—it will continue to head straight toward whatever it was heading for when you slammed on the binders.

But an ABS-retarded-but-still-rotating tire, even one that is hauling you down from high speed, will still permit you to make steering input and find some way to steer around an obstacle, or keep from driving off the outside of the curve you've entered at too high a speed.

Applied intelligence

There are several different antilock brake systems currently on the road, from such diverse manufacturers as Bosch, Teves, Kelsey-Hayes, Bendix, Delco Moraine and Nippon. Some of the systems are quite similar to one another, and others have major technical differences.

Some antilock brake systems, such as those on many pickup trucks, operate only on the rear brakes, while other systems—the ones appearing with greater frequency on passenger cars—work on all four wheels. But regardless of the differences in the brake systems, they all work in essentially the same way.

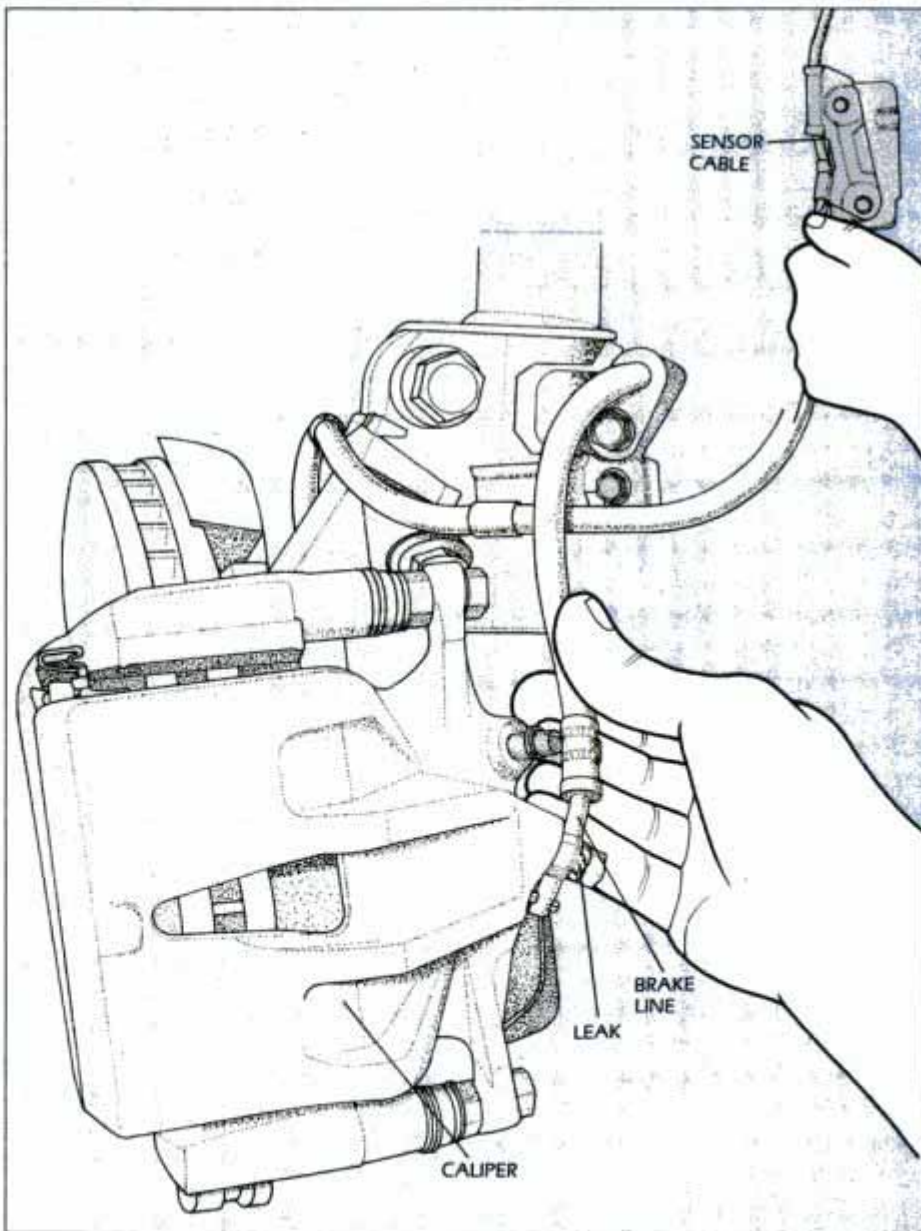
Antilock systems use a combination of electronic and hydraulic technology to modulate the brakes individually,



Check the brake master cylinder reservoir for fluid level at regular intervals.

keeping them from locking. The systems rely on wheel-speed sensors, a microprocessor or electronic control unit, and a sophisticated valve body called the hydraulic control unit. The wheel-speed sensors are located at each wheel, or in the differential carrier, where a sensor head reads the wheel's (or axle's) speed by way of a toothed ring. The electronic control unit constantly compares the relative speeds of all four wheels.

When the brakes are applied, the control unit determines if any one of the wheels is decelerating at a far greater rate than the others, indicating that that brake is beginning to lock. The microprocessor unit then directs the valves in the hydraulic control unit. These valves control fluid flow to that brake to release, hold or reapply hydraulic pressure to the



Inspect each hose and ABS sensor cable for signs of fluid leakage or damaged wiring.

CAR CARE

brake until that wheel is decelerating at the same rate as the others.

Most passenger-car antilock brake systems are of the 3-channel variety, which, while monitoring the speed of each of the four wheels, controls brake-line pressure to the two rear brakes as though they were one, regardless of which wheel may have been locking. Some high-performance cars have 4-channel systems that modulate the brakes on the rear wheels individually.

Due to the complexity of the electronics and hydraulics, all the antilock systems conduct a thorough self-check each time you start the engine. As the system is checking itself, the dashboard warning lights remain lit. If there are no detected problems, the lights go out. Some systems have two dashboard warning lights, one typically labeled ABS and the other labeled BRAKE. Some systems have only one warning light. However, the warning lights can be triggered by anything from a faulty parking brake or brake light switch to a failure of one of the wheel sensors or a failure of the electronic or hydraulic control units.

All ABS systems are designed so your car will still have normal, non-ABS modulated braking *even if the ABS system itself fails.*

Back to basics

Begin diagnosing any antilock brake system problem the same way you would diagnose a problem on a car without ABS.

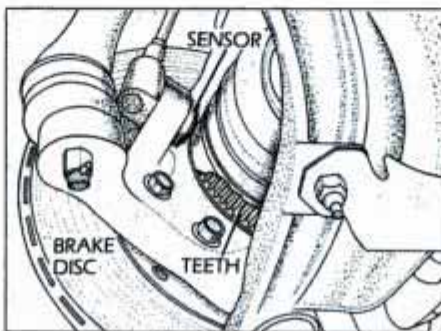
Check the master cylinder reservoir for a sudden fluid-level drop. As with all disc-brake systems, the fluid level in the master cylinder slowly goes down as the linings on the brake pads wear out. A precipitous drop in the fluid level indicates a leak.

Many antilock systems use hydraulic pressure to reduce brake-pedal effort instead of the vacuum assist on most disc-brake systems. An electrically driven hydraulic pump pressurizes the brake system. In addition, there may be a separate accumulator that stores the pressurized brake fluid. Since the brake fluid in these systems is kept under high pressure, usually over about 35 psi, the chances for a leak are greater, and you must depressurize the brake lines and cylinder before working on the system.

If there is no large vacuum diaphragm attached to your car's master cylinder, look for an electric hydraulic pump and an accumulator. The accumulator typically resembles a cylinder or bulb, and is mounted near the

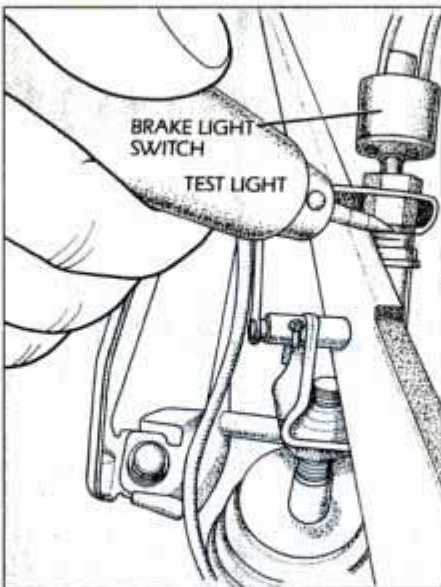
master cylinder and the pump. The accumulator has a diaphragm separating it into an upper and lower chamber. The upper chamber is filled with an inert gas, such as nitrogen, and the lower chamber contains the brake fluid. The pump runs as necessary to fill the lower chamber, compressing the gas in the upper chamber. When you step on the brakes, the pressurized gas helps the brake fluid flow out toward the brakes.

Remember, before loosening any connections in a hydraulically boosted system, you must relieve pressure in the system. To reduce system pressure, first turn off the ignition or dis-



Inspect the sensors for missing or broken teeth on the speed ring in the hub.

connect power to the hydraulic pump. Then step on the brake pedal as many times as needed—perhaps two dozen or so. Your leg will tell you—pedal effort dramatically increases. The increase in pedal effort indicates that the pressure is relieved.



Check the operation of the brake light and parking brake switches with a test light.

Begin the search for leaks at the master cylinder, working your way to the hydraulic control unit and then to

the wheels. Inspect the steel brake-line connections at each juncture. If you find signs of leakage—such as stains—at any of the fittings, undo the fitting nut and inspect the nut, the flare at the end of the brake line and the mating surface inside the master cylinder or hydraulic control unit. Any cracks or splits mean the defective part must be replaced.

Make certain that the mating surfaces of the brake-line flare and master cylinder are perfectly clean. Then reattach the brake line, threading the nut into place by hand. Do *not* force it. Once you're sure the nut is being properly threaded, snug it up using the proper size flare-nut wrench. Flare-nut wrenches resemble box wrenches with a small section of the box missing. Slip the wrench over the brake line and then slide it onto the flare nut. Flare-nut wrenches are sold in both metric and SAE sizes. Use the right one.

Inspect the brake-line connections at all the wheels next. Look for signs of leakage where the brake line attaches to the brake caliper as well as where the flexible brake hose connects to the steel brake line. Carefully inspect the brake hoses for signs of chafing, tearing or bulging. Replace any suspect or clearly damaged brake hoses. If you find stains or brake fluid at any of the connections, undo, inspect and clean the connection before reattaching it. If your car uses hydraulic pressure to reduce brake-pedal effort, also inspect the fluid-pressure accumulator for a leak. A leaking accumulator must be replaced.

Let it bleed

As with any brake system, if an antilock brake system has been leaking, you must bleed the trapped air from it after you've repaired the leak. But, in addition to bleeding an antilock brake system after a repair, you should regularly, at least every two years, totally flush, refill and bleed the system.

While it's a good idea to flush the brake fluid from any brake system every two years to remove moisture and contaminants, it's critical to do so with an antilock system. The dirt and moisture that can invade the hydraulic portion of an antilock brake system can seriously damage the expensive and complex hydraulic control unit.

Any time a brake system is flushed and refilled, the air must be bled from it. However, due to the complexity of the hydraulic circuits and valving in the hydraulic control units, the indi-

(Please turn to page 96)

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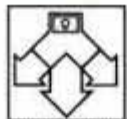
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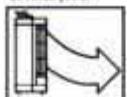
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CAR CARE

vidual antilock systems have specific bleeding sequences. Some systems require a pressure brake bleeder. Others can be bled using the system's own hydraulic pump and accumulator to supply the pressure.

Some systems have bleeder screws at the hydraulic control unit which are part of the bleeding sequence. Bleeding the hydraulic control unit often entails disconnecting the electrical connector at the control unit.

Before attempting to bleed the brakes of your antilock system, check your car's factory service manual for the exact procedure.

When the ABS is activated, the pulsing of the valves in the hydraulic control unit may or may not be felt through the brake pedal, depending on the system. However, if the brake rotors or drums are warped or out of round, you will also feel a pulsing in the brake pedal. You'll feel the ABS-induced pulsing only when the system is activated by your overpowering the available traction and hitting the pedal hard enough to skid at least one wheel. You'll feel warped rotors full-time whenever you're on the brakes.

To ascertain that the rotors are in good condition, check their thickness in at least four locations around the circumference using a micrometer. Check the factory service manual for allowed tolerances. Also check the runout of the disc, using a dial indicator. An out-of-round, warped or otherwise defective rotor should be machined back to specifications or replaced.

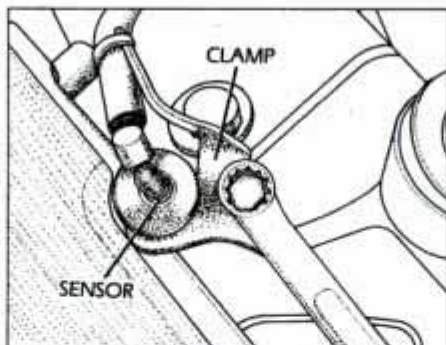
Also inspect all the calipers for signs of rust, corrosion, bent slide pins and other damage. Verify that the pad lining is wearing evenly on both pads on each disc—uneven wear indicates a sticking caliper.

Switch!

If there is no hydraulic problem, but the dashboard warning lights indicate something is wrong, check the mundane wiring before even inspecting the ABS components.

Make sure that the brake lights come on when you step on the brake pedal. If not, check the brake light switch. If they do turn on, check the switch for the parking brake warning light next.

Use a 12V test light and, with the ignition on, probe both sides of the suspect switch. The test light should show current on one side of the switch. With the brake pedal fully depressed or the parking brake lever fully engaged, there should be cur-



Tighten a loose wheel sensor to be sure it's the proper distance from the ring.

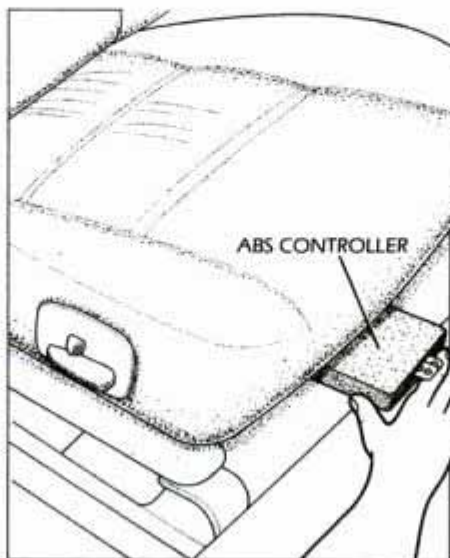
rent to the other side of the switch as well. If not, check the adjustment of the switch—possibly its contact plunger or tab needs to be adjusted. Check the wiring connections and circuit for the suspect switch, looking for an open connection or broken or chafed wire.

If the switches prove to be working properly, the problem is likely to be in the antilock system.

Don't overlook the obvious

Despite the sealed electronic and computerized nature of the antilock system, you can still make simple mechanical checks to the system's components to find the problem.

First ascertain that the system's various relays and circuit breakers are in place and working. Check that the relays are tight and there is no corrosion on any of the terminals. You can use a volt/ohmmeter to check the operation of the individual relays, following the diagnostic procedure and specifications listed in the factory shop manual. If you are satisfied that the relays, fuses and circuit breakers



The ABS control unit may be under the seat, in the trunk, under the dash or hood.

are working properly, inspect the sensors at the brakes.

Check the sensor at each wheel. The sensors are not serviceable if they are defective. However, inspect the wiring to each sensor for cuts and chafes. The signal-carrying wire is typically covered in a thick protective sheath. Carefully inspect the sheathing for tears, slices or other signs of damage.

Next, check to be sure that the sensor itself is securely in place. Road debris and stones could have dislodged or broken the sensor. Also be sure that the sensor's mounting bolt is snug. Be sure that the sensor head is squarely in position to read the wheel-speed ring on the hub.

Then, inspect the sensor ring itself. On some systems the ring is under a protective cover, on others it's exposed. In some systems it's inside the brake drum housing, on others it is visible and accessible behind the rotor. In some 2-wheel ABS applications, the sensor and speed rings are inside the differential case. Carefully check the ring for broken or missing teeth. Be certain that there are no pebbles or other pieces of debris wedged into the teeth of the ring or between the ring and the sensor head. Lastly, be sure that the ring is tight in place on the hub and that it spins with the hub.

Next, check the wiring at the electronic control unit and at the hydraulic control unit.

The electronic control unit is a sealed box, mounted typically under a passenger seat, in the trunk or on a shock tower under the hood. Be sure that the control unit's wiring connector is solidly connected. Try tugging on the connector and its wiring loom. Also be sure that the control unit itself does not move while you tug at its wiring. Tighten the unit's mounting bolts if they're loose.

The hydraulic control unit is located in the engine compartment, either at the brake master cylinder or remotely. Check the wiring connector for looseness and corrosion. Also inspect all the wires in the control unit's loom. There should be no looseness in the connection, and the wires should be in perfect condition.

If everything checks out, but the warning lights are still on, you must defer to the antilock system's self-diagnostic capabilities. Since this often requires a dedicated tester and always requires a trouble-code chart, it's also time to defer to the dealership's mechanic.

PM

NEW PRODUCTS IMPROVE YOUR CAR



Chips Ahoy

History continues to prove that as sophisticated as cars may be, hot-rodders will always find a way of improving them. This latest improvement is called PROMPAQ, and it allows owners of many vehicles to alter the computer program of their engine and



transmission while driving. The unit accepts four different chips—from your stocker to any of the many high-performance aftermarket chips that are available. A simple switch on the dash-mounted control unit lets you activate the chip you decide is most appropriate for the conditions, and a key lock prevents anyone else from tampering with the unit. There's also a special security chip available. Prices range from \$219 to \$279, depending on your car, plus another \$39 to \$49 for the security chip. From Adaptive Technologies, (800) 677-6672.

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Garage Diaper

Try as you might, it's nearly impossible to keep the garage floor under your car spotless. Somehow, even if you don't work on your car, there are always a few drops polka-dotting the floor. An improvement over dumping sand or crushed clay on the little puddles and stains is a mat, like this Garage Diaper, which catches drips and spills before they hit the floor. The Garage Diaper is a thick absorbent pad that wicks up liquids and holds them. Stepping on the mat won't leave a stain on the floor or oil on your shoes. The mats cost \$19.95 each and should last about six months with normal usage. Available from Billie, Inc., (703) 978-3109.



Portable Air Compressor

A flat tire is bad enough. A flat spare is more than most mortals should have to bear. However, with a portable air compressor, you can inflate any tire anywhere. Campbell Hausfeld has a portable that runs on its own internal battery pack. The compressor weighs 11 pounds, so it's transportable and delivers more pressure than any tire could need.

The power pack recharges either via household current in 8 to 10 hours, or through your car's cigarette lighter receptacle in 3 hours (when the engine's running). Included are nozzles for inflating pool toys or beach balls. The Cordless Air Compressor is available for about \$50, from Campbell Hausfeld, (800) 634-4793.



No-Mess Filter Change

Frequent engine oil and filter changes are good. Properly disposing of the old oil and filter is even better. Unfortunately, it's difficult to avoid spilling dirty oil. Enter Clean Catch oil filter cups. These lightweight polypropylene cups fit over the filter—even filters mounted in cramped, hard-to-reach spots—to catch the oil as you loosen the filter. A separate lid keeps the oil and filter in the cup until you can drain the filter into the rest of your waste oil for the recycler. In three different sizes, it costs \$5.95 from Clean Catch, (908) 360-2525.

Running Boards

Ford Explorers are terrific sport/utilities. But, like every other vehicle out there, they're not perfect. One thing that brings them closer to perfection is a set of running boards, like these fiberglass ones from Fibernetics.

The plastic boards follow nicely and complement the lines of the truck, and make getting in and out of the rig just that much easier. They look pretty good, too. The running boards come with all the necessary mounting hardware and brackets. Being

plastic, they'll never rust. You should have them up and ready in well under an hour. In primer, or painted black or tan, the running boards cost \$499, from Fibernetics Molded Products, (213) 639-9870. **FM**



GOOEY SOFTWARE

BY RON SCIBILIA

● In the ongoing clash between computers and computer users, the so-called "graphical user interface" (or GUI—pronounced gooey) has been a sort of peacemaker between man and machine.

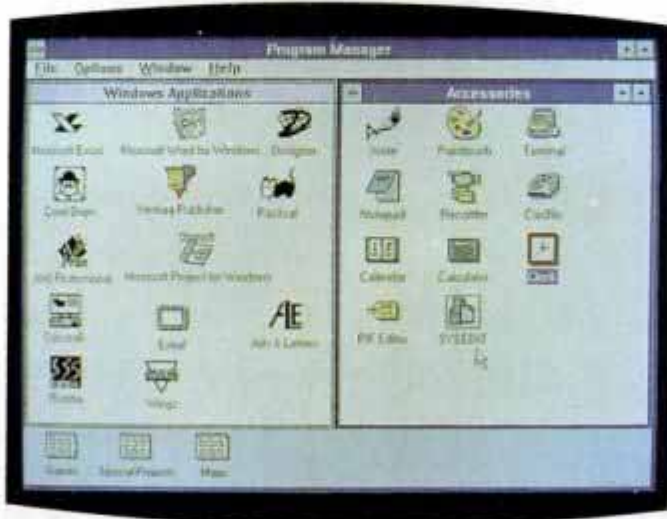
While traditional computer interfaces—the means by which you give commands to the computer—rely on words (or sometimes cryptic abbreviations) entered by keyboard, the GUI transforms the computer into a kind of picture box where users point, using some kind of device, at on-screen images to tell the computer what they want done.

Highly sophisticated from a technical point of view, GUIs depend on the primitive for their appeal: our joy in seeing and making pictures, the close link between hand and eye. The result is a way of communicating with a computer that many users seem to find easier and more productive.

GUIs aren't new. Xerox was playing with GUIs at its Palo Alto, California, facility back in the '70s. But it took the arrival of Apple Computer's Macintosh in 1984 to first popularize the idea of a "graphical" personal computer. Other suppliers, with varying success, attempted to bring the graphical approach to different computing platforms.

While the first two releases of Windows managed to win over a portion of personal-computer users, it was the Macintosh, designed from the outset as a "picture" computer, that remained the unchallenged system of choice for the graphically minded. Until now.

What's threatening the Mac's previous dominance is Microsoft's Windows 3.0 (\$149, upgrades \$50). Microsoft touts Windows 3.0 as the fastest-selling software program in history. One-year results should see well-over 4 million copies of Windows 3.0 in user's hands, a sizable chunk of those coming from computer suppliers bundling the hot software free with their machines to encourage sales. Impressed by the program's performance and its enthusiastic reception



from both trade and the public, virtually every major software supplier has announced intentions to back Windows 3.0 with applications software expressly crafted to take advantage of Windows 3.0's capabilities, and that even includes such previous Windows hold-outs as Microsoft archival Lotus Development and WordPerfect.

Why all the shouting? For one thing, Windows 3.0 finally brings much of, though still not all, the kind of graphical power and convenience long offered by Apple's Macintosh to the vastly larger DOS/IBM-compatible world. It does this at, arguably, a much lower cost for an equivalently powered system (though Apple wisely counter-attacked last fall with three new lower-cost Macs).

While Microsoft did develop two earlier versions, Windows 3.0 offers a considerably refined package. What's new with Windows 3.0 is a much-improved interface that's not only far prettier to look at with its larger color palette and 3D effects, but a lot easier to use; a simplified and "smarter" installation (and system modification) program that is much more flexible than Windows' previous setup procedure; easier manipulation and management of files—again mouse-controlled; and an enhanced

suite of basic Windows applications. The latter now includes a macro recorder, a truly usable telecommunications program and an upgraded paint program.

Perhaps the single most significant plus, though, is Windows 3.0's ability to break DOS's fabled and long-frustrating "640K barrier." On '286- and '386-powered PCs, Windows 3.0 can draw on as much memory as a computer has—up to 16 megabytes—when running Windows 3.0-compliant applications. The payoff is much larger, more powerful applications without degrading performance.

Already the DOS world is seeing applications that make earlier character-based DOS applications look antique and compete favorably with the best Macintosh programs.

Is Windows 3.0 something every DOS-user should have? Not necessarily. Some people, whose computing needs may be limited, may find their tasks made more complicated by graphical displays, icons and overlapping windows. Others may find the tradeoff in execution speed exacted by the graphical approach, with its



Windows 3.0 (top) is hot, but GeoWorks is a contender.

demands on processing power and hardware "overhead," unacceptable.

Windows 3.0 works best inside a fast, multi-meg '286 or, even better, a '386 with two, three, four or even

more megabytes of memory. Those more powerful machines are certainly destined to be common computing coin a year or two from now, even for beginners. But today, Windows 3.0, for all its capability, is still a power user rather than a populist solution.

But what about those millions of XT and plain-jane AT owners who crave the charms of the graphical interface? Well, rest easy, there may yet be a way to taste computing's future, thanks to a small software supplier in Berkeley, California.

GeoWorks, which has previously staked its fortunes in the Commodore and Apple markets, has come up with an entirely new graphical operating environment—dubbed PC/GEOS—for the less-endowed DOS crowd. For \$195, you get not only the PC/GEOS operating system but, as with Microsoft's Windows, a suite of integrated applications called GeoWorks Ensemble. Some of the programs are basic stuff, some surprisingly sophisticated.

In the package are several small but useful programs intended for the casual computer user. These include a simple address book, notepad, day planner, calculator, banner-maker and a Solitaire game.

The full-blown applications consist of GeoWrite, a word processor; GeoDraw, a drawing program; GeoDex and GeoPlanner, more powerful versions of the address book and calendar; and GeoComm, a telecommunications program. GeoManager oversees operations and manages file operations with a mouse.

One of GeoWorks Ensemble's key strengths is its built-in font generator and manager that puts an exact replica of what's on the screen out to your printer. And the program comes stocked with a generous range of built-in scalable fonts—something that's not yet standard-issue even in Microsoft's Windows.

What does this otherwise impressive package lack? Neither a spreadsheet nor a database program are included in the software suite, and GeoWrite, though versatile, won't satisfy demanding text-editing requirements with its inability, for example, to reformat an entire file at once. Surprisingly, given its graphical orientation, the program also omits a PostScript printer driver.

The main challenge for GeoWorks will be, as with all new computing environments, to convince software developers to write applications that take advantage of its strengths. Given a few key converts, PC/GEOS might well give Microsoft Windows some healthy competition at the economy end of the market. **PM**



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AMERICANS STORM PARIS

BY ABE DANE, Science/Technology Editor

● 1991 was an unusually good year to be an American in Paris. The 39th biennial Paris Air Show, granddaddy of all aerospace trade conventions, came hard on the heels of Operation Desert Storm. As a result, every American exhibitor, whether they



Top attractions at the 39th Paris Air Show included "Le Stealth" (above) and the Russian Albatross amphibian (left).

made fighter jets or airliner upholstery, enjoyed a boost in prestige.

Backing up the 140 U.S. companies that came to show off their wares was a sprawling outdoor display of practically every American aircraft that fought in the Persian Gulf. That included the show's biggest attraction—the F-117A, or "Le Stealth." In its first air-show appearance outside the United States, the odd black aircraft was mobbed, and its pilot and ground crew overwhelmed with questions and requests for autographs.

Among the aircraft sharing the limelight was an F-15E from Seymour Johnson Air Force Base in Goldsboro, North Carolina. Tech. Sgt. Chris Forcum had been with the plane in Saudi Arabia, where there had been "nothing but tents and a strip of runway." He seemed to be enjoying the change of scenery, although he pointed out, "Paris is a little expensive for folks like me."

The American military presence served a more serious purpose than providing R&R for a few worthy soldiers. While best known for its spectacular flying displays and staggering variety of aircraft, the Paris Air Show is first and foremost a place to do business. The Department of Defense was there at the request of the Department of Commerce, making sure no potential customer missed out on the

connection between the skills of the American aerospace industry and the victory over Iraq.

While still relatively new to the world of international trade, the Russians, too, are trying to translate military strength into commercial success. What they lack in marketing savvy, they make up for in a continuing stream of innovative aircraft, an outgrowth of years of Cold War research. Although nothing could match the show-stopping string of aircraft debuts they pulled off in '89, there were more than a few surprises at this year's event.

Among the most striking was Beriev Design Bureau's A-40 Albatross. This bizarre looking craft, by far the largest amphibian currently flying and the *only* jet, holds practically every record in its class—by default. Roughly the size of a Boeing 727, the A-40 was originally designed for anti-submarine warfare, but now is being touted for its potential in search-and-rescue missions.

According to Viktor M. Kobzev, deputy chief designer at Beriev, the most difficult part of building the A-40 was developing the proper shape for the underside of the fuselage. "The hydrodynamics took us most of the development time," Kobzev told me. "These hydrodynamics permit us to operate in a very stable manner over

the whole range from takeoff to landing." Capable of operating in seas up to 6 ft., the Albatross places its two 26,500-pound-thrust Soloviev turbofans above and well aft of the wing to protect them from water.

In order to increase the marketability of its amphibian expertise, Beriev is now developing a downsized model called the BE-200, which they hope will find use in roles ranging from passenger carrying to forest-fire water bombing. Kobzev also said that technical proposals for gargantuan sea birds ranging up to nearly 2 million pounds were in the works. Even more intriguing was his veiled mention of a 70-passenger, surface-skimming wing-in-ground-effect transport. Western experts have long speculated that the Soviets were developing



Wind-tunnel model gave the West a glimpse of Russia's supersonic V/STOL fighter.

AVIATION WEEK PHOTO

WIDE WORLD PHOTO

AVIATION WEEK PHOTO

such vehicles for military use.

The Russians were also responsible for one of the more impressive flying displays of the show—put on by the mighty MiG-31. Designed in the early '70s to block incursions by America's superfast SR-71 spyplanes, the high-speed, long-range interceptor proved itself to be an absolute thunderous beast of a performer. With nearly 70,000 pounds of total thrust pumped out by its two Tumansky turbofans, it is far more powerful than any American fighter. One American described it as the equivalent of "two F-14s welded together." Its mission is long-range combat, rather than close-in dogfighting, and as a result considerable effort was focused on the development of its radar. Removal of the MiG's nose cone at the show revealed this to be a large, electronically steered phased-array type, much to the surprise of western observers. No western aircraft maker has yet incorporated such an advanced design into a production fighter.

Of course, the hometown favorites in the air displays were the French Mirage and Rafale fighters. Although based on an aging design, the Mirages, particularly the new 2000-5 version, put on the most aggressive aerobatic displays of the show. The much-heralded Rafale C01 preproduction prototype (see [Tech Update, page 17, April '91](#)) took a day off from its flight testing to show the world the latest in French fighter fashions. Although its rakishly sculpted fuselage and canard control surfaces look distinctly state-of-the-art, the demonstration was brief and relatively tame. No doubt, manufacturer Das-



With a maximum takeoff weight of 90,000 pounds and 70,000 pounds of thrust, the brutish MiG-31, shown here with speedbrakes extended, tore up the sky for the Paris crowds.

AVIATION/VEEP/PHOTO

sault was loath to risk its one-of-a-kind prototype.

Back on the ground, countless fascinating odds and ends crammed the exhibit halls. The Soviet pavilion featured an unlabeled wind-tunnel model that was eventually announced to be the world's only V/STOL fighter capable of supersonic flight. The Yak-141 is now undergoing tests in the Soviet Union, and is said to combine the vertical takeoff abilities of the Harrier with flying performance comparable to the MiG-29.

Even in the afterglow of Desert Storm, civilian aircraft earned their

share of attention. One of the few American aircraft in the flying displays was the Swearingen SJ30, the world's smallest business jet. While the sexy little 6-passenger craft looks like a scale model next to its competitors, its 445-knot cruising speed and comparatively low cost could make it a hit with thrifty executives.

On the opposite end of the business jet spectrum, the unlikely collaboration between the Russian Sukhoi Design Bureau and America's Gulfstream Aerospace continues to work toward its goal of a supersonic business jet (see [Tech Update, page 13, Feb. '90](#)). Significant evolution was evident in a sleek, twin-engine configuration shown in mockups displayed in both the Soviet and American pavilions. Basic wind-tunnel testing is said to be complete for the Mach-2 aircraft, which is expected to make its first flight in 1994.

As we go to press, the Gulfstream/Sukhoi venture remains on track, despite the August coup attempt in Moscow. And it remains what one can only hope will be the first of many joint ventures pooling the talents of East and West.

PM



Slick new Gulfstream/Sukhoi business jet was shown in American and Soviet pavilions.

WIDE WORLD PHOTO

PINATUBO'S TOLL

BY ABE DANE, Science/Technology Editor



WIDE WORLD PHOTO

● Sometimes nature appears to be its own worst enemy. Take for example the explosion of Mt. Pinatubo in the Philippines last summer. The blast, which has been equated with 2000 to 3000 Hiroshima bombs, blew millions of tons of sulfur dioxide, dust, debris and ash miles into the atmosphere. And much of what went up won't come down for three or four years. All the burning oilwells in Kuwait don't hold a candle to it in terms of environmental impact.

Paradoxically, most scientists agree that Pinatubo will temporarily reverse one of the most serious consequences of man-made pollution. Glob-

al warming, the gradual change in climate brought about by man's release of carbon dioxide and other heat-trapping gases into the atmosphere, will be counteracted for as long as Pinatubo's plume remains aloft. In fact, over the next four years or so, we're likely to experience a barely noticeable global *cooling*. For this brief period, scientists believe that Earth's climatological clock will be set back to sometime during the 1950s.

That's great news for winter sports fans, but overall the blessing is pretty mixed. Ozone depletion, which allows cancer-causing ultraviolet radiation to reach the Earth's surface, is likely

to be accelerated. On the other hand, Pinatubo will give scientists an unparalleled chance to study the effects of sudden changes in the atmosphere.

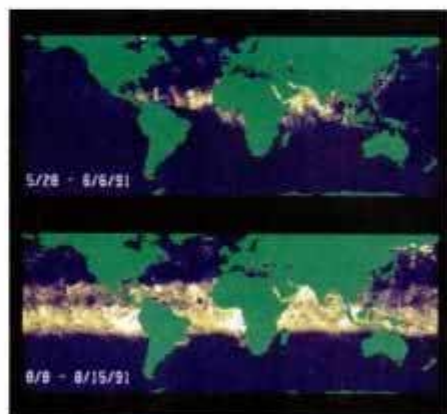
Sudden Impact

Pinatubo was one of the most violent volcanic events of the century. After lying dormant for more than 600 years, it let loose with a load of debris that is estimated to be two to three times that from Mexico's El Chichon eruption in 1982. El Chichon, the biggest eruption in 50 years, blew out at least 6 million tons of dust and gas.

Pinatubo's immediate effects were devastating. Philippine skies darkened and ash rained down so heavily that hundreds of people were killed in building collapses. Drivers couldn't see without their windshield wipers, and jet aircraft lost their engines when they ingested clouds of abrasive dust.

More telling from an environmental point of view, the blast injected 15 to 20 megatons of sulfur-dioxide gas into the stratosphere, more than 14 miles above the Earth. Mixed with oxygen and water from the air, the gas solidified into about 30 to 40 megatons of sulfuric-acid particles. Measuring less than a micron across, these particles are so tiny that they will stay aloft for three to four years. Within 21 days, high-speed stratospheric winds had spread a thin layer of the reflective particles into a ring running clear around the equator.

For now, the effects of the cloud are barely observable. Where the dust is thickest, sunsets are already more



Satellite images show aerosol thickness before Pinatubo (top) and after (bottom).

NASA/PHOTO

colorful than usual, and during the day, the sky is just noticeably more hazy. According to Dr. Larry Stowe, an atmospheric scientist with the National Oceanic and Atmospheric Administration (NOAA), the cloud continues to spread out from the tropics, reaching from about 30° north latitude down to about 50° south latitude at the time this is written.

Under a cloud

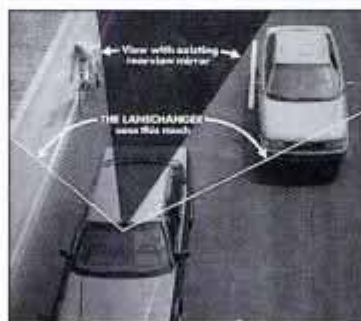
The most serious long-term effect of the cloud is likely to be increased destruction of the ozone layer. The aerosol particles in Pinatubo's cloud cause the chlorine from man-made chlorofluorocarbons to become more reactive. Within the cloud from El Chichon's eruption, Ozone was depleted by 10% to 15%.

Stowe and his colleagues have tracked cloud spread with the Advanced Very High Resolution Radiometer, carried aboard the NOAA-11 weather satellite. Using satellite measurements of the amount of sunlight bouncing back from the Earth, Stowe's group can determine the thickness of atmospheric aerosols at points all over the globe. Where the reflectance is greatest, the cloud is thickest (see graphic on page 102).

According to Stowe, the cloud will have two basic effects on climate. At the Earth's surface, temperatures will be slightly cooler, because 2% to 3% of the Sun's energy will be blocked out. In the stratosphere, the aerosols will absorb a small amount of infrared radiation, actually raising temperatures a few degrees.

Predicting the severity of the cooling effect can be done simply by extrapolating from the effects of El Chichon's smaller cloud. El Chichon spewed out about 7 megatons of sulfur-dioxide gas, and temperatures dropped by $\frac{2}{10}$ to $\frac{3}{10}$ of a degree Centigrade. Doubling that to account for Pinatubo's 15 to 20 megatons results in a predicted drop of about 1° F. The cooling should reach its peak two to three years from now. Four years from now, the long-term global-warming trend is expected to resume.

Complex computer climate models have been used to verify the cooling prediction, a fact that leads to one of the most scientifically important findings likely to come out of the Pinatubo explosion. These models are the same ones on which predictions of long-term global warming from the greenhouse effect are based. How well they predict Pinatubo's effects over the next four years or so will give a good indication of how accurately they forecast our long-term climatological future. **PM**



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We have recently learned of a broken firing pin in a P85 automatic pistol which caused the pistol to fire as a result of decocking. This is the first report of this nature in over 200,000 pistols delivered to customers since 1987. No injury occurred because the shooter kept the pistol pointed in a safe direction during decocking.

Nevertheless, we regard this incident as important because it reveals a potential danger which we are prepared to eliminate in all P85 pistols now in use. This modification is very simple and does not alter the handling or appearance of this pistol, but it must be installed at the factory.

Accordingly, we urgently request that all owners of P85 pistols contact us immediately to obtain any further information they may desire, and to arrange for return of their P85 pistols to the factory for modification. Please contact us at:

STURM, RUGER & CO., INC.
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Prescott, AZ 86301

Or call us for P85 inquiries *only* at: 1-800-424-1886. Please have your pistol serial number available when contacting us.

We will schedule your gun for factory installation of a new safety/decock system free of charge. It will prevent this type of accidental firing even in the rare event of firing pin breakage.

This free safety modification applies *only* to pistols rollmarked "P85" on the slide. Pistols which are rollmarked "MKII" will have these modifications as part of their original manufacture, and are not subject to this modification.

We are also taking this opportunity to remind shooters of the most common and basic firearms safety rule:

ALWAYS KEEP THE PISTOL POINTED IN A SAFE DIRECTION!

This is particularly important when loading, unloading, or decocking any pistol.

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A BERLIN AFFAIR

BY FRANK VIZARD, Electronics Editor



PHOTO BY FRANK VIZARD

● Call it "Fifties Future." The picture above is one vision of the living room of the future. This room was part of a Philips exhibit at Funkausstellung, the giant electronics show held every two years in Berlin.

In addition to the wild color scheme, the living room is remarkable because of the featured television and stereo system. The television, part of a somewhat traditional console, is a wide-screen model with a 16:9 aspect ratio rather than the currently used 4:3 aspect ratio.

The stereo, with speakers mounted in each end of the wood cabinet, is very compact, but still offers 150 watts of power and has all the features associated with today's larger systems. Deep bass is supplied by a subwoofer installed just to the right of the electronics.

Televisions with wider screens were the darlings of Funkausstellung. Nearly every major European television maker had 16:9 models on display. When first conceived, 16:9 TVs were to be the size that would introduce high-definition television (HDTV) to the world. Now it appears 16:9 models will be introduced in the United States even before an HDTV technical standard is adopted. If any of the behind-the-scenes trade talk is accurate, Thomson may introduce a 16:9 model in the United States next year under its RCA brand. Making

the jump to wide screen and HDTV in one shot is being seen as too costly for both consumers and broadcasters. A more gradual approach is now being contemplated.

Funkausstellung, which attracts more than a half-million visitors to 25 exhibit halls the size of aircraft hangars, was mainly a video showcase. Making the biggest splash in all areas, though, was Philips, which took over an entire hall. In addition to 16:9 televisions, Philips, whose gear is sold primarily under the Magnavox name in the United States, showed:

- Working prototypes of Digital Compact Cassette (DCC) audio gear. Due here next year, these machines can be connected to televisions so song lyrics and other text contained on the tape can be displayed. You'll also be able to add text yourself.

- A videocassette recorder that can record either 16:9 or 4:3 images automatically.

- A 15-in. cube-shaped television called The Prophecy. Its smooth, black, perfectly proportioned look is enhanced by a built-in lamp that surrounds the TV in a soft glow. It's the perfect TV for fans of television evangelists.

- A portable compact disc player with a cordless headphone. Music is transmitted between the CD player and the headphones using FM radio waves. The cordless headphone oper-

ates on rechargeable batteries.

Another video innovation comes courtesy of BASF, the German tape manufacturer. New videocassettes from BASF will feature a sliding colored plastic tab that protects recorded material. When the tab is slid back, the tape cannot be accidentally erased. When the tab is visible, the videocassette can be used for a new recording. The company plans to include this tab on all but its standard-grade videotapes.

Radio fans should be intrigued by a new shortwave receiver from Grundig. Called the Satellite 700, this model features interchangeable ICs so that a 3-chip arrangement can store as many as 2048 frequencies and station names in memory. Keeping track of radio stations around the world becomes much easier since an individual IC could be matched to broadcasts at certain times of day. Grundig is distributed in the United States by Lextronix, Inc., of Redwood, California.

Not every innovator at Funkausstellung is distributed in the United States, however. One noteworthy innovation, called the TV Mouse, comes from Nokia, a name virtually unknown in the U.S.

Nokia's TV Mouse is a remote control that operates very much like a magic wand. TV Mouse uses natural wrist movements to control the functions of a TV or VCR. Unlike a computer mouse control, the Nokia re-



Slide the colored tab back on a BASF tape to prevent accidental erasures.



Nokia's remote control uses wrist motion to issue commands.

remote doesn't have to be moved across a flat surface.

Let's say you want to control the volume on the TV. After choosing the appropriate menu with a button, all you have to do is rotate the remote to the right to make the volume louder or turn the remote to the left to make it lower.

Making the remote work is a tiny ball housed in a thimble-size box within the remote. As the ball moves, it switches between differently modulated beams of infrared light that relay your commands. TV Mouse can also work with just the buttons.

All these innovations can be seen by everyone since Funkausstellung is open to the trade and public alike. The festive atmosphere surrounding the Berlin show may soon be duplicated in the United States. The Chicago Consumer Electronics Show will open its doors to the public on May 30 and 31 for the first time. Like Funkausstellung, CES hopes to be an unrivaled technological experience. **PM**



Store frequencies on interchangeable ICs with Grundig's new shortwave radio.



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THE PROBLEM WITH DAMS

BY JOE SKORUPA, Boating/Outdoors Editor



IMAGE BANK PHOTO

● It only took 56 years to kill the Colorado River. Since the building of the Hoover Dam near Las Vegas in 1935, the 1450-mile Colorado has been strangled by scores of aqueducts, tunnels, pumping stations, canals, diversion dams, reservoirs and hydroelectric plants.

Today, the once-wild Colorado is the most legislated, litigated and controlled river in the world.

I've been on, across, in, above and under the Colorado in a dozen places in the seven states that comprise its 244,000-sq.-mile drainage system. One place I've never been is 50 miles south of the U.S. border in Mexico's Baja, California. It's not a sight I'd care to see. Here, at the river's delta, the Colorado vanishes before it reaches its outlet to the sea. All 15 million acre-feet of its water are diverted and used up.

To the millions of boaters and fishermen who use Lake Mead and Lake Powell, it probably seems difficult to comprehend that the Colorado River is in trouble. But the truth is that half of its native fish are on the verge of ex-

tingtion, Lake Powell is silting up like a delta, and the Grand Canyon's spectacular rock formations are threatened by wildly fluctuating releases from the hydroelectric plant at the Glen Canyon Dam.

For these reasons and others, the Colorado was recently designated the most endangered river in the United States by the conservation group American Rivers. This watchdog group compiles an annual roster of endangered waterways and tries to raise public awareness of impending riparian doom. Here are the 10 threatened rivers that comprise the group's most recent list:

1. Colorado River, in Arizona.
2. Asek and Tatshenshini rivers, in Alaska and Canada.
3. American River, in California.
4. Penobscot River, in Maine.
5. Susquehanna River, in Pennsylvania.
6. Upper Mississippi River, in Minnesota, Wisconsin, Iowa and Illinois.
7. Columbia and Snake rivers, in Idaho, Oregon and Washington.
8. Gunnison River, in Colorado.

9. Passaic River, in New Jersey.
10. New River, in North Carolina.

Correcting past mistakes

The modern era of conservation and environmental awareness is not the best of times for the U.S. Bureau of Reclamation or the U.S. Army Corps of Engineers. In fact, the future of these agencies probably hinges on their efforts to undo environmental damage caused by earlier projects.

In case you're not familiar with the Bureau of Reclamation, which was formed in 1902 by public and private interests concerned with watering the arid West, this is the agency responsible for building and operating such massive dams as the Hoover, the Glen Canyon and the Grand Coulee. Once hailed as glorious achievements, these concrete monsters have become increasingly controversial.

Most Americans think of the Grand Canyon as the crown jewel of the National Park system. Four million people visit its rim each year. Only 15,000 go to the canyon's base and actually run the river in a raft, but most visi-

tors think that one day they *might* do it. Or they think that one day their children might. It's a pleasant thought, but current Grand Canyon river running isn't what it used to be.

Sixteen miles upstream from the Grand Canyon is the huge Glen Canyon Dam. It's the last and crowning achievement of the Bureau of Land Reclamation's big-dam era. When it was completed in 1963, it plugged the Colorado River and changed the Grand Canyon forever.

The Colorado used to run cold and silty in the spring and trickle warm and clear in the fall. Now, below dams like Glen Canyon and Flaming Gorge, in Utah, it runs clear and cold all year long. The dams trap silt and release frigid water from their depths. The result is a complete change in the Colorado River's ecosystem and the near extinction of half its endemic fish.

To make matters worse—if that's possible—the Bureau of Reclamation sends two surges through giant turbines in the bowels of the Glen Canyon Dam. These are timed to satisfy peak power demands in Phoenix and other distant cities. The man-made tides quadruple the volume of water in the Colorado, and at night and on weekends, when demand is low, the river is almost turned off.

For rafters attempting to experience the adventure of a lifetime in the jewel of the National Park System, the Bureau of Reclamation's water-release policy has dire circumstances. To date, four species of fish have been wiped out, natural beaches are being scoured of sand, endemic plants and animals are being replaced by non-native species, rock formations are eroding, and 300 Indian archeological sites are in the process of being eaten away. The wildly surging waters fluctuate as much as 13 ft. within a few hours.

If this is how a national treasure is treated, imagine what happens to rivers of lesser stature.

River of grass

Everglades National Park, in South Florida, is another natural wonder threatened by federal mismanagement. This time, the agency in question is the U.S. Army Corps of Engineers, which built a massive flood-control project on the Kissimmee River, which leads into Lake Okeechobee and ultimately the Everglades. After a disastrous flood in 1947, the Corps built a series of levees, canals and pumping stations to solve the flood problem. However, the project altered the natural flow of water into the park. Ever since the project's completion, the Everglades

and Lake Okeechobee have been slowly dying.

Fortunately, state and federal agencies have acknowledged the problem and are acting to solve it. The Corps of Engineers is restoring the Kissimmee River to its natural state and, in the process, is dismantling some of its former work.

For the Corps, which dates back to 1824, there is no shortage of work to undo. Dams, locks and flood-control projects on the Upper Mississippi, the Missouri and the Columbia rivers all need help to return to some semblance of their former natural state.

In addition to the top-10 endangered rivers, American Rivers also lists 15 other threatened waterways. For a copy of this roster and other information, write to American Rivers, 801 Pennsylvania Ave. SE, Washington, D.C. 20003; or call (202) 547-6900.

Disregard for the environment and mismanagement have led to problems for many of our nation's rivers. While many dams and other riparian works were considered outstanding achievements in their time, unforeseen consequences are now coming to light. We have the ability to make things right. Let's do it. **PM**

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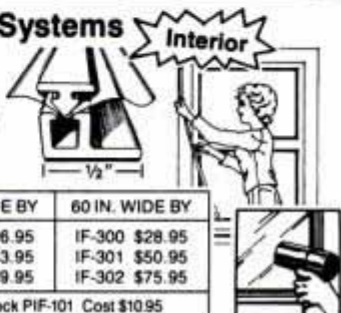
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AUTOMOBILES

DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



Toronado Tuneup

● Although the camouflage panels effectively hide the nose and tail of this 1994 Toronado development mule, it does reveal something new for Oldsmobile's personal luxury line—an extra set of doors.

What is not known is whether Olds will make a V8 engine available when the 4-door Toronado makes its showroom debut in late '93. Lansing insiders insist that the decision hasn't been made yet, but that a V8 is a strong possibility.

These same sources say that the Toronado's soft sales record is partly due to the absence of a V8 engine. The current Toro uses GM's 3800 V6.

If a V8 does become available in the new Toronado, it will be an sohc version of Cadillac's Northstar V8, due to make its debut this spring in the Allanté roadster.

Safety Statistics

According to a recent GM study, your chances of setting off the airbag in your car during your lifetime are low indeed. The study pegs the statistical frequency of airbag deployment for the average driver at once every 175 years.

By way of contrast, GM safety statistics indicate that antilock braking systems are activated an average of once per year.

While these numbers add fuel to the active-ver-

sus-passive safety debate, the argument is largely academic, since virtually all new cars will probably have both systems before the end of the century.

L-H Name Game

With their first public viewing on the near horizon, Chrysler has revealed the names of its long-awaited L-H front-wheel-drive sedans. Scheduled to go on display at the Detroit Auto Show January 10 through 19, the new cars get names that are new to the corporation: Dodge Intrepid, Eagle Vision and Chrysler Concorde.

The Intrepid and the Vision are scheduled to go into production at Chrysler's Bramalea, Ontario, plant

in June, and are due in showrooms in late '92. The Concorde will follow about six months later.

While the Chrysler concept sketches shown below are fanciful in detail, both reflect the cab-forward design and limited front and rear overhang that were key elements in the Eagle Optima concept car.

All the L-H cars will be powered initially by a longitudinally mounted Chrysler V6.

Disposable VWs

Spurred by Germany's powerful environmental factions, Volkswagen is introducing an end-of-service disposal program for its domestic model Golfs, beginning with the 1992-model year.

Basically, the program is designed to ensure that the old cars are disposed of responsibly, with emphasis on optimizing recycling. Anticipating increasing pressure from Germany's "Green" political groups, VW elected to develop the program on its own, rather than wait for legislation.

VW plans to implement the program through its dealer body. When a Golf has reached the end of its life span, the owner will simply bring it to a franchised Volkswagen dealer. The dealer will issue a document certifying that the car was dismantled at an official recycling yard.



Chrysler has revealed names for its new L-H sedans—Dodge Intrepid (top) and Eagle Vision (above). Chrysler Concorde is due in 1993.

PM

AMERICA'S SECRET AIRCRAFT

(Continued from page 35)

The big wing

Meanwhile, several Antelope Valley residents say they've seen a craft that simply strains credulity.

According to reports over the past two years, a vast black flying wing, estimated at between 600 and 800 ft. in width, has passed silently over city streets, empty desert and rural freeways. The craft moved so slowly one observer said that he could jog along with it. A pattern of seemingly random white lights on the vehicle's black underside provided "constellation camouflage" against the starry sky. Observers who followed the craft long enough detailed unlikely maneuvers in which the vehicle stopped, rotated in place and hovered vertically, presenting a thin trailing edge to the ground.

Although such sightings encourage those who link the military with unearthly technology, a mammoth, quiet flying wing may have a conventional explanation: It could be a lighter-than-air craft pushed by slow-turning propellers. Certainly, such a vehicle could elude Doppler radar by slowing to a crawl. Alternatively, the fact that the craft holds station vertically suggests that it might serve as a huge reflector for a bistatic radar system. Other possible missions include troop delivery or covert surveillance.

Black and white

Sightings of all these aircraft may offer a preview of 21st-century air power. Or they may be hints of experimentation, hardware versions of engineering concepts. Denied classified data, experts must simply guess. "In the late '70s," says Wolfgang Demisch, an aerospace analyst with UBS Securities, "there was concern at senior levels of government that a lot of technology was about to disappear because people were close to retirement. Projects in the 1980s may have pushed this technology as a way of maintaining the national capability built up in the '50s and '60s."

Masking such capability behind classified special-access status has been the trend for the past decade. But that trend is shifting now. The growing number of unofficial sightings may signal that security will soon lift, just as the F-117A went public because daytime flight requirements would reveal the aircraft anyway. If the "black" air vehicles now prowling desert skies also venture into the "white" world, technology spinoffs may be enormous. If not, then these aircraft will remain America's most closely guarded secrets. **PM**

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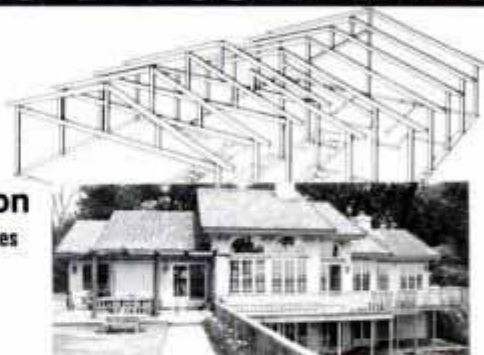
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SATURN AT SPEED

BY TONY SWAN, Automotive Editor



● Since we've followed the Saturn story from the very beginning, we were naturally very interested to see how well this car's already good handling would lend itself to racing. And we got a chance to experience this firsthand, when Dave Rosenblum and Peter Farrell invited me to drive in the Firestone Firehawk 24-hour race last summer at Watkins Glen.

Rosenblum and Farrell teamed up for 1991 to campaign a pair of Saturns under Rosenblum's Valvoline/ICY (Inner City Youth) banner. ICY is Rosenblum's concept, allowing mechanical arts students from tough sections of the Philadelphia area to travel with and crew for the team. It's a remarkable one-man campaign by Rosenblum to get kids away from drugs and into something that's both fun and educational.

The ICY cars run in the Firehawk series Touring class, where the principal competition is provided by a herd of Honda CRXs. These are not your garden-variety Hondas. The Firehawk rules allow some suspension modifications, and the CRXs have years of development behind them. Making a brand-new car competitive against such formidable players is a tall order.

Nevertheless, by the time the Glen 24-hour came along, the ICY Saturns had already won two races. And as we went to press, Farrell had just captured the season championship.

Our fortunes at the Glen were mixed. A couple of minor racing inci-

dents (read crashes) cost both cars some extra pit time for repairs, and the team wound up fourth and ninth in its class. However, in the early stages the Saturns were one-two in class, and one of them led through 12 hours.

More significant, neither car had any mechanical failures. Both ran strong and sweet throughout. Their brake performance was first rate, and their handling exceptional.

We've been impressed by the Saturn's capabilities in every encounter, and that goes double for the racing version. We're also thoroughly impressed by the job of development and organization provided by Rosenblum and Farrell.

Moreover, we can't think of another new manufacturer that's gone out and won a championship in its first year of operation. Not only is this car durable, it's a winner.

My Favorite Race

The world is full of peculiar endurance races. The French 24-hour race for Citroën 2CV cars is a superb example. The prospect of 24 hours in a car that makes a VW Beetle look like a Porsche 959 certainly takes an extraordinary level of racing addiction.

But for my money, the Nelson Ledges 24-hour race is just about the most intriguing of them all. First conceived for Showroom Stock (SS) cars, Nelson's Longest Day has evolved into a rich mix of Showroom Stockers and Improved Touring (IT) machines.

In general, the Sports Car Club of

America Improved Touring classes are for cars that have retired from Showroom Stock. A variety of suspension modifications are allowed, as well as engine enhancements. IT cars also run open exhausts.

Although SS cars won the first 11 runnings of this race, the IT cars have been slowly closing the gap, and last summer one of them—a 20-year-old Datsun 240Z—came home first overall. Our congratulations to drivers Doug Christensen, John Legg, Jeff Lucas and Kip Gaynor.

I was fortunate enough to be adopted this year by Wedge Rafferty and his Team Turtle cohorts. Performing impressively on Bridgestone Potenza tires, Rafferty's IROC-Z Camaro came home third overall and first in the SSGT class.

Our thanks to Team Turtle for its generosity and excellent preparation. And stand by for the 1992 Longest Day of Nelson. We may have a surprise or two. **PM**



Team Turtle Camaro topped Showroom Stock entries in upset year at Nelson Ledges.

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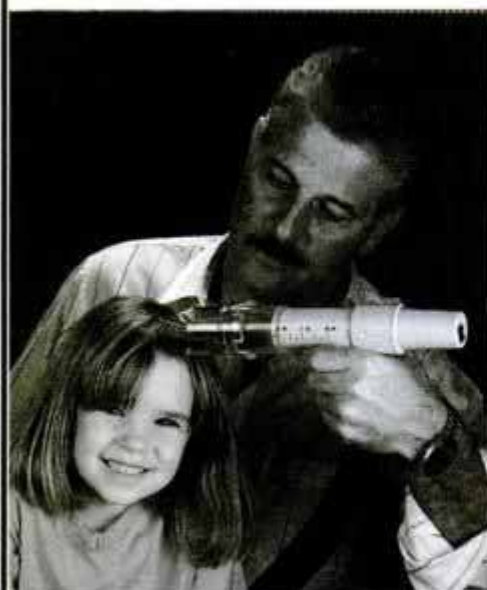
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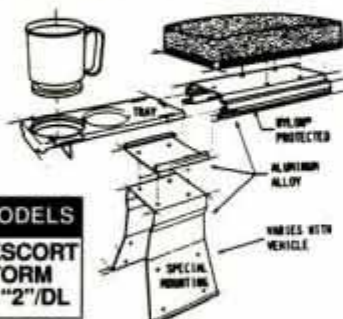
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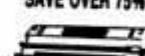
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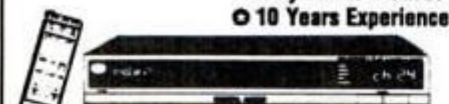
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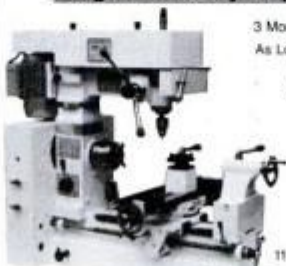


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