





Named Clyde,

WHO WAS SEARCHING FOR A COOL,

ONE DAY HIS HOPES SOARED,

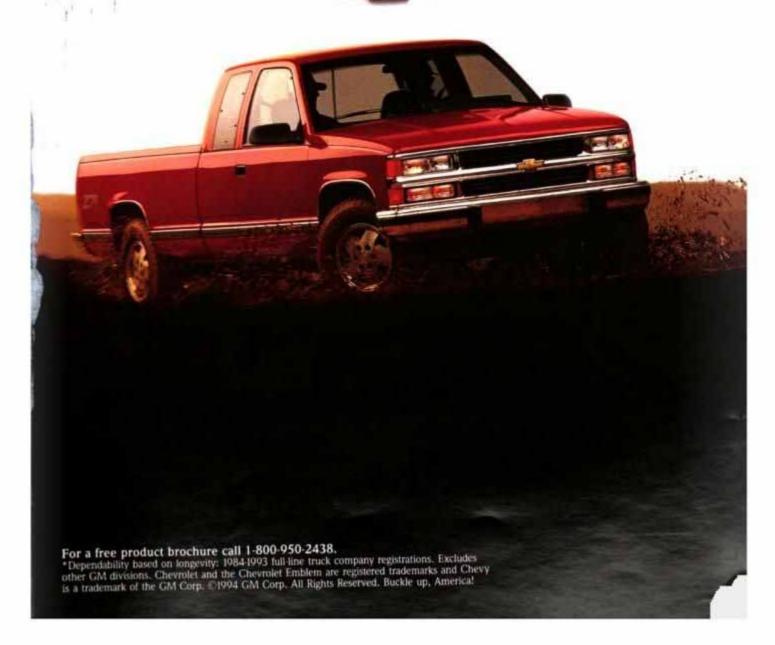
WHEN HE DROVE THE RANGER FROM FORD

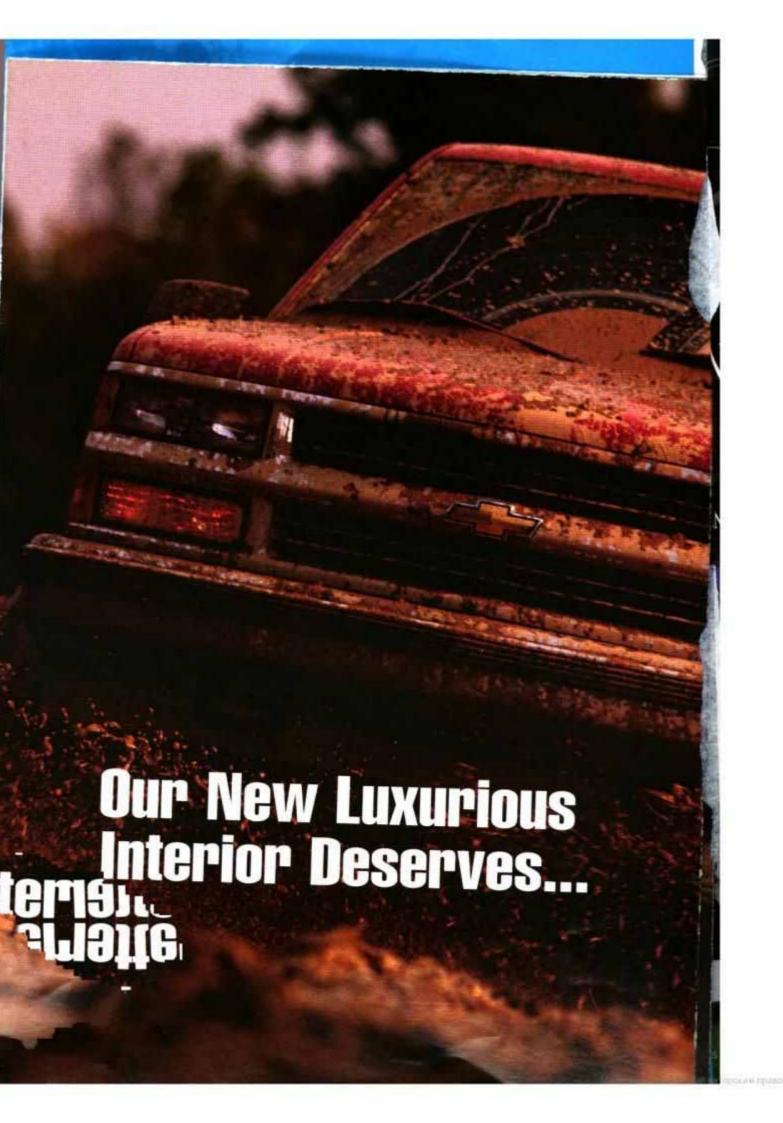


Always wear your safety belt. * Feature optional. J.D. Power and Associates 1994 Light Truck Initial Quality Study. Based on a total of 12,056 consumer responses

Chevrolet. The Most Dependable, Longest-Lasting Trucks:

LIKE A ROCK







ND DISCOVERED ITS HOT NEW INSIDE.

New Standard Driver's Air Bag*

MORE POWERFUL ENGINE

New 4-Wheel Anti-Lock Brakes"

BEST COMPACT PICKUP IN INITIAL QUALITY

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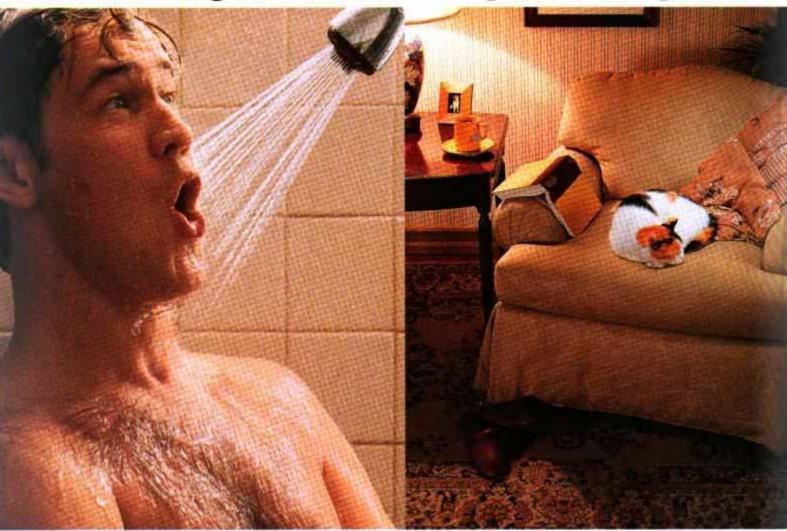
NEW REMOTE KEYLESS ENTRY"

New Six-Way Power Driver's Seat**



BUILT FORD TOUGH

Introducing the Lennox CompleteHeat system.



All the hot water you'll ever want.

The luxury of virtually unlimited hot water. The comfort of high-efficiency home heating. The economy and environmental advantages of clean-burning natural gas.

They're all reasons why you'll find yourself singing the praises of the innovative new Lennox CompleteHeat system, which combines home heating and water heating in one unit with a phenomenal 90% efficiency.*

CompleteHeat produces three to four times more hot water than conventional water heaters. And advanced

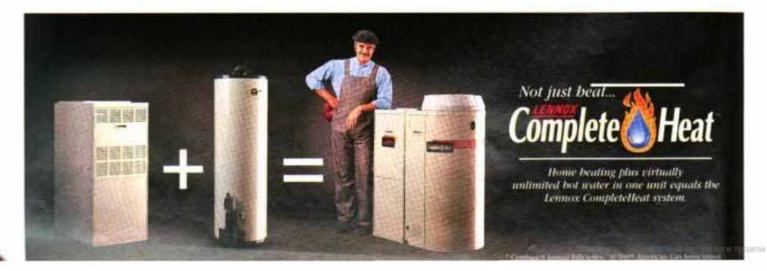
All the warmth you'll ever need.

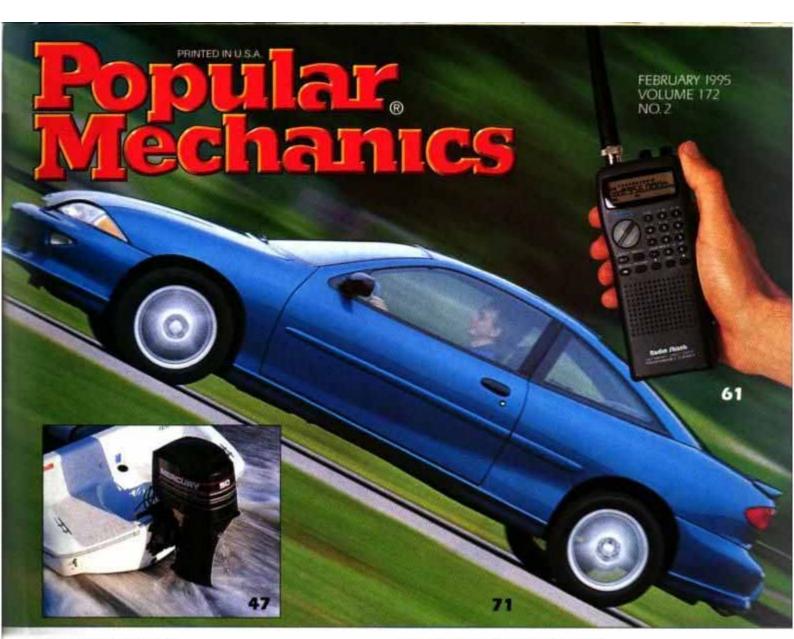
electronics control home heating for complete comfort.

The CompleteHeat system is available in capacities to meet the heating needs of almost any home. And Lennox is so confident of this gas-fueled system, it comes with one of the best

warranties in the business: a 15-year limited warranty on the heat exchanger and water tank. Other primary components are covered by a five-year limited warranty.

See your independent Lennox dealer for more information. Your whole family will thank you.





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Sprinter Jon Drummond



light Phylon midsoles for a leaner, faster, more efficient shoe. Wear them and you'll understand.

EDITOR'S NOTES

 It seems like you can't turn on the news these days without hearing of another aircraft falling out of the sky. As someone who travels by air virtually every week, believe me, this is a concern. But what really is going on? Is there a link between the incidents? Does deregulation of the airlines have something to do with it? Is air travel less safe than it used to be? Can the federal government do anything? And what about USAir? Is it less safe than other airlines? These



Motorsports fan at speed.

are just some of the questions that were tossed about recently at an editorial meeting here at POPULAR ME-CHANICS. Fact is, there are so many unanswered questions that we hardly knew where to begin. I asked Senior Correspondent Abe Dane to investigate the whole area of air safety in general and the recent spate of crashes in particular. Dane also looked at what we are learning from these air disasters in order to prevent similar occurrences in the future. He worked closely with the National Transportation Safety Board, the independent agency that investigates air disasters, to determine what the heck is going on. His cover story begins on page 66. . . . If you're a motorsports fan, as I am, you know that the inside story at any race takes place within each race team. The race strategies, refueling schedules, pit stops, car malfunctions and all the other variables are a fluid, constantly

changing story throughout the duration of the race. Since the advent of pitto-driver electronic communications a few years ago, the crew chief can discuss these points with his driver during the race. And now, with the newest electronic scanner equipment, you can listen in on these pit-to-driver communications and really get the inside story of what's happening on the track. Before you go to your next race, read the article beginning on page 61. . . . You may not think much about your home's foundation. And why should you? If it keeps everything standing, then no news is good news. But the same isn't true for builders and architects who are always searching for techniques that will lower construction costs, improve efficiency or both. Their interest in new foundation systems has fueled a lot of activity in a marketplace that, until recently, moved about as fast as tectonic plates across the face of the Earth. Assistant Home Improvement Editor Roy Berendsohn takes a look at these new developments in the article beginning on page 76. . . . How would you like to own a brandnew 1995 Buick Roadmaster Estate Wagon complete with a 260-hp LT1 V8 engine, leather interior and trailer-towing package? And how would you like to get it free? Now we're talking, right? Hey, just enter and win our new contest and the car is yours, courtesy of Buick Motor Division. The complete story and rules are on pages 74-75. Get in on this one now. . . . With all the environmental concerns presently floating around, it was inevitable that boaters would eventually have to look to 4-stroke power for outboard engines. Until the manufacturers learn how to make the otherwise-more-efficient 2-stroke powerplant cleaner and more environmentally friendly, the trend to 4-strokes will continue. That being the case, you need to know more about 4-stroke outboard engines.

So beginning on page 47, you'll find a complete report on 4-stroke outboards-in effect, the future of boating-plus a complete rundown on all the new '95 small-boat powerplants. Till next time.



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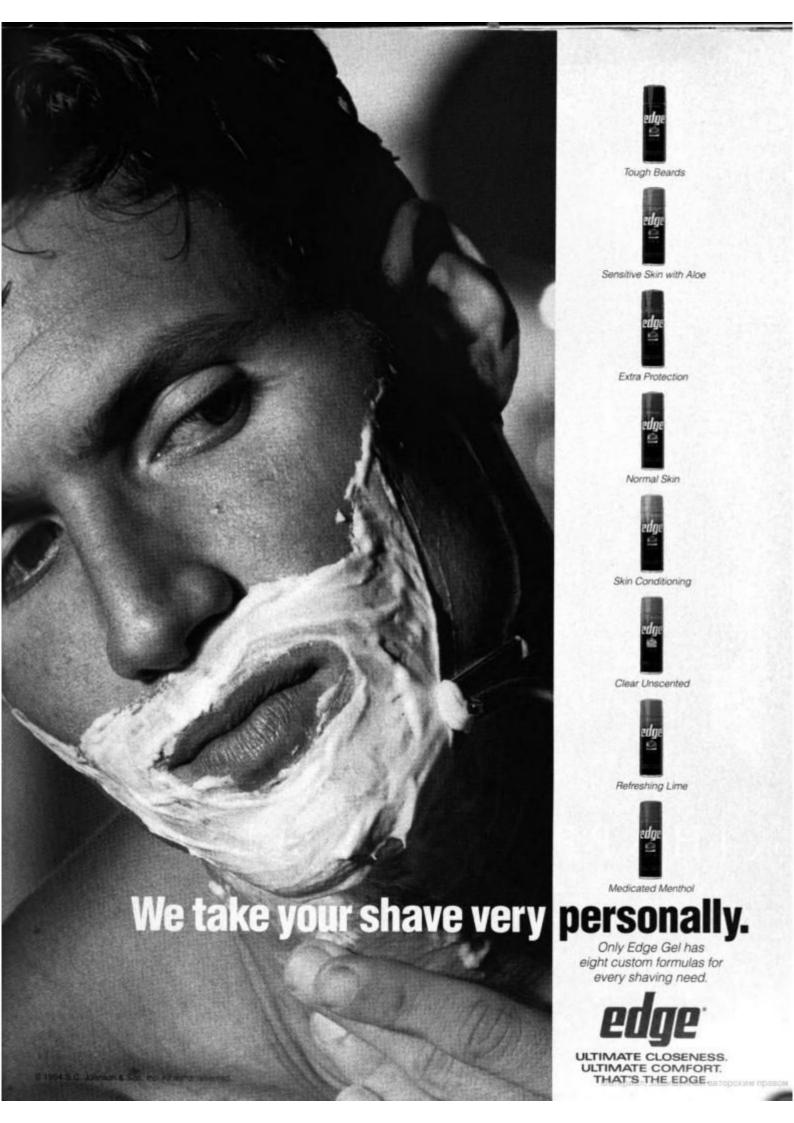
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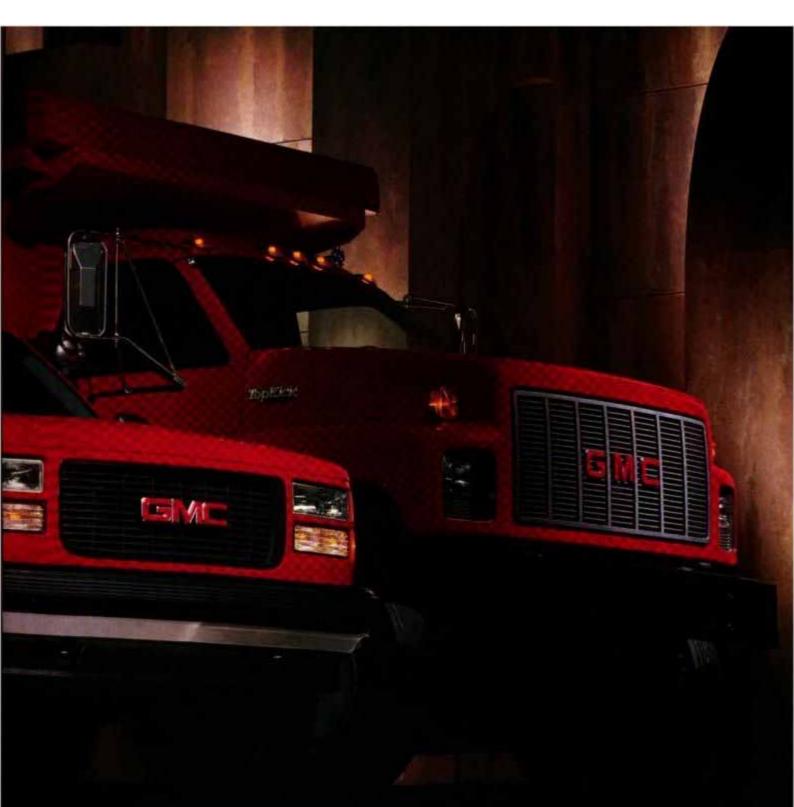




[HAPPILY, WE ALSO OFF

Whether it's industrial size or a more personal version, you always get full strength in a GMC Truck. Indeed, you'll find the strength of the big TopKick is embodied in the Sierra. Its body panels are made of double-galvanized sheet metal. Even its frame has a similar C-channel design to the one used on our medium duty trucks. Of course, there's more to Sierra than steely functionality. Just to be on the safe side. we've added standard four-wheel antilock brakes, along with a driver's-side air bag on Sierra models below





ER A TAKE-HOME SIZE.]

8600 lbs. GVWR. And with Sierra's independent front suspension, you'll get a smooth, comfortable ride on most any road. Just slide back into the accommodating new interior, then pity the poor souls bouncing around in lesser pickups. All in all, Sierra is everything you'd expect from GMC Truck, a company with over 90 years of experience in the truck business. So if you're looking for a strong, capable truck, Sierra delivers. Big time. For more information on the 1995 GMC Sierra, give us a call at 1-800-GMC-TRUCK.

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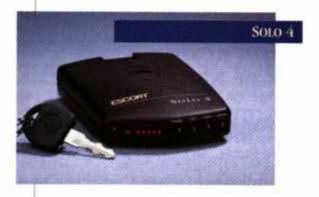
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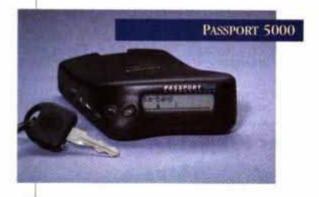
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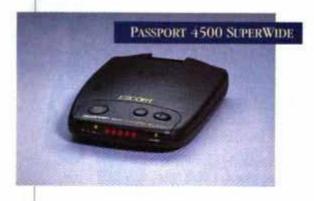
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LETTERS

Interactivity



The InfoHome and the information superhighway are an absolute must. Without them, think of all the workers who will be laid off in Hong Kong, Japan, Taiwan and Singapore.

ED JONES JR. SOMERSET, NJ

I believe you would get an excellent response to a computer and software clinic very similar to your homeowners and car care clinics. There are probably many readers such as myself who could use a single, accurate source to answer their questions regarding computer hardware and software. Many of us need to know the proper care and maintenance of our investment. I learned the hard way to perform regular backups and hard-disk diagnostics, rebuilding my files and spending hours on the phone waiting to speak to technical support staff who can't believe it's their equipment or software that is causing the problem.

JIM McKINLEY WYLIE, TX

Night Hawks

The night-vision cameras used by the T.A.R.G.E.T. Team in your article were amazing. I think every

Letters are subject to editing for length, style and format. large city should have such a team equipped with this infrared camera to help cut down on auto theft and drug dealing. I am a junior in high school and I live in a rural community of about 2000 people. Our small town is pretty much crimefree, but I think infrared cameras in the squad cars that patrol at night would be very beneficial.

JARED PORTER SHELBINA, MO

Fast Freighter

As one experienced in planning and supervising the loading of freighters, I find the Euro Express RoRo 225 as impractical as the car-plane. The ship would sail with too much empty space. Present container ships can be loaded to between 90% and 98% of usable cargo space. It is doubtful that the Euro Express can be loaded to 70% of usable space, and that's compounded by the inaccessibility of the bow area for storage. The Euro Express is expected to make money by cutting the time in half for each trip. But if it will be used only in the Baltic or Mediterranean, the savings will not be that great, if any. Also, the ship doesn't appear capable of sailing in either the North Atlantic or North Pacific, where it could encounter gales. In very heavy seas, its pointed bow would plunge beneath the waves rather than ride the surface. In all, the designers have a great deal to work out before we see a Euro Express actually at sea. The difficulty they have is in keeping the bow as light as possible, but that means sacrificing other features that contribute to seaworthiness.

> JACK ALLEN PACIFIC PALISADES, CA

Made In America?

I was infuriated when I read, "The [Honda] Accord is now about as American as apple pie." How can you say that when the profits go to a Japanese company?

PAUL CATANESE CHARLOTTE, NC

My idea of made in the U.S.A. is something that is designed, engineered, tooled for production, manufactured and assembled in the United States. And for which the money paid goes to an American-based, American-owned company. If I purchase a bicycle from France and assemble it in my basement, does that make it made in the U.S.A.?

LAWRENCE J. HOOKER KENMORE, NY

You guys are real Neanderthals. I'm a patriot, too. But you can't ignore the fact that companies like Honda employ thousands of Americans who get paid American money, then turn around and spend it right here in the United States. As for "designed, engineered, tooled for production, manufactured and assembled in the United States," there isn't a car made that could meet those criteria 100%. You'd better start walking.

As an owner of a '94 Accord, I read your Owners Report with great interest. You wrote, however, that an LX model is not available with ABS. My car is a 4-door LXA. The A stands for ABS. And my dealer has a lot full of them.

TERRY A. MILLER MACON, GA

Reader Project Of The Month



the stools, but staining and painting them as well. Each stool was made just a little different from the other and painted in different colors. The one shown here is decorated with colorful rosemaling—a traditional style of painting flowers, scrolls and leaf shapes.

FENTON, MO



"I'm stopping to go to the bathroom more than ever now. I wonder what's wrong with me."

Your urinary symptoms may be caused by a condition called benign prostate enlargement or BPH. BPH is not cancer and does not lead to cancer, although the two conditions can exist at the same time. Remember, only a

Is this you?	Yes	No
Do you get up more than once or twice a night to urinate?		
Do you often have sudden, uncontrollable urges to urinate?		
Do you have a hesitant or slow urine stream?		
Do you have a frequent need to urinate?		
If you answered yes to even one question, tell your doctor.		

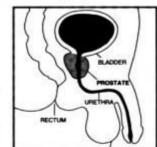
doctor can evaluate your symptoms and their possible causes.

Today, symptomatic BPH can be treated by your doctor in several ways. The options are monitoring the condition with regular checkups, surgery, or oral medicines. One oral medicine is

PROSCAR, the only prescription medicine for the treatment of symptomatic BPH that can shrink the prostate.

PROSCAR works by blocking a hormone that can cause the prostate to enlarge. But it is important to know: PROSCAR doesn't work for everyone.

Although the prostate may shrink, there may not be an improvement in urinary symptoms. However, in clinical studies with PROSCAR, some men have seen an improvement in their urinary symptoms after



The prostate surrounds part of the urethra, the tube that carries urine from the bladder. As the prostate enlarges, it can squeeze the urethra and cause urinary problems.

2 weeks. Others have found that PROSCAR took up to several months to help them. Because all men are different, you and your doctor will need to determine how PROSCAR is working for you.

If you have any urinary symptoms, see your family doctor or a urologist soon, and ask about PROSCAR. For free information to help you discuss your symptoms with your doctor, call 1-800-770-4686.

For the treatment of symptomatic BPH



The only medicine that can shrink the prostate.



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PATIENT INFORMATION ABOUT PROSCAR* (Probe-par)

PROSCAR* (Prahs-car) Generic name: finasteride (fin-AS-tur-eyed)

PROSCAR is for the treatment of symptomatic benign prostatic hyperplasia and for use by men only.

Your doctor may prescribe PROSCAR if you have a medical condition called benign prostatic hyperplasia or BPH. This occurs only in men.

Please read this information, as well as the leaflet which accompanies your medication, before you start taking PROSCAR. Also, read the leaflet each time you renew your prescription, just in case anything has changed. Remember, this leaflet does not take the place of careful discussions with your doctor. You and your doctor should discuss PROSCAR when you start taking your medication and at regular checkups.

What is BPH?

BPH is an enlargement of the prostate gland. After age 50, most men develop enlarged prostates. The prostate is located below the bladder. As the prostate enlarges, it may slowly restrict the flow of urine. This can lead to symptoms such as:

- · a weak or interrupted urinary stream
- a feeling that you cannot empty your bladder completely
- a feeling of delay or hesitation when you start to urinate
- · a need to urinate often, especially at night
- · a feeling that you must urinate right away.

Treatment options for BPH

There are three main treatment options for BPH:

- Program of monitoring or "Watchful Waiting". If a man has an enlarged prostate gland and no symptoms or if his symptoms do not bother him, he and his doctor may decide on a program of monitoring which would include regular checkups, instead of medication or surgery.
- Medication. Your doctor may prescribe PROSCAR for BPH. See "What PROSCAR does" below.
- Surgery. Some patients may need surgery.
 Your doctor can describe several different surgical procedures for BPH. Which procedure is best depends on your symptoms and medical condition.

What PROSCAR does

PROSCAR lowers levels of a key hormone called DHT (dihydrotestosterone), which is a major cause of prostate growth. Lowering DHT leads to shrinkage of the enlarged prostate gland in most men. This can lead to gradual improvement in urine flow and symptoms over the next several months. However, since each case of BPH is different, you should know that:

- Even though the prostate shrinks, you may NOT see an improvement in urine flow or symptoms.
- You may need to take PROSCAR for six (6) months or more to see whether it helps you.
- Even though you take PROSCAR and it may help you, it is not known whether PROSCAR reduces the need for surgery.

What you need to know while taking PROSCAR

- You must see your doctor regularly.
 While taking PROSCAR, you must have regular checkups. Follow your doctor's advice about when to have these checkups.
- About side effects. Like all prescription drugs, PROSCAR may cause side effects. Side effects due to PROSCAR may include impotence (or inability to have an erection) and less desire for sex. Each of these side effects occurred in less than 4% of patients in clinical studies. In some cases side effects went away while the patient continued to take PROSCAR.

Some men taking PROSCAR* (Finasteride) may have a decrease in the amount of semen released during sex. This decrease does not appear to interfere with normal sexual function. Rarely, some men have reported breast swelling and/or tenderness or allergic reactions such as lip swelling and rash.

You should discuss side effects with your doctor before taking PROSCAR and anytime you think you are having a side effect.

- Checking for prostate cancer. Your doctor has prescribed PROSCAR for symptomatic BPH and not for cancer—but a man can have BPH and prostate cancer at the same time. Doctors usually recommend that men be checked for prostate cancer once a year when they turn 50 (or 40 if a family member has had prostate cancer). These checks should continue while you take PROSCAR. PROSCAR is not a treatment for prostate cancer.
- About prostate specific antigen (PSA).
 Your doctor may have done a blood test called PSA. PROSCAR can alter PSA values. For more information, talk to your doctor.
- A warning about PROSCAR and pregnancy.

PROSCAR is for use by MEN only.

PROSCAR is generally well tolerated in men. However, women who are pregnant, or women who could become pregnant, should avoid the active ingredient in PROSCAR.

If the active ingredient is absorbed by a woman who is pregnant with a male baby, it may cause the male baby to be born with abnormalities of the sex organs. Therefore, any woman who is pregnant or who could become pregnant must not come into direct contact with the active ingredient in PROSCAR.

Two of the ways in which a woman might absorb the active ingredient in PROSCAR are:

Sexual contact. Your semen may contain a small amount of the active ingredient of the drug. If your partner is pregnant, or if you and your partner decide to have a baby, you must stop taking PROSCAR and talk to your doctor. If your partner could become pregnant, proper use of a condom can reduce the risk of exposing her to your semen (discuss this further with your doctor).

Handling broken tablets. Women who are pregnant or who could become pregnant must not handle broken tablets of PROSCAR. PROSCAR tablets are coated to prevent contact with the active ingredient during normal handling. If this coating is broken, the tablets should not be handled by women who are pregnant or who could become pregnant.

If a woman who is pregnant comes into contact with the active ingredient in PROSCAR, a doctor should be consulted.

Remember, these warnings apply only if the woman exposed to PROSCAR is pregnant or could become pregnant.

How to take PROSCAR

Follow your doctor's advice about how to take PROSCAR. You must take it every day. You may take it with or between meals. To avoid forgetting to take PROSCAR, it may be helpful to take it the same time every day.

Do not share PROSCAR with anyone else; it was prescribed only for you.

Keep PROSCAR and all medicines out of the reach of children.

FOR MORE INFORMATION ABOUT PROSCAR' AND BPH, TALK WITH YOUR DOCTOR. IN ADDITION, TALK TO YOUR PHARMACIST OR OTHER HEALTH CARE PROVIDER.



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PM HOTLINES

COMMUNICATE WITH US

We're trying our best to make it easier for you to communicate with us. Here are four ways you can do it.

LETTERS

Your written letters are always welcome. If we think your letter would be interesting to other readers, we might even print it in our Letters column (unless you request that it not be printed). Our editors are listed by department on the masthead printed in the front of the magazine next to Editor's Notes. Our address is: Popular Mechanics, 224 W. 57th St., New York, NY 10019.

FAX MACHINE

You can fax written mail to us if you have access to a fax machine. Our fax number is (212) 586-5562, and is available 24 hours a day.

ELECTRONIC MAIL

You can call the PM computer any day between 6 pm and 8 am (only) Eastern time. The number is (212) 582-8369. Once you're online, you can leave messages for specific editors, or direct inquiries and comments to a specific department. The department bulletin board also allows you to share your thoughts with other readers who call in.

New users get an identification number and password that allow them to access the system. Simply set your communications software to 8 bits, no parity and 1 stop bit (8-N-1), and set the baud at 1200, 2400 or 14,400. Please remember that we are not a professionally staffed, fully operational bulletin board. We're simply trying to make it easier for you to communicate with us. So please bear with us if it takes awhile to answer your message.

READER SERVICE BUREAU

Our Reader Service Bureau is operational five days a week during regular business hours. The phone number is (212) 649-3127. Please call our Reader Service Bureau, not our editors, for information on back issues, reprints of articles, subscription inquiries and so on. It will save all of us time.

HOTLINE PHONE NUMBERS

Unfortunately, our Hotline Phone Service is temporarily discontinued.

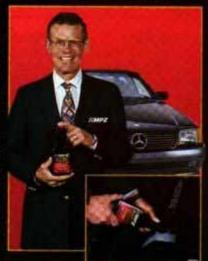
"RACING'S BEST KEPT SECRET PTFE IS NOT A ...NOW AVAILABLE TO YOU!"

BOBBY UNSER SAYS:

"Oil is just oil without MPZ...but with it you get more horsepower, more torque, and more wear protection. MPZ has proven these benefits with Torco's Racing Oil in the world's most powerful and fastest racing cars, boats and motorcycles...including 300 MPH race cars on pavement and 400 MPH race cars on the Bonneville Salt Flats.

Now this racing secret is available to all engine owners in Torco's MPZ Magnetic Friction Reducer...that stays on metal and won't let go.lt protects at start-up...and after start-up. Just pour in MPZ. It only takes a minute...and it will save money every mile

So order MPZ now! You'll save money on gasoline, oil, filters and engine repairs. You'll help protect the environment and save energy resources. There's no risk. It's guaranteed."



MPZ Reduces Friction Here... Where 97% of Friction Occurs

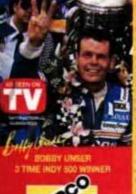




SLIPPERIEST FRICTION REDUCER By The World's Top Car Manufacturers.

MPZ's Formula Of Active Ingredients Is Rated As The

TECTS AT START UP





I've tried most of them myself. Believe me, there's nothing like MPZ. Here's why! MPZ adheres to iron and steel engine parts

magnetically where it is chemically absorbed into the surface. Therefore, MPZ won't wash off, burn off or rub off. It stays put and won't let go of cylinders. piston rings and valvetrain parts where energy is lost due to friction.

"We all know there are a lot of oil and

engine treatments. I've seen them all...and

NASA FACILITY TESTS



Dynomometer tests show an increase of 9 horsepower and 7 ft/lbs of torque when MPZ is added to an API certified SH/CD motor oil. These tests were documented by Dr. Robert Hoekstra of the University of Central Florida.

MPZ recovers energy lost to friction. This saves money on gasoline. It protects the oil from oxidation and heat breakdown into residual carbon. So your oil and filter will last longer...saving money. MPZ protects your engine from wear...saving even more money.

Order now! There's nothing like MPZ for saving money on gasoline, oil, filters and engine repairs. It's guaranteed. Only \$19.95 per bottle plus \$4.00 shipping and handling. Call now! Order desk open 24 hours...1-800-879-3800."

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Highway Driving 8.5%

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50,000 MILE TREATMENT.

THERE IS NO SUCH THING AS A "ONE TIME" 50,000 MILE ENGINE TREATMENT.

Reliable sources clearly state the facts: PTFE 50,000 mile engine treatments provide no protection benefits to the engine owner.

Here are the facts:

FACT #1 PTFE has been proven to be worthless by the United States Army Research and Development Center.

FACT #2 Four different universities in the United States conducted engine tests on 50,000 mile PTFE engine treatments and found no benefits. NONE!

FACT #3 General Motors Corporation Fuel and Lubricant Department conducted microscopic inspection on engine parts treated with 50,000 mile PTFE treatments and could not even find PTFE on the surface of the parts.

FACT #4 DuPont Chemical Corporation is the world's largest manufacturer of PTFE and Dupont's technical service department does not recommend the use of PTFE in combustion engines.

BUT THERE IS AN OIL ADDITIVE - NOT A "ONE TIME" ENGINE TREATMENT - THAT WILL PROTECT YOUR ENGINE MORE THAN 50,000 MILES... MMPZ

It works on accepted lubrication principals by treating the oil, at accepted oil change intervals, so the oil can protect the engine from friction and wear every mile you drive... 100,000 miles...150,000 miles...200,000 miles, or more!

The right way is with:



Order now! There's nothing like MPZ for saving money on gasoline, oil, filters and engine repairs. It's guaranteed. Only \$19.95 per bottle plus \$4.00 shipping and handling. Call now! Order desk open 24 hours.

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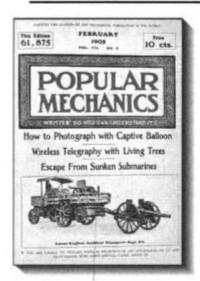


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TIME MACHINE

90 YEARS AGO: FEBRUARY 1905



Guns On The Run

Mechanized combat was years away, and pack horses still provided the motive power for field cannons. But Great Britain, embarrassed by quick-strike commando tactics in the Boer War, wanted to lend speed to its artillery and turned to motor vehicles. The steampowered wagons could haul two guns while towing several more on their own wheels. Military planners were convinced that the next great war would feature highly mobile artillery.

Fire Power

Meanwhile, motor vehicles would soon extinguish the era of the horse-drawn fire

department. In America, cars hustled only the fire marshals to the scene of a blaze, but in parts of England entire brigades rode trucks into action. The vehicles could carry 2500 pounds of

equipment-mostly chemical fire extinguishers and 9-ft. ladders. Durability meant more than speed: The trucks were fitted with solid rubber tires and heavy



springs, and could travel no faster than 25 mph.

60 YEARS AGO: FEBRUARY 1935



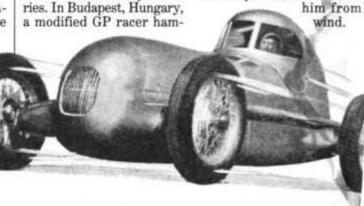
Blade Runners

Bored with ice fishing, Midwesterners turned to a new lake-top sport-racing sleds powered by outboard motors. A Chicago manufacturer offered the machines in kit form, the fuselages made of wood covered with canvas. A 21/2-hp engine, linked to a 4-ft, air propeller, drove the sled at 35 mph. Ice-fingered driv-

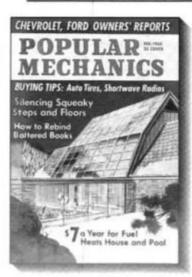
Star Car

Mercedes-Benz ruled the Grand Prix circuit in the years before World War II, with Rudolf Carraciola at the wheel for many victories. In Budapest, Hungary,

mered home the Benz technical supremacy by reaching a record speed of nearly 198 mph. Piloted once again by Carraciola, the car's driver compartment shielded



30 YEARS AGO: FEBRUARY 1965



Hot House

ers even enjoyed some engine heat via vents in the dash.

Sunshine made a local legend of Harry E. Thomason, who roofed a house in Washington, D.C., with an enormous solar collector. Behind glass, water cascaded down blackened aluminum to pick up heat. A 1600-gallon tank stored the water, which circulated through ductwork to heat the house in winter. In summer, water trickled across the collector at night to provide air conditioning.

Special Forces

The Pentagon's munitions labs were supplying an ar-



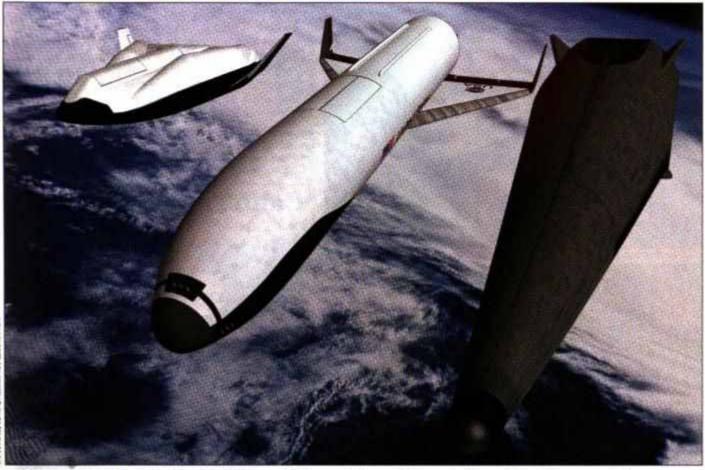
senal of concepts to fight the kind of "dirty little war that was taking shape it Vietnam. Counter-insur gency called for unusua weapons, ranging fror miniature handgun-fire rockets to truck

> mounted Clay morette mine that blaste any would-l ambusher More radical ideas i cluded a huge track robot that cov destroy ener supplies.



TECH UPDATE

News Of Tomorrow's Technology Today



X-33 Will Point The Way To Shuttle Follow-On

HUNTSVILLE, AL—After years of blueprints and blue-sky studies, NASA looks ready to get serious about replacing the space shuttle. The space agency has challenged America's aerospace industry to design an experimental rocket—called the X-33—to demonstrate technologies for a next-generation commercial launch vehicle. Under a new Clinton administration policy, NASA must focus on new reusable launchers, while advanced expendable rockets have become the Air Force's province.

Significantly, NASA won't bankroll

Significantly, NASA won't bankroll the spacecraft's development, but expects private companies to throw their own money behind the project. While aerospace firms may balk, several have already proposed unmanned single-stage-to-orbit vehicles that would suit the requirements.

Lockheed, now teamed with Martin

rocket, a lifting body powered by a linear aerospike engine (see Tech Update, page 19, Jan. '94). Rockwell, builder of the shuttle, has drafted a winged cylinder that would launch vertically but land horizontally. Meanwhile, McDonnell Douglas still has its vertical-takeoff/vertical-landing Delta Clipper in mind, previewed by the subscale DC-X (see Tech Update, page 14, Jan. '95). Boeing has joined forces with McDonnell Douglas to pursue this and other X-33 concepts.

Marietta, is detailing its aeroballistic

Lifting body, winged cylinder and verticaltakeoff-and-landing rocket (from left) are among NASA's choices for the X-33.

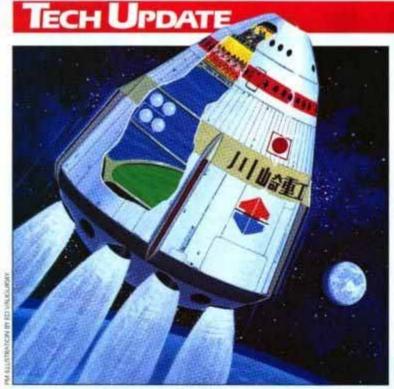
Ideally, NASA will narrow its choices to one design by the end of 1996 or else hold a fly-off contest.

If all goes according to plan, one contractor will also build a second vehicle, the X-34, designed to carry 2000-pound payloads into orbit. This smaller vehicle would not only complement the X-33's development but also stand ready for commercial use by U.S. satellite makers.

Highlights This Month

- Star Gazing—Japan's rocket for sightseers.
- Glass Eye—New 3D display is solid-state.
- Super Tram—Electric carriage runs on flywheel.
- Check Your Bags—Fixing Denver's new airport.
 Shipping Abroad—High-tech frigate for foreigners.
- Bug Antennas—Sensors catch termites in the act.
- Car Killer—Electronic device freezes stolen vehicles.

Editor/Writer: Gregory T. Pope Reporters: Philip Chien, Chris Chinnock, Mike Fillon, William Garvey, Scott Gourley, David Hughes, Suzanne Schoenfelt, Rick Schrader, Herb Shuldiner



Robot Parks Two Trailers

TROY, NY-Parallel parking is hard enough. Now imagine that your car is pulling a trailer. How about two trailers? That's beyond most drivers, but a robot built at Rensselaer Polytechnic Institute (RPI) does it with ease.

The CATmobile (named for RPI's Center for Advanced Technology) carries sensors to measure jackknife angles, steering angle and other conditions. An on-board computer then predicts the vehicle's movement and feeds back data to guide the robot through a perfect path.

With a few adjustments, the system could aid truck drivers with difficult maneuvers.

CATmobile negotiates tight spaces.

Orbital Tourism

TOKYO, JAPAN-While NASA ponders the future of reusable commercial rockets, the Japanese Rocket Society is already thinking about the next step. Led by engineers from Kawasaki Heavy Industries, researchers have put together plans for a single-stageto-orbit vehicle for space tourism.

Twelve liquid hydrogen/oxygen engines would hoist the 550-ton vehicle into low Earth orbit for a 24-hour tour. On two decks, 50 passengers would experience weightlessness, frolic in a microgravity amusement zone and take in the view.

The craft appears to draw inspiration from the McDonnell Douglas Delta Clipper proposal, with

Japanese tourist rocket would carry 50 sightseers into low Earth orbit for a 24-hour period.

composite materials and a tail-first re-entry maneuver executed with aerodynamic control surfaces.

California Split

DAVIS, CA-A drive from Los Angeles to Sacramento, California, usually devours a tank of gas. But a hybrid vehicle recently made the 440-mile run on only 5.7 gallons of fuel and a battery charge.

Last October, AfterShock—a car built by stu-dents from the University of California at Davis demonstrated its performance. The vehicle runs on 26 nickel-cadmium batteries and a modified Briggs & Stratton 2-cylinder gasoline engine. Had the car been burning regular unleaded, instead of the oxygenated gasoline sold seasonally in California, it would have averaged 85 miles per gallon.

AfterShock took first place in the Ground-Up category of last year's Hybrid Electric Vehicle Challenge (see Tech Update, page 38, Nov. '94).



Gasoline and batteries power U.C.-Davis's AfterShock.

Switch-Hitting Machine Gun

HERSTAL, BELGIUM-It's billed

as the first fully ambidextrous weapon system in history. But the P-90 sub-

machine gun, made by FN Herstal S.A., is arousing interest for its other un-

usual features.

Configured as a "bullpup," with the firing mechanism deep in the stock, the gun is only 101/2 in. long.

Charging handles, magazine releases and triggerfunction switches lie on both sides of the weapon.

Designed for special operations, Belgian P-90 has ambidextrous features and cross-aligned magazine. Atop the P-90 is a 50-round magazine, with bullets aligned perpendicular to the barrel. The cartridges rotate within the magazine so

that they are in line with the firing axis by the time they touch the weapon.

The ammunition itself is a new size $(5.7 \times 28 \text{mm})$, and is able to penetrate 48 layers of aramid-

fiber armor from more than 300 ft. Built mostly of composite materials, the P-90 offers a substantial weight savings over comparable sub-

machine guns.

COMPARE HOME FITNESS MACHINES WE DID - SO CAN YOU



Over-Priced at \$329.00?

Yes. Over-Priced because it under-performs.

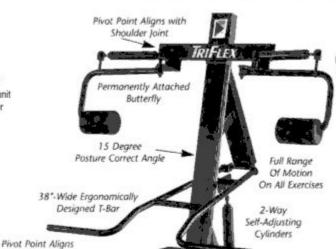
Although relatively cheap, HealthMax offers poor value. Constructed of lightweight materials, the unit shakes and rattles and will actually lift off the floor during a workout.



Design limitations severely restrict range of motion, resulting in "topping" or "bottoming," and prevent you from performing even basic exercises such as squats. The cylinders require constant adjustment, work in only one direction, and the leg extension cylinder is undersized.

HealthMax is an imported product that is supported by only a one-year limited warranty

All in all, you get very little value for your money.



Made In The U.S.A.

5 Year Warranty

NordicFlex Gold A \$999.95 Disappointment

Everyone knows that NordicTrack makes a great cross-country ski machine. Problem is they tried to extend this well earned reputation to NordicFlex Gold. They didn't succeed - instead they built a wire and pulley contraption.



Using a similar clutching mechanism as the ski-machine, long lengths of cable are threaded through 18 pulleys to the different attachments. The cables and pulleys continually need rerouting during your workout, requiring frustrating assembling and disassembling. The resistance is in one direction only, with a spring recoil, much like pulling the starter rope on your lawn mower,

You'll get a lot of metal, parts and pieces for your money, but very little satisfaction.

TRIFLEX[™] Rock Solid Value at \$795, or Only

Measures 75" Long 65" Tall

40" Wide

150 lbs

Simple 15 Minute

9. Rolf Assembly

Solid Steel Construction

Start by looking at the design. From the machine's pivot points to your body's limb joints, you're in an ergonomically correct position for the 44 different exercises. Smoothly articulating hydraulic cylinders are simple, self-adjusting and safe. The cylinders provide isokinetic resistance in both directions, cutting your exercise time in half and developing your muscles in the shortest possible time.

with Knee Joint

But, that's not all. Because the TriFlex workout is so intense, you will experience rapid calorie burn and your heart will be elevated

into its cardiovascular training zone. The net result is a total body workout that will make you stronger, increase your endurance and control your weight. And, all it will take is 30 minutes a day, 3 days a week.

In short, you get what you expect from your investment: Results. Strong claims? Yes - And you have every right to ask, "How do I know that this is not just more advertising bombast?" That's why we support our claims with an extraordinary offer.

You Make the Comparisons - We Pay the Freight

Deep Padded

Incline-Decline

Bench

Take our claims into your living room . You decide for yourself if TriFlex is right for you and your family - and, at absolutely no risk.

Order a complete TriFlex and either a HealthMax or NordicFlex Gold - or both if you are so inclined. Test us side by side for 30 days. Here's the kicker - call us when you've made your decision and we'll arrange for a truck to pick up the unit(s) you

decide to return. We'll gladly reimburse all shipping costs on the returned units. You get to kick the tires hard, with absolutely no risk, no hassle, no buyers regret.

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Call toll-free 1-800-600-3050 to order your complete TriFlex for a 30 day risk-free home trial.

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Dept. 219

FEBRUARY 1995

How Small Is Small?

CAMBRIDGE, MA-NASA is determined to slim down its planetary probes, but how low can they go? Would you believe just 7 pounds?

That's the possibility raised by Massachusetts Institute of Technology graduate student Lilac Muller, who has pinpointed technologies needed for a future generation of microspacecraft. Rockets could loft such probes en masse, so that one spacecraft failure needn't scotch an entire mission.

Each probe would bristle with innovation. For example, a single set of optics could serve as a scientific camera, laser data transmitter and star tracker (a device used to steer a spacecraft into position). In addition, the propulsion system would center on an array of 100 microthrusters carved into a 4-in. disc of ceramic rather than the weighty plumbing of conventional thrusters.

While the microspacecraft would still carry solar panels, ultra-stingy electronics would allow it to run on the equivalent of two AA batteries.

Microspacecraft would showcase low-power electronics and ceramic microthrusters.



3D Under Glass

STANFORD, CA-Three-dimensional displays continue to lure engineers. While some have harnessed spinning helixes on which to cast images (see Tech

Update, page 24, Oct. '94), others seek a display with no moving parts.

At Stanford University, researchers have demonstrated a prototype display that produces 3D images inside a block of glass. Two scanning lasers excite the glass into releasing photons. Only where the beams intersect do the photons become



Moving image squirms inside glass block excited by intersecting lasers.

energetic enough to show up as visible points of light. Future improvements to the display will incorporate multicolor light emissions and arrays of diode

lasers to eliminate scanning mirrors.

Robots Get Sensitive

MERRITT ISLAND, FL-Robots in NASA facilities must operate around unpredictable humans and sensitive flight hardware. The last thing anyone wants is a robotic elbow in the solar plexus—or for that matter in a spacecraft's solar panels.

To minimize unforeseen collisions, Merritt Systems Inc. has

designed a kind of skin for robotic limbs. Called SensorSkin, the material is a flexible circuit board embedded with three different kinds of proximity sensors. These tiny devices communicate with each other and send data to the robot's control electronics. The skin can be customtailored and wrapped around the robot in a single piece.

Fitted with sensor-laden skin, robot avoids cracking noggin of human co-worker.



Flyweight Tram With Flywheel Power

CRADLEY HEATH. ENGLAND-While electric trams have long shuttled people around cities. they haven't picked up much new technology of late. Now, a British company called JPM Parry & Associates has designed a tram for the 21st century.

The Parry People Mover offers two advantages over conventional trams. For one, its cars weigh only





6000 pounds, as opposed to Flywheel tram can run for several miles without electrical connection.

40 tons for a traditional tram carriage. For that reason, construction crews can install its tracks on existing roads without extensive engineering for heavy axle loads.

In addition, the vehicles gain power not from overhead cables but from flywheels mounted between their axles. Untethered, they need only top off at safe low-voltage third-rail strips near station stops. To recharge, each tram takes only 90 seconds.



BREAKTHROUGH TECHNOLOGY CUTS MOWING TIME IN HALF!

The TROY-BILT WIDE-CUT Mower finishes the job in half the time ordinary walk-behind & riding mowers take!

The unique TROY-BILT® WIDE-CUT Mower is a revolutionary HIGH-SPEED way to mow, finishing your lawn in half the time...and giving it a beautiful, high-quality cut, too!

Professional-style technology... at a homeowner price!



America's FASTEST walkbehind mower, the TROY-BILT WIDE-CUT Mower is 50% wider than ordinary mowers, and far more nimble than riding mowers!



Twin-blade mulching deck recycles clippings & leaves, cuts almost a yard wide!

Engineered after the mowers lawn cutting professionals use but priced for homeowners — it has technological breakthroughs that get the job done fast: extra-wide cut, more horsepower than most conventional mowers, multiple speeds, no-rake/no-bag mulching, instant height adjustment, superb maneuverability...all backed by an exclusive 7-Year Warranty! For a free copy of the warranty, write to the address below.

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VES! Please rush me facts on the TROY-BILT* WIDE-CUT Mowerincluding sp FREE Catalog, TROY-BILT* EASY Details, and your current offer!	
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UATE TO SERVICE THE SERVICE TH	
City	ILT
City	The Land."

TECH UPDATE

High-Flying Hydrogen

HAMBURG, GERMANY-Hoping to ground fossil fuels

for good, Deutsche Aerospace Airbus is refining its plans for an airliner powered by



hydrogen (see "The Hydrogen Age," page 21, Sept. '90). Together with other German aerospace firms and Tupolev and TRUD of Russia, the planemaker has conceived Cryoplane, so called because it would carry cryogenic hydrogen as fuel. The concept poses challenges. Not

only must liquid hydrogen stay superchilled and pressurized, but it also takes up more room than kerosene jet fuel.

For these reasons, the wings can't store hydrogen. Instead, Cryoplane would stash its fuel in insulated cylindrical tanks atop the fuselage. On the plus side, because hydrogen has a high energy-to-mass ratio,

Hydrogen airliner would have distinctive silhouette from overhead fuel tanks.

the airliner could carry more payload than a conventionally fueled equivalent.

Plastic-Weapons Sensor

RICHLAND, WA-While metal detectors may do a fine job intercepting concealed handguns, nonmetallic weapons are raising a new security threat at airports, prisons and elsewhere. One system that may nip that threat in the bud is under development at Pacific Northwest Laboratory.

The holographic imaging system relies on millimeter-





Holographic imager reveals body and concealed objects.

wave radiation in a frequency range that easily penetrates clothing but poses no known health hazards. A transceiver bounces signals off the target and captures reflections. A computer digests these readings and reconstructs a 3dimensional image of the target.

Although the apparatus can reveal plastic and ceramic objects, it requires that subjects pause to be imaged.

Russia's Weather Maker



MOSCOW, RUSSIA-The Russians have taken swords-into-plowshares to new heights with the M-55 Geophysica, a weather-manipulating follow-on to the high-flying M-17.

Dubbed "Mystic" by Western ob-servers, the original M-17 was the Soviet Union's answer to the U-2. with altitude capabilities approaching 70,000 ft. Since the late 1980s, the aircraft has been dedicated to ozone-layer research.

The M-55 differs from its forebear by a shorter 122ft. wingspan and twin engines. Russia is touting the Geophysica for a unique purpose: protecting crops from hail. The plane could soar above threatening storms, then release chemical rockets that induce clouds to discharge rain.

Fast-climbing M-55 Geophysica could seed clouds to prevent hall or relieve drought.



Denver Airport: A Tale Of Two Baggage Systems

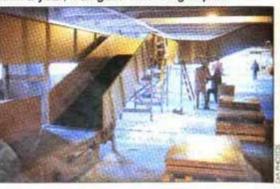
DENVER, CO-Its balky automated baggage system turned what might have been the best of times into the worst of times (see "Denver International," page 36, June '94). Now, after more than a year of embarrassment, Denver International Airport (DIA) is slated to open-as of press time, at least-at the end of this month.

The original system relied on a network of 300 computers to route bags. Laser scanners were to read multidigit bar-coded luggage tags, while photocells tracked the movement of toboggan-like baggage carts. But buggy software crashed the system again and again.



So now two separate DIA's Infamous baggage system is underbaggage systems will oper- going repairs to meet Feb. 28 opening date.

ate when the first revenue flights touch down. United Airlines will use a version of the original system, revamped to provide redundancy. Continental and other carriers will rely on a backup system of conventional tugs, carts, conveyor belts and people. They'll switch to the automated system within a year, if all goes according to plan.



Mind Power Breakthrough!

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Plus Get \$600 of Free Learning CDs!

By Dane Spotts



Absolutely mind blowing!!! I popped a French Learning CD into the Learning Machine: Immediately I was sucked into a deep, dreamlike trance. Weird colors and patterns

were created on the insides of my closed eyelids. While in this super-relaxed but hyper-aware state, the special Learning CD began unfolding its magic programming.

A Vacation in 22 Minutes

It was as if a movie were playing inside my head. I could see myself in France having lunch at the Eiffel Tower. The music, the sounds, even the fragrance of summer in Paris. A beautiful woman spoke to me. "Bonjour, mon ami," she said. In an almost unconscious way I began following the dialogue. The mental imagery was so intense I not only understood what was going on, it was like I was there.

Learning at Light Speed

The Learning Machine is more than virtual reality. More than just a cool way to relax after a hard day at work. According to one college professor, "It may be the most powerful learning tool since the invention of the book."

Here's why. When you do a Learning Machine session your mind is cut off from outside distractions. Your attention becomes focused inward as the powerful sensory stimulation (light-sound matrix) bombards your imagination. Ideas and mental images float in and out of your consciousness. It feels like the best

dream you've ever had. Then while in this highly euphoric mental space, the Learning CD opens your learning centers to peak receptivity and pours in new knowledge and skills. It's the ultimate mind trip. But it's not just for fun.

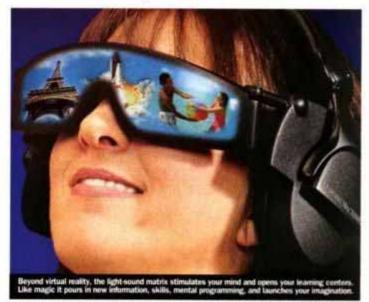
Let's say you want to learn a foreign language, improve your reading and comprehension, or increase your math skills. Or just give your kids a powerful edge in school, learning many times faster than their peers. It's simple.

You select a specially programmed Learning CD in the area you want to study. Plug it into any ordinary CD player. Then attach your Learning Machine digital headset into the headphone jack. Push play and a few moments later your mind is launched into a pre-programmed learning session. In a fun, almost effortless way, the Learning CD unfolds its program and literally forces you to learn. It's the most amazing thing you've ever experienced.

Speak French, Spanish, German & Italian

Learning foreign languages, or anything for that matter, at rocket speed can be very empowering. And I'm going to include a ton of valuable Learning CD software with your Learning Machine so you can get immediate results from this new technology.

You'll receive 4 basic language courses — French, Spanish, German, and Italian. Plus a Super Vocabulary course, a Super Memory course, and a Super Speed Reading course. And for your kids, a SuperPhonics' reading program. Over \$200 worth of Learning CDs make this the deal of the century. But I also



want to show off its other incredible mind expanding powers.

10 Fantastic Mind Journeys

So I'll include the 3-D Mind Sync"
Library, with 10 mind launching
programs on 3 CDs. Turn your Learning
Machine into a meditation, self-hypnosis,
and virtual fantasy computer. You'll get
the following titles: Creativity Booster,
Quick Energy, Stress Zapper, Mental TuneUp, Virtual Visualization, Imagination
Stimulator, Learning Accelerator, Super
Intuition, Lucid Drawning, and Super Zen
States

A \$150 value, this extensive collection is a super added bonus. But even more exciting is how it can be used for habit control, success conditioning, and eliminating self-sabotaging behavior.

Super Motivation Library

Let's say you want to transform a loser mind-set into a winning one. Or you'd like to quit smoking or lose weight. Pop in an InnerMind" Programming Disc. The sensory stimulation matrix opens a window into your unconscious mind. Then by infusing your "inner mind" with positive programming, you can rescript negative, self-defeating attitudes. I'm including an awesome 18-title InnerMind Programming Library. From success conditioning to weight control this is another \$150 value.

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Plus in addition to the Language Learning Library, the SuperPhonics, Super Speed Reading, Super Memory, and Super Vocabulary programs, the 3-D Mind Sync Library, and the InnerMind Programming Library (a \$600 combined value), I'm including coupons worth a thousand dollars. These coupons are for hundreds of future Learning CD applications, including software that links your mind directly to a multi-media computer. It's something you absolutely must experience.

Try the Learning Machine for 30 days risk free. Take your mind on an incredible journey. If for any reason you're not totally blown away by the experience, send your kit back to me for a full refund.

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\$600 Super CD Bonus Pak

undeeds of defeats worth of valuable Learning Disc Libraries are bundled with your Learning Machine III to make this air incredible deal. Hele is just a sample of the mind boggling benefits of your Learning Discs that will be bundled FREE as part of this special introduction offer.

The Teacher^{IM} (559 Value) Start up demonstration disc will take you on a journey and prep your mind with all the incredible things you can be set up to be a few to be a few

Accelerated Interactive Language Learning** Library (\$200 Value) 4 language training courses teach you basic French, German, Spanish, and Italian using the same course materials taught to international diplomats.

3-0 Mind Sync** Library (\$150 Value) 10 mind journeys: Creativity Booster, Quick Energy, Stress Zaipper, Mental Tune-Lip, Virtual Visual Institution, Imagination Stimulator, Learning Accelerator, Super Intuition, Locid Decarring, and Super Zen States. Launch your mind anto-

InnerMind** Programming Library (\$150 Value) 18 programs on 3 Learning Discs program success behaviors into your subconscious. Titles: Building Self Esteem, Ennimate Fear & Atwiety, Projecting a Winner's Image, Attracting Love Relationships, Health & Healing, Establishing Programmer & Washing Tenanger & Washing Tenanger



fanagement & Organization. Creativity & Problem Solving. Effective hable Speaking, Increase Pocus & Concentration. Super Memory & earning, Stay Fit Exercise Motivation. Permanent Weight Loss, liminate Procreatination. Quit Smoking Now, Meet Your Deadlines. Jacob on Torris.

Super Speed Learning™ Beginner's Pak (\$59 Value) 4 accelerated learning programs. Super Speed Reading, Super Memby, Super Vocabullary, and SuperPhonics (for lods R-6) teach you learning skill you'll use for life.



Plus \$1,000 Worth of Coupons for More Software at in your kit are coupons for additional Learning Disc programs. Plus lists on future programs.

including ESL Japanese. Chinese, and fluesian. The Photographic Mind Series. Transcendental Mind Series, Lapanese. Chinese, and fluesian. The Photographic Mind Series. Transcendental Mind Series. Faratastic Journeys that learned your consciousness into incredible new worlds. The Time Traveler Series. World Motory, Science & Space. World's Greatest Mind Series. Study Habits Diocs. Self-Esteem For Midd. Children's Classic Literature Series. Corporate Training Programs and more. Future Billes include the Chil War series. Everything 18 Ever Wanted To Know, plus existing CD-ROM software converted into Learning Machine formatics.



Introducing the TOYOTA It's

It's having both SPACIOUS comfort for six and AGILE handling.

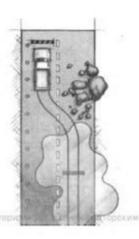
It's having both a new 190-HORSEPOWER engine and the multi-valve technology to still deliver sensible fuel ECONOMY.*

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It's the rugged CAPABILITY of a welded steel cab and full-box frame.

The finishing touch to the state-of-the-art suspension system is the available 4-wheel Anti-lock Brake System (ABS).

Multi-valve technology delivers 2,150 lbs. payload capacity, 5,200 lbs. towing capacity* and valuable fuel economy.







Craftsmanship abounds in the spacious interior with room for six people, standard driver air bag** and 3-point seatbelts at all outboard positions.

T100 XTRACAB. THE Toyota of BIG trucks.

It's an attention to DETAIL in refinements like a superbly CRAFTED

interior, available CFC-free air conditioning and sophisticated SAFETY systems. It's an ALL-NEW truck that comes with Toyota's legendary REPUTATION.

The T100 deep steel cargo bed is as rugged as it is functional, constructed with sheets of heavy-gauge metal.



It's ENGINEERING that goes beyond. It's the all-new Toyota T100 Xtracab.

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I Love What You Do For Me

TECH UPDATE

Export Frigate

NEWPORT NEWS, VA—Kept afloat with Navy contracts during the Cold War, American shipyards have taken a broadside from recent budget cutbacks. Newport News Shipbuilding and Dry Dock Co. hopes to adapt by looking abroad. Its latest design is the FF-21, a warship for friendly foreign nations that seek frigates as their navies' workhorses.

While intended for export, the FF-21 meets the stringent requirements of construction for the U.S. Navy. The frigate is an all-steel vessel with proven NATO-standard features. Roughly 350 ft. long—about 100 ft. shorter than America's *Perry*-class frigates—the vessel weighs in at just under 3500 tons.

The ship runs on a combined propulsion system in which a pair of diesels chug away for a cruising speed of 23 knots, while two gas turbines can kick in to boost speed beyond 34 knots. Automated combat systems have reduced the shipboard complement to just 85—less than half that of the *Perry*.



Clean lines mark the FF-21, a new export frigate for America's allies.

Into The Solar Wind

GREENBELT, MD—After a 2-year delay, NASA finally launched its Wind spacecraft last November. Wind is the second of three international probes lofted to study the solar wind, the first being Japan's Geotail (see Tech Update, page 23, Sept. '92).

A gale of charged particles, the solar wind blasts from the Sun at 1 million mph. To learn



MARTIN MARKETTA ILLIATRATICA

how these particles interact with Earth's magnetic field is Wind's mission. The probe will venture 990,000 miles toward the Sun, executing two figure-eight orbits.

After that, Wind will perch at a point in space where the gravities from Earth and the Sun balance out. From there, the spacecraft will investigate the solar wind before it bombards Earth.

Wind carries six instruments to gauge composition, energy and effect of solar-wind particles.

Humvee's Light Punch



WASHINGTON, DC—What happens if a group of Humvees, reconnoitering ahead of rapid-deployment troops, stumbles upon a platoon of hostile tanks? If the scout vehicles are equipped with Outriders, they have a fighting chance against their heavily armored foes.

Developed by Martin Marietta, Outrider combines a suite of sensors with an electrooptical

> countermeasures system—in short, a laser designed to destroy enemy fire-control optics. Meanwhile, the sensors acquire target information and relay it to commanders.

> Outrider, currently in prototype stage, has piqued interest from both the Army and the Marines.

The Virtual Firefighter

SAN ANTONIO, TX—To test fledgling firefighters, fire schools ignite specialized burn buildings, cinder-block houses torched with propane or diesel fuel. But training facilities want to sidestep this expensive—and risky—technique, and so they are turning to virtual reality.

At the Southwest Research Institute, engineers are

developing a virtualenvironment training system that involves more than just a helmet-mounted display. Computer-controlled heat and odor generators augment sights and sounds to provide a "deep-immersion" experience. Trainees can even use a virtual water hose to extinguish simulated fires.

Virtual-reality training system for student firefighters engages four out of five senses.



Carried by scout Humvee, Outrider can pinpoint targets or blind hostile optics.

10 EXCITING WAYS YOU CAN EARN UP TO \$2,000 A WEEK IN YOUR OWN BUSINESS.

How would you like to be your own boss! Call all the shots! Set your own hours! Enjoy financial security and a better life for you and your family! Be highly respected! It's easier and quicker than you think ... With Foley-Belsaw's help.

Here are 10 of the hottest career opportunities of the '90s! Choose any one and you'll be well on your way to owning your own profitable Big Money-Making Business. Thanks to Foley-Belsaw and their easy-to-follow hands-on do-it-yourself technical service training, you can learn at low cost in your spare time at home and start making big money quick! No previous experience or special education necessary.

This is a once-in-a-lifetime opportunity. Take that first step now. Pick the business that interests you the most and send in the coupon for Free Information today! No obligation. No salesman will call. Don't put it off and let your future slip through your fingers!

........



- LOCKSMITHING With rising crime rates, people are seeking more protection than ever before. Professional locksmiths are in great demand. Course in Burglar and Fire Alarm Systems included at no extra cost.
- SMALL ENGINE REPAIR There's an acute shortage of qualified Small Engine Repairers—many technicians have found this to be a profitable business 52 weeks a year.
- SAW & TOOL SHARPENING 90 cents out of every dollar you take in is <u>cash profit!</u> The work is easy machines do the work for you.
- 4. <u>UPHOLSTERY</u> Instead of buying new furniture, more and more people are re-upholstering to save money. And repairing damaged furniture will add additional big profits in both commercial and consumer markets.
- WOODWORKING Build over \$3,000 worth of fine furniture while you learn. Create heirloom-quality furniture for customers or to sell. Save thousands on your own home repairs alone.
- 6. <u>GUNSMITHING</u> Collectors and hunters pay big money for professional expertise to keep their guns in tip-top condition. Law enforcement officers have their weapons serviced regularly.
- 7. VCR REPAIR Our unique "Fundamentals Method" concentrates on the mechanics involved in 90% of all repairs, without wasting time learning unnecessary electronics. Our way is faster, simpler, lower cost.

- **8.** <u>COMPUTER REPAIR</u> There are over 60 <u>million</u> personal computers in service, 50,000 new ones sold every day! There are just not enough technicians to service them. Customers will pay you <u>big bucks</u> to keep their PCs running.
- 9. SATELLITE DISH/TV/ELECTRONICS SPECIALIST Few technicians are equipped to service this fast emerging field. Foley-Belsaw gives you Satellite Dish technology (including new mini-dish), along with electronic expertise to make big money servicing TVs and other devices.
- 10. <u>PERSONAL COMPUTER PROGRAMMING</u> Drastic shortage of qualified computer programmers can mean big earnings in a career for you. Learn fast at low cost.

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TECH UPDATE

Bringing Home A Piece Of The Rock

LAUREL, MD-Although a samplereturn mission to Mars would be exciting, it could cost a bundle. That's mainly because the return spacecraft would have to bring enough power to escape the planet's gravity. But a similar mission to an asteroid needn't be such an undertaking.

Johns Hopkins University's Applied Physics Lab has proposed just such a venture. Called Near-Earth Asteroid Returned Sample, or NEARS, the spacecraft would rocket toward one of Earth's tiny neighbors in the year 2000.

Upon arrival at the asteroid 4660

Nereus, NEARS would search for target sites. The spacecraft would then perform touch-and-go landings. As NEARS NEARS would selze samples of asteroid and fire them back to Earth in a return capsule. brushed Nereus, one of six shotgun-like tube penetrators would fire into the surface and grab a sample. Because no



would have to cut through anything from goo to granite. Protected by an aeroshell, the probes would then be launched back to Earth and would parachute to safety.

Electronic Roadblock

SLEEPY HOLLOW, IL-A barrier of police cars, dozens of officers with guns trained on an onrushing car: That's the traditional way of bringing a high-speed

one knows an asteroid's true composition, these probes



auto chase to a halt. But Creative Electronic Consultants is offering a less brutal alternative.

Called Anti-Vehicle Electronic Counter-Measures, or AVECM, the device is a 42-in.

plastic pancake riddled with electrodes. Police can deploy the discs before the suspect approaches.

As the auto passes over an AVECM, electric discharges scramble the vehicle's engine controls and associated circuitry. The car stops and cannot restart.



AVECM car killer mimics a bump in the road.

Drive 'Em Or Fly 'Em

MARSHALL, IL-Military hardware has long rolled off specialized assembly lines to meet Defense Department

requirements. But what's good enough for GM may prove good enough for the Pentagon (see Tech Update, page 18, June '94). For example, the Air Force has given TRW the go-ahead to build avionics for the F-22 fighter on the same line that produces automotive electronics.

TRW will modify



the plant's equip- Automotive electronics and F-22 avionics ment to swap be- will roll off a single TRW assembly line.

tween car components and communications, navigation and identification modules. If 90 prototypes pass muster, the line could produce the units throughout the lifetime of the F-22.

Newest Icebreaker

NEW ORLEANS, LA-In the late 19th century, Capt. Mike Healy pioneered icebreaking for the Revenue Cutter

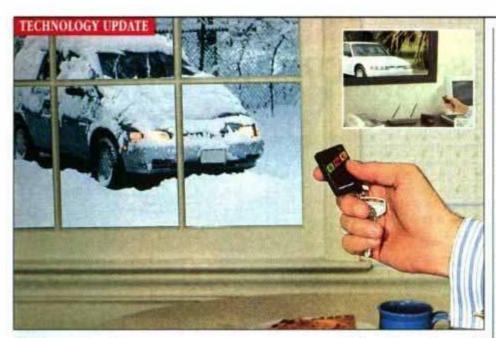
Healy will be Coast Guard's first new icebreaker in nearly 20 years.

Service, now known as the U.S. Coast Guard. The legendary skipper's name will honor the Coast Guard's newest polar icebreaker-CGS Michael A. Healy, under construction at Avondale Industries. The Coast Guard will

take possession of the Healy in late 1997.

Joining Polar Star and Polar Sea for high-latitude duty, the Healy will replace the two Wind-class icebreakers that had served for more than three decades. A research specialist, the new icebreaker will carry only 75 crew members and pack in as many as 50 scientists. But it also will wield enough muscle to carve trails into iced-in sites such as Thule, Greenland.

Four 10,600-hp diesels, supplied by Westinghouse Marine, will drive the 420ft. vessel, which will offer a range of 18,000 miles and an endurance of 180 days.



New microprocessor puts the brain of a \$50,000 car under your hood...

Breakthrough remote control lets you start your car, turn on its headlights, sound a panic alarm and unlock the doors and trunk...from up to 400 feet away.

by Charles Anton

ow many times have you had to bundle up and brave freezing weather to start your car? Or sit in a sticky car and touch a blistering-hot steering wheel to get your car started? What else can you do besides shiver while a defroster blows cold air in your face or roast in the scorching heat of your car?

A better way. The new AutoCommand keychain transmitter gives you the power to start your car from the comfort of your home or office. Simply press a button to start warming up or cool-

ing off your car from up to 400 feet away. You can turn on the heater, air conditioner or defroster without leaving your seat.

The powerful microprocessor brain learns your car's starting pattern. It adjusts the starting routine based on the outside temperature,

Why AutoCommand is better...

- Range. Most remotes only work up to 100 feet away. AutoCommand gives you a range of up to 400 feet.
- Self-diagnostics. The unique feedback lights on AutoCommand confirm proper wire connections during and after installation, just like a car's on-board computer.
- Total security and convenience. AutoCommand gives your car the capability of remote car starting, keyless entry, panic alarm and car security. It also has built-in low temperature and low battery voltage start options.

battery voltage and the amount of time since your car was last run to guarantee starting every time.

Give your car a brain. AutoCommand gives your car the same features as luxury cars, and even some they don't have, by adding this microprocessor brain. In addition to remote car starting, your car will have

features such as keyless entry and built-in car security. You can call for help or scare someone away with the panic alarm; locate your

car with CarFinder; and

have your car automatical-

ly turn on its headlights when it gets dark or turn them off 20 seconds after leaving your car. You can even leave your car running with the doors locked and no key in the ignition. If you forget your car is running, it will automatically shut off after 10 or 15 minutes, you choose. Intelligent benefits. With AutoCommand, your car can't be driven until a key is put into the ignition. The AutoCommand immediately cuts off the engine if your vehicle's hood is raised, brake pedal is pressed or the vehicle is

shifted out of gear without the key in the ignition, preventing theft or tampering.

AutoCommand also monitors your car while you are away. The built-in Vacation Option will automatically start and run your car for 10 minutes every four to six hours when the temperature drops below zero. On hot summer days, AutoCommand will also start your car when the interior reaches 140 degrees. If your battery drops below 11 volts, Auto-Command will start your car to recharge it.

Try it risk-free. At Comtrad, we back all our products with a risk-free home trial. Try AutoCommand in your car and if you're not completely satisfied with its value and performance, return it within 90 days for a full refund, "No Questions Asked."

UPGRADE OPTIONS.

You can replace your existing garage door remote control with the Garage Door Remote Control replacement system. This system can be added to any garage door that has an existing electrical garage lift unit. It will share the same transmitter as the Auto-Command, eliminating extra keychain remotes! You can also add the Shock Sensor. option to the built-in car security system. It detects any impact on your car, giving you added protection.



AutoCommand is also backed by a two-year manufacturer's limited warranty. Most orders are processed within 72 hours and shipped UPS.

Exclusive \$50 installation discount

AutoCommand comes with an installation video and has patented self-diagnostic feedback lights which confirm wire connections step-by-step during installation. But for those who prefer to have AutoCommand professionally installed, we offer a \$50 installation discount. Use the money for professional installation, or install it yourself and keep the money. Either way, AutoCommand makes it easy and affordable to add luxury car features to your automobile.

Please mention promotional code 691-PO1108.

For fastest service call toll-free 24 hours a day 800-992-2966



To order by mail, send check or money order for the total amount including S&H (VA residents add 4.5% sales tax.) Or charge it to your credit card, enclosing your account number and expiration date.

COMTRAD

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AUTOCOMMAND FEATURES

Automatic shut-off after 10 or Built-in self-diagnostic Security switch prevents system, cold start to drive car unauthorized use 15 minutes (you choose) nd "no tach" feature olify installation Pin switch disables unit If hood is opened Fuel check option Monitors temperature and voltage to prevent dead batteries you to lock and unlock oors and trunk Panic Alarm, headlights and/or horn Transmission check to Works on diesel or can be activated verify car is in park Built-in car security system by remote control

TECH UPDATE

Panic Button For Car Renters

FORT LAUDERDALE, FL-Responding to last year's spate of deadly car-jackings, Avis Rent A Car has added electronic countermeasures to cars at Miami International Airport. The Oldsmobile Eighty Eights fea-



Panic button sends car identification and locating signal to control center.

ture cellular phones and GPS-based Guidestar navigation systems, but the key deterrent is an emergency button on the phone panel.

Once pressed, the button sends out a signal picked up by three towers in South Florida. Computers at a control center triangulate to pinpoint the car's location, and an operator alerts the police.

Sounds In The Woodwork

INDIANAPOLIS. IN-Detecting termites has traditionally called for sharpeyed inspection, although stethoscopes, fiberoptics and even termitesniffing dogs have been tried. But now an acoustic-emissions detector is proving a reliable alternative.

Developed by two University of Minnesota engineers. the device senses the high-frequency acoustic waves released when termites munch on wood fiber. To filter out noise, the detector only registers readings in the 40- to 60-KHz range, which lies beyond human hearing.

Two sensors con-

fiers and a digital display. To check against false positives, one sensor can monitor a clean piece of wood while the other lies on a suspect plank.



nect to a handheld unit housing amplifrom insects' destructive activity.

DowElanco has been field-testing a prototype for a year with good results, but has not yet developed the device commercially.

Space Needle Search

HOUSTON, TX-How bad is the space-junk problem? Not as bad as NASA feared, according to a new analysis. At the space station's planned altitude, there's only about half the debris estimates suggested, chiefly because spacefaring nations are simply less messy these days.

The new data inspires confidence because debris-detecting radar has been accurately calibrated with target spheres released into orbit (see Tech Update, page 20, Feb. '93). Now a followup experiment, planned for this month, will provide a much more stringent test for groundbased radar stations like Haystack in Tyngsboro, Massachusetts.

In addition to three more spheres, the shuttle will eject three platinum-iridium needles into orbit. Each will look like a sharp edge from any angle, with little radar reflection.



Radar technicians will be looking for needles with a Haystack.

Flame Darts Test Rockets



HUNTSVILLE, AL-Researchers at Marshall Space Flight Center have recently spent their time throwing darts. The 14-pound pro-

jectiles represent a new way to measure how well a rocket engine burns during test firings.

Launched with a burst of high-pressure nitrogen, each dart carries sticky foil that traps microscopic particles. The dart arcs through an exhaust plume. spending 2 or 3 seconds in the gas before being recovered for analysis.

Other applications could include research on volcano emissions or determining the origin of a building fire.

Dart captures microscopic particles during trajectory through rocket exhaust plume.



Natural Prostate Relief

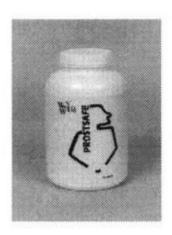
It's a natural fact. If you are a male over 40 and don't already suffer from a prostate gland disorder, the odds are 2 to 1 that you will before you are 59. By the age of 65, most American men have enlarged prostates.

As the years pass, mild discomforts can become disabling. Today, prostate surgery is the second most commonly performed surgery in men over age 65! Surgical complications can include total loss of bladder control and sexual dysfunction.

Prescription drugs may halt the swelling, but rarely ends the suffering. Like many prescription drugs, they have side-effects, like weak erections and low sex drive.

Many doctors feel that prostate disorders can be treated or prevented by giving the prostate gland the nutrition it lacks.

Recent scientific research has shown how to remedy the underlying problems associated with prostate disorders--safely and effectively. These results have been published in the British Journal of Clinical Pharmacology, the American Journal of Gerontology and papers from the National Cancer Institute. They reveal that several vitamins, minerals and natural herbs can dramatically shrink the prostate and improve urinary performance in older men.



Our customers have said Prostsafe helps to:

Halt the endless trips to the bathroom during the night!

Stop that burning sensation during or after urination!

Prevent uncontrollable wetting!

Improve bladder control!

Empty bladder completely!

Sustain erections and enhance virility!

Please a concerned wife!

The most modern application of these healthy ingredients is found in **Prostsafe** from Whitewing Labs. **Prostsafe** is the nutritional "tool kit" for men with prostate problems, and those who wish to prevent them. It is a mixture of zinc, serenoa serrulata, ginseng, certain amino acids, bee pollen and vitamins A, B-6 and E. Working as a team, these ingredients have been scientifically proven to shrink a swollen prostate.



Dr. Michael Rosenbaum, M.D. says "Prostsafe supplies essential vitamins, minerals and herbs needed to nourish and maintain a healthy prostate."

For as little as a dollar a day, that seems like inexpensive insurance against deadly prostate disorders. If for some reason you are not satisfied, just return the unused portion within 30 days for a full refund.

The reasons why men over 40 use **Prostsafe** are clear. If you are looking for relief, order **Prostsafe** today.

Whitewing Labs, Dept. 114

"Now I get a good night's sleep without getting up every two hours to urinate."

 Mr. C. Hussy Cleburne, TX

"Prostsafe has stopped the burning after urination."

- Mr. C.E. Black Barboursville, WV

"I empty my bladder and have a good stream of urine with no strain."

> -- Mr. S.J. Hymel Houma, LA

"I previously encountered discomforts such as bladder urgency. These problems are now completely absent."

-- Mr. B. Doser Holland, MI

"This is a little personal but, how can I say, I am more virile."

> -- Mr. G. Howard Clevland, OH

"...and in the sex department, my wife thanks you."

> -- Mr. G. Sawin Lynwwood, WA

PS1 1 month	supply of Prostsafe on	ly \$34.95 plus \$4.50 S&I	
	[PLS - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	ive \$9.95) plus \$4.50 S&I	
		ave \$89.75) plus \$4.50 S&I	
Check enclosed	\$ CA res. add 8	8.25% & AZ res. add 5.509	
Visa/Mastercard	#	Exp. date	
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City	State	Zip	

AUTOMOBILES

New Cars

Hyundai Accent

 Hyundai executives describe the new Accent as good, solid, quality basic transportation. They bristle when the word "cheap" enters the conversation. But they are proud to describe this Excel replacement as "the lowest-price car in America." Built in 3- and 4-door models, and equipped with two airbags and a base 92-hp engine, Accent is much more than a run-of-the-mill econobox. Performance is perky, especially when controlled through the 5-speed manual transmission, and noise levels inside its 5-passenger cabin are surprisingly muted.



Toyota's T100 gets a stretched cab as well as more power.

ter fuel economy than the older Six.

As for room, the T100's cab is now available with a 21.7-in. stretch, providing room for groceries or luggage,

and even a nifty little 50/50-split bench seat. Also, Toyota's venerable small-size pickup, now labeled Tacoma, is all-new for this year and is due soon.

-Mike Allen

The C36 reaches 60 mph from zero in 6.5 seconds and hits a governed top speed of 156 mph.

AMG also stiffens the suspension, adds larger brakes and very wide 17in. tires. And so the neighbors know the market's been good to you, the front spoiler, rocker sill extension, rear-bumper apron and rectangular chrome tailpipes separate your \$50,000 C36 from a pedestrian C280.

-Scott Oldham

Mitsubishi Montero

Mitsubishi's Montero is the "forgotten" sport/utility in a world of Grand Cherokees, Blazers and Explorers.

Hyundai designed the Accent to appeal to a new group of low-price-car buyers. It's targeted as a second car for families who don't want to spend another \$20,000 or so for basic needs, like shopping and commuting trips. Its small size, ease of operation and moderate level of comfort combine with its low price, making the Accent an appealing package.

Options include a 96-horsepower high-torque engine, 4-speed automatic transmission, ABS, air conditioning and sunroof. Still, the delivered price of a fully equipped Accent remains below the \$13,000 level.

-Jim Dunne

GNX was known as a "bankers hot rod." In 1995, leadfoot loan officers drive a Mercedes-Benz C36. The latest from Mercedes-Benz and German specialty tuner AMG, the C36 is a heavily modified version of the recently intro-

Mercedes-Benz C36

In 1970, Buick's 455-cube V8-powered

duced C280. Only 400 will reach U.S. Mercedes-Benz dealers, each car covered by a full factory warranty.



It may look like a C280 Benz, but it's not. It's the C36 hot rod.

Toyota T100

When it was introduced, Toyota's full-size truck received criticism in two main areas: lack of power and a cramped interior. For 1995, Toyota has addressed both issues. The 3.0-liter V6 engine has been bumped to 3.4 liters, gaining 40 hp and 40 ft.-lb. of torque. Also available on 2-wheel-drive models is a 16-valve 2.7-liter balance-shaft 4-cylinder that

pumps out 150 hp, but with bet- Mitsubishi refines the Montero with a new engine.

For '95, Mitsubishi has upped-or lowered, actually-the Montero ante with a new engine. The smaller 177-hp

sohe 3.0-liter V6 is available in the LS model. Performance is adequate, although the engine gets a bit buzzy when pressed. We still prefer the extra power and flexibility of the 214-hp 3.5liter V6 in the SR model.

During a 3-day jaunt through the Mojave Desert, combined with a brief rock-trail-climbing exercise, the Montero demonstrated a comfy on- and off-road ride and refined handling.

-Cliff Gromer

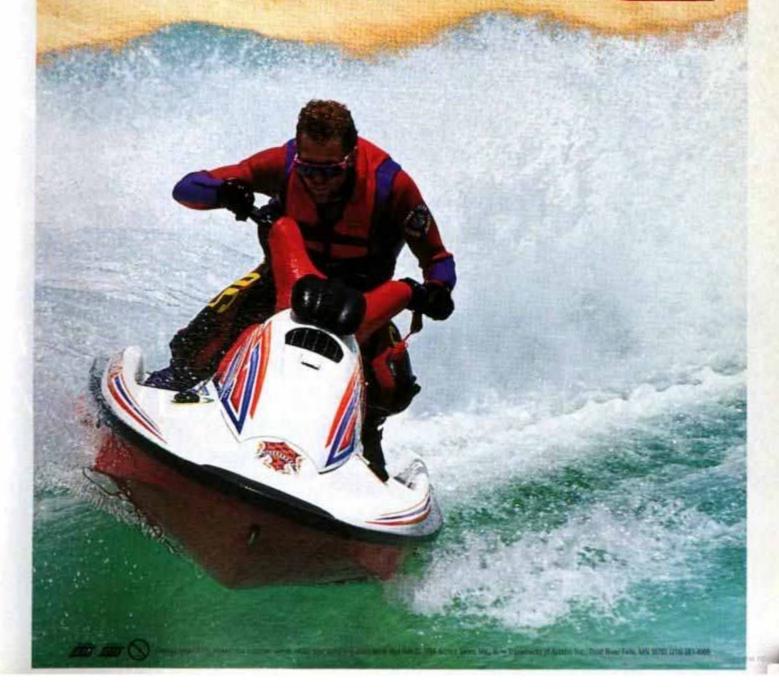
FOR PRECISION Handling ON WET SURFACES.

On water, the rules are different. And nothing performs under these conditions like the aggressive-handling, hard-charging Daytona from Tigershark. With a high-performance, twin-carb 039cc engine

and power trim, there's plenty of muscle. And when you combine all that raw power with our new M.A.D. hull design,

you're ready for the kind of hard-core riding that demands precise handling. If you want a machine where you-

drive-it rather than it-drives-you, ride a Daytona. After all, one good turn deserves another.





It's what you get a diesel locomotive wi

You may find the most impressive characteristic of the Ram Cummins Turbo Diesel Pickup

isn't that it gives you more standard torque than any other diesel pickup. Or that it can tow more than ten thousand pounds without breaking a sweat. Or even that its 5.9L power plant can squeeze nearly 15 miles out of a single gallon of fuel.¹

What may be the most desirable trait of this Ram is how it can do all that-while surrounding

you in comfort. Its available three section 40/20/40 bench with center console offers the luxury of a six-way power driver's seat, which makes finding the perfect position as easy as pushing a button.

And Ram has more cab room than any comparable full-size pickup. So you have more personal space to just kick back and



when you cross th a really nice sofa.

relax. You can literally put your work behind you, too-thanks to an ingenious optional storage system of interlocking bins, cargo netting and a divided tray behind the seats.

With Ram's standard driver's airbag² and new Customer One Care™ 3-year or 36,000-mile bumper-to-





bumper warranty and 3/36 Roadside Assistance your mind will be at ease, as well. It's also pleasing to know, Ram's Cummins Turbo Diesel engine is backed by its own 5-year or 100,000-mile warranty.3

Ram Cummins Turbo Diesel. It's the hardworking truck that's easy on you.

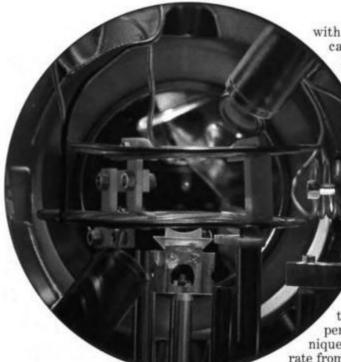
America's Truck Stop The New Dodge



SCIENCE

Record Cold Snap

BY GREGORY T. POPE, Science/Technology Editor



 Think this has been a chilly winter so far? You don't know the meaning of the word "cold" until you step into a laboratory at the National Institute of Standards and Technology (NIST) in Gaithersburg, Maryland. There, a team of researchers, led by physicist William Phillips, has mastered the art of the deep freeze, chilling a cloud of cesium atoms to a temperature only 700 billionths of a degree above absolute zero. Even the farthest reaches of deep space never get that cold.

The record chill shatters a 6-year mark by a millionth of a degree. A decade ago, scientists believed this new all-time low to lie beyond the limits of technology. But the advent of a new class of laser has changed all that. Powerful and capable of being tuned to unleash a beam of a pinpoint wavelength, the titanium-sapphire laser has allowed temperatures to plunge to new depths.

Ultra-cold research is done in the name of time, because if atoms are frozen stiff, atomic clocks run more accurately. But how is it done? After all, with their blazing beams of light, lasers are typically thought of as machines that add heat, not whisk it away.

Light, however, can also exert a tiny mechanical force, called radiation pressure, best known for the way it shapes the tails of comets. Wielded

with care, this pressure can calm quivering atoms by retarding their natural

movements. In atomic physics, slowness and coldness are virtually synonymous. After all, absolute zero is defined as the temperature at which atomic thermal motion ceases.

Since NIST physi-

cists first demon-

strated it in 1978,

laser cooling has come a long way. Its current incarnation stems from a collaboration between NIST and the Ecole Normale Superieure in Paris. The technique begins as atoms evaporate from a block of cesium heated in an oven. As they pass through a pinhole, the atoms form a gaseous stream, which then runs head-on into a laser beam. The radiation pressure from the laser slows the atoms down to the point that they can be snared in

a mesh of laser beams. In this arrangement, known as an optical lattice, four laser beams converge and interfere with each other, setting up a spatially varying light field. According to NIST physicist Steven Rolston, the best way to picture how the atoms behave in this light field is to visualize them as ball bearings rolling in and out of the cups of an egg carton.

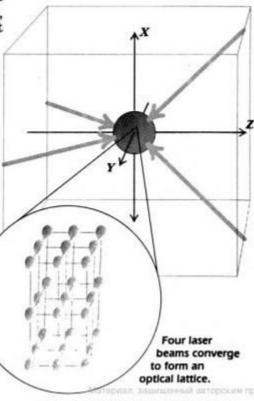
As they are peppered by the laser beams, the atoms absorb the lightand then re-emit it at a higher wavelength that carries more energy. Consequently, the atoms steadily lose energy until they are too weak to climb over the lip of any given cup. They are reduced to oscillating feebly at the bottom of the cup.

Physicists then begin lowering the power of the lasers, dropping the temperature even further. The effect is to cause the atoms to oscillate even more sluggishly. Then the lasers shut off, and the atoms suddenly plummet. "Gaseous atoms usually don't notice gravity because they're moving so fast," says Rolston, "but these are so cold they just drop like rocks."

The atoms plunge through another laser beam, with which physicists can gauge how much the cloud of atoms has spread out after falling a few inches. From that measurement, they can readily extrapolate to a temperature.

To appreciate how dead-cold cesium atoms could warm a physicist's heart, recall that NIST is the keeper of American time. Cesium atoms, in fact, have formed the basis for the international definition of the second since 1967; time is no longer measured by the passing of the heavens. Today, the official U.S. timepiece is NIST-7, a huge atomic clock that gains its accuracy from the rocksteady natural vibrations of cesium atoms (see Tech Update, page 22, Sept. '93).

NIST-7 also works with lasers. But these don't so much influence the thermal motions of atoms as alter their intrinsic states of energy (cold atoms can still attain different energy states). Inside the clock, a laser sweeps cesium atoms into the lowest energy level, through a process known as optical pumping. The atoms can then respond to a microwave emitter.



The microwaves boost the atoms a step further by radiating at the same frequency at which the atoms themselves are vibrating. In cesium atoms, that frequency is dependable enough to serve as a kind of pendulum for the atomic clock, but it can't be harnessed directly. Instead, a separate laserbased detection apparatus measures how many atoms were excited by the microwaves. It then feeds back information to narrow the microwave emitter's output to the exact frequency. Thus corrected by the atoms, the microwave emitter drives the clock.

While NIST-7 ticks off seconds with extraordinary precision, winding up such a clock with ultra-cold cesium could add more accuracy, because chilled atoms move so slowly. They wouldn't be jiggling about when struck by the microwaves, so they'd "see" the frequency more cleanly. In other words, they wouldn't perceive the apparent frequency shift, known as the Doppler effect, that occurs when a moving object collides with a wave-type signal. What's more, the slow-moving atoms would simply spend more time interacting with the microwaves.

One way to incorporate lasercooled atoms into an atomic clock, researchers have proposed, is by way of a setup called an atomic fountain.

Here, an optical lattice first cools down the cloud of cesium. Then the lasers impart an upward velocity to the atoms. As they rise, the atoms pass through a microwave chamber, then pass through a second time on the way down.

The second pass Laser cooling forms egg carton that traps atoms.

provides a check on the first pass.

Because chilled atoms move so slowly, a long time elapses between checks. That contributes to precision, just as testing your watch once a week gives you a better sense of its accuracy than checking it every 5 minutes.

Does the world really need an atomic clock that keeps time better than NIST-7, which might lose a second every 3 million years? Well, no one can deny that life moves quickly these days. "The demands on timekeeping," says Rolston, "are greater as we keep speeding our rate of communication," noting that the synchronization of computer-data transfer depends on precise time signals.

Science itself relies on meticulous chronometry. Astrophysicists who

want to study pulsarsspinning dead stars that emit pulsing radio signals -are hampered because some of the signals from some pulsars simply outperform Earthly clocks. Measurements of relativity also require precise timekeeping.

More important, better clocks can generate their own purposes. "Every time there's been an improvement in atomic clocks, there's been an application that's appeared," notes Rolston, adding that the Global Positioning System "came about purely because of advances in atomic timekeeping."

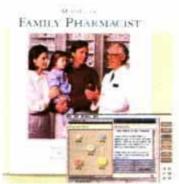
For these reasons, the quest to keep better track of time must continue. And that should keep things mighty chilly around the National Institute of Standards and Technology.

Mike Fillon contributed to this article.

FAMILY HEALTH BOOK



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What side effects are possible with my over-the-counter cold medicine?



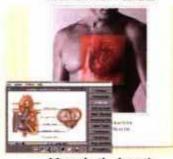
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SPORTS SCIENCE

Low Impact, High Results

BY JOE SKORUPA, Boating/Outdoors Editor

● I once worked with a well-known TV muscleman who had an opinion on everything, and I appreciated his candor. After all, it fit his role perfectly as an on-site PM fitness expert. But interestingly, he refused to be quoted about two areas he knew well—biomechanics and the science of fitness. The reason? According to the muscleman, noted professionals in these fields are wildly inconsistent. There is very little repeatable hard data to work with and they heavily promote a particular point of view.

This, according to the muscleman, is true even of hard-science fitness experts such as Ph.D.s and M.D.s. They disagree on such common areas as definitions of terms, fundamental fitness concepts, overall biomechanic theories, specific workout techniques and virtually everything else

ally everything else. Besides, the muscleman said, they regu-

larly change their minds.

A great idea this year will

A great idea this year will be a bad one the next.

Wow. I didn't expect to hear this from such a celebrated fitness authority. I mean, this guy is big—both in muscle bulk and in media exposure. But ever since our talk, I've paid attention to his message, and I can't say he's been proven entirely wrong.

Take high-impact workouts, for example. Not long ago, the term "high impact" was a buzzword among exercise gurus. On a fundamental level, it refers to a workout or a component of a workout that calls for having both feet off the ground. Vigorous running, jumping and bounding up high steps are examples of high-impact technique.

Interestingly, you don't hear much about it anymore. Certainly, the basic concept has some value, especially for those who want to break out of a rut and rise to a higher level of fitness. After all, if hard-body wannabes want to get some air time and crank up the pace, what's so bad?

What's bad is that many of us aren't built to take the pounding. The jarring nature of high-impact exercise increases stress on the joints to the point that injuries can occur. Those with known physical problems—in the knees, ankles, hips and even the lower

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back—are shut out from high-impact exercise right from the start. Those without such problems (a group more rare among adults than you might think) frequently develop problems after beginning a high-impact program or later on in life. As a result, the high-impact concept has lost some of its luster among fitness gurus.

So, where does that leave us? According to current thinking, the way is through high-energy workouts that use low-impact techniques (where one foot is always on the ground). This type of program offers a good workout but doesn't cause immediate or future stress-related problems to the joints.

Filling this bill is a new line of treadmills from Cybex (12911 Northeast Place, Kirkland, WA 98034). While it's true that running, jogging and fitness walking (exercises typically performed on a treadmill) can be hard on knees, ankles and other joints, the new Cybex Q25ci (for controlled impact) and Q20ci minimize the potential for injury.

What's different about the new Cybex controlled-impact treadmills (shown above) is that they're designed to reduce the shock distributed throughout the body as a result of the runner's foot striking the ground. The Cybex treadmills accomplish this in several ways. First, the belt is made with an integrated layer of elastimere material that provides absorption of vertical shock (caused by the initial foot strike) and lateral shock (caused by side-to-side movement of the foot).

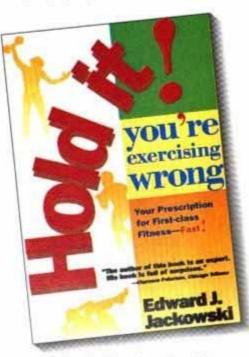
Second, users can adjust impact absorption to suit their individual weight, running speed, foot plant and gait in ways not found on other machines. Typically, these parameters are linked together and preset according to estimated averages. The difference with the new controlled-impact treadmills from Cybex is that these units have nine optional settings that adjust the motor-speed

erized operation that compensates for the natural slowing of the belt that occurs each time a runner's foot strikes the treadmill. By ad-

response of the belt-a comput-

justing the motor-speed response, the individual is able to direct the shock that occurs with each foot strike away from the body and onto the treadmill.

Both new Cybex treadmills come with a 5-year warranty, a minimum of eight preprogrammed workouts and



The book on low-impact technique.

customizing features, a 0% to 12% incline, 0- to 11-mph variable speed, an electronic control board with display and an emergency tether shutoff.

The Q20ci has a 1.75-hp DC motor and a suggested retail price of \$2495. The Q25ci has a 2-hp DC motor, 16 preprogrammed workouts with customizing features, detachable handrails (optional on the Q20ci), and a suggested retail price of about \$2795.

While there are a number of newcomers to low-impact exercise, Ed Jackowski, founder of the New Yorkbased fitness company Exude, has been a low-impact advocate since he was a teenager. Jackowski has marketed his methods through Exude (47 E. 68th St., New York, NY 10021) for the past 14 years. Before that, he used them to get in shape while playing Big Eight football, much to the surprise of his high-impact, power-lifting teammates. While the football jocks were loading weight bars with stacks of heavy metal, Jackowski was keeping up with them by working out with the bar alone and using other low-impact techniques.

Last year, Jackowski wrote down his ideas about working out and his book, Hold It! You're Exercising Wrong (a Fireside Book published by Simon & Schuster), has recently been released. Like the title indicates, Jackowski butts heads with common assumptions about exercise, and he has his reasons.

I first met Jackowski about a year ago at a time when I was anxious to change my workout routine. Over the years, I've tried a number of fitness approaches, but after a while I always felt that something was missing. I tried aerobics, running, fitness machines (both aerobic and anaerobic), free weights, competitive sports, crosstraining and combinations of all of the above. Despite being fairly dedicated (averaging three to four one-hour sessions per week), I never felt I was reaping the expected benefits. (On a personal note, the methods I've been most satisfied with are running and free weights with some crosstraining and competitive sports thrown in.)

So at the time I met Jackowski, I was ready to try something new. At first, I was attracted by his low-tech approach, because I hoped it could be effective away from the health club, both at home and on the road. The only problem was that I was a bit skeptical about the benefits of a work-out that relied on such simple components—jumping rope and pumping a 10-pound curling bar.

However, as Jackowski points out in his book, no low-impact exercise is better at improving cardiovascular conditioning, coordination, balance and agility, and strengthening and toning all muscle groups, than jumping rope. And the point of using a 10-pound curling bar is to perform highrep sets to build the type of muscle you most need in life—endurance muscle, not simple bulk.

After a couple of weeks of using Jackowski's one-hour workout every other day, I came to realize that it was the overall soundness of the approach that worked as opposed to reliance on a hot new technique. The program consists of the following sequence: warming up, stretching, exercising (curling bar work, sit-ups, crunches, leg raises, push-ups and quite a few others) and jumping rope, which is alternated between the other phases. The final part of the sequence involves cooling down.

The effect of going through this one-hour routine is that you burn a maximum number of calories (since your heart rate and metabolism are elevated throughout the entire program) and you reach all your muscle groups for toning. Very few exercise programs are designed to reach all muscle groups (in such a short period of time), and I find this to be one of the great strengths of the program.

The book, Hold It! You're Exercising Wrong (\$9.95), is written in an easy-to-read nontechnical manner, yet it's filled with a generous supply of hard data about body types, fitness theory, analysis of specific exercises, a guide to home fitness equipment and special recommendations regarding physical challenges and injuries. Jackowski is able to accomplish this feat by setting up a sound-bite kind of format, where he offers a continuing series of numbered and highlighted tips, more than 150 in all.

Several tips in the book are basic, such as those referring to the importance of consistency, motivation and the benefits of being fit. But quite a few offer fresh insight, such as those matching body types to specific exercises and a detailed analysis of popular exercises and exercise machines. Several sections are particularly well done and rarely seen in fitness books, such as how exercise affects aches and pains, pregnancy, old age and those with a physical disability.

The overall impression you get from Jackowski's relatively slim volume (just over 200 pages) is that it not only covers its subject well—correcting misconceptions and advocating a new method of low-impact exercise—but it also covers fitness as comprehensively as a reference book.

For those worried about the pounding your body takes during vigorous workouts, a good low-impact program is the way to go.

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ELECTRONICS

Office On Wheels

BY FRANK VIZARD, Electronics Editor

 Imagine working in an office that gets 22 miles per gallon. Yes, you say, I already work in an office like that and it runs on coffee.

Well, we're talking about real gas-putting an office on wheels and redefining the term "road warrior."

You probably already know a road warrior. He's the businessman who's running around with a portable laptop computer and a cellular phone in his briefcase. Sounds cool, but the truth is he gets only as far as his battery pack allows. And sometimes he is not very far down the highway before his best intentions are short-circuited. Besides, carrying around all that gear gets tiring.

Now imagine an office that goes wherever you want to go. It's comfortable and all the information technologies are at your fingertips. And the window view

changes every day.

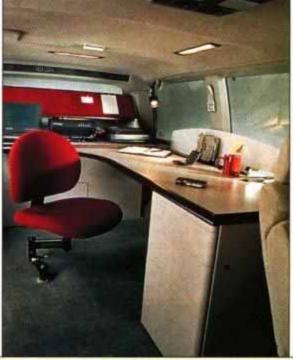
That's the idea behind the mobile office vehicle designed by MO-V (pronounced "mo-vee") of Zeeland, Michigan. The MO-V vehicle is actually a Chevrolet Astro van. The vehicle choice was deliberate, say company executives. The Astro van is very close in size to a standard full-size passenger car, so it can maneuver into any space a car can.

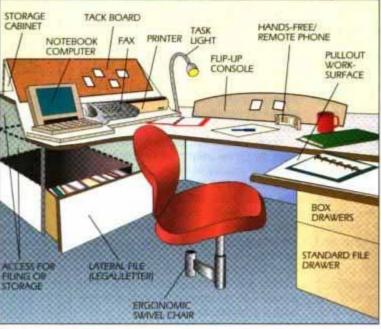
Secondly, the interior roominess of the Astro is like no other minivan. The MO-V Astro has three seats: the driver's, a front passenger seat that swivels to face the rear and a swiveling of-

fice chair anchored to the van floor.

Lastly, the Astro can idle during any weather condition for indefinite periods of time, running the air conditioner and all the on-board electronics without exhausting the battery.

Once you sit down at the desk, you've got everything that might be available to you at an office. There is a 486 laptop computer featuring a 33-MHz processor, 4MB of RAM and





a 120MB hard drive. Connected to the computer is a deskjet portable printer.

The modem-equipped computer, of course, is a communications tool, but that's not the only means of communicating. Wedged between the laptop computer and the printer is a fax machine that doubles as a copier. Up front by the driver's seat is a 3-watt cellular phone for voice communica-

tions. This phone is connected to the work area's extension phone, which looks like a standard cordless phone. The office phone is detachable and has a range of 1000 ft. It also operates as a

speakerphone.

An office, of course, is not a paper-free environment so there is plenty of storage space aboard. To the right of the office chair is a large filing drawer and two smaller drawers for office supplies. To the left, a large lateral file can accommodate both letter and legal files. And if you need to post a few reminder notes, there is a fold-down tack board for you to use.

Standing still, the MO-V looks like a nice place to work. Indeed, the MO-V is reminiscent of a larger mobile office van PM built into a Dodge Custom Ram Wagon in 1983 (see page 78, Dec.

'83). But what happens if you're driving along and suddenly hit the brakes?

Believe it or not, everything should stay in place. The computer, printer and fax machine are all locked in place. The office chair is movable only when the vehicle is parked. The rear lateral file is bolted to the chassis of the van and is reinforced to withstand a 30-mph impact. In the event of a collision, the worksurface is designed to shear upward, basically allowing it to "give" with the impact.

The MO-V van may be just the ticket for mobile business people in real estate and other service

industries. The van can be purchased for between \$25,000 and \$35,000, depending on the options ordered. It can also be leased. And yes, MO-V plans to offer larger van conversions.

Great, you say, but what if I'm only on the road part of the time? MO-V installs a docking station that lets you connect to a house phone and household current. Think of it as a house extension with wheels under it.



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AUTOMOBILES

Detroit Spy Report

BY JIM DUNNE, Detroit Editor

Chrysler's New Minivan

• Though the mechanical details are still just a bit sketchy, the vision is not. This is the next generation of Chrysler's market-leading Caravan/Voyager minivan. Shown earlier this month at the Detroit and Los Angeles auto shows, the van is due at your dealers in another few months. This view reveals one important new feature:

a sliding door on the driver's side of the van. The interior, like the exterior, boasts fresh, rounded and modern lines, emulating Chrysler's latest batches of contemporary, userfriendly passenger cars.

Future Roadmaster?

Chrysler isn't the only carmaker showing off its future a little early at the big domestic auto shows this winter. Here's what Buick calls the XP2000 concept car. While it clearly looks like it may be a 4-door version of the Riviera, it is not. The XP2000 sits on a 115.4-in. wheelbase—½ in. shorter than the Roadmaster—and has a V8 engine and rear-wheel drive.



The Buick XP2000 looks like a 4-door Riv, but it has rear drive and a VB under its skin.

XP2000 is only 196.7 in. long, about 3 in. more than a Regal coupe. Naturally, like other concept cars, the XP2000 is crammed with all manner of technological goodies-some of which will make it to production, some of which won't. One of the most interesting features is the car's electronically controlled 5-speed transmission. But its most important feature is its drive configuration. Buick has not developed a new rear-drive car since 1977. And though nobody at Buick will say when-or even if-the XP2000 will see production, it's interesting to note that the current Roadmaster is due to be replaced in 1998.

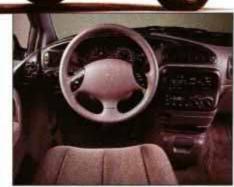
identical door openings, so the same rear door fits both body types—a money-saver in both manufacturing and assembly. As of yet, we have no details about any mechanical changes for the new car.



Saturn is rounder and smoother for '96.

Rounding Saturn

Saturn will get its first major styling change since the car was introduced. The overall styling of the 1996 models is radically different from the nowfamiliar look. However, despite the changes, a number of Saturn's identity cues, particularly the headlight and taillight layouts, are still visible. For '96, for starters, the car's nose is more rounded-there are no sharp edges around the headlight boxesand the hood and fenders carry the round theme rearward. Note the shape of the doors: The door tops have an arched frame that follows the rounded profile of the roof. Both the station wagon and sedan



Chrysler minivan is modern inside and out.

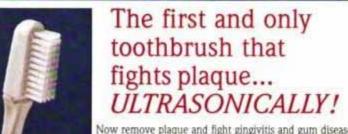
Here Comes Opel

GM wants to get its European Opel subsidiary more involved in the U.S. market. And it looks like the need for new rear-wheel-drive models is the impetus for the input. So the home office in Detroit is calling on its European branch to furnish modern rearwheel-drive engines, transmissions and chassis. You can look for a number of moves in this direction in the next three years. For starters, Cadillac has already announced its intention to import a version of the Opel Omega and sell it here as the 1997 Cadillac LSE. In addition, there will be a Buick version of the car, sourced in Australia, planned for 1998. Then, look for Saturn to get a version of the smaller Opel, the 2.0-liter Vectra. Ultimately, it's possible that the next Firebird and Camaro chassis will be an Opel variant.

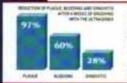
Cadillac Saab

Almost, but not quite. Cadillac officials, on a trip to Sweden, took a long look at the Saab 9000 station wagon. They wanted to see if it would fit into their lineup as an entry-level variant. But in the end, the project was rejected. Cadillac, as noted above, wants to get the Opel-based LSE launched in the U.S. first, before expanding its lineup with another European car.





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Accepted by the ADA and recommended by dentists, the UltraSonex is not an electric toothbrush, It has no mov-

ing parts, does not vibrate and is absolutely silent. It works by emitting 1.6 million cycles per second of incredibly effective ultrasonic waves that penetrate the gum tissue to disrupt bacterial growth, which helps reduce gingivitis. No other product available



for home use does this. The UltraSonex can also reverse the progression of gingivitis and gum disease. It is extremely gentle, yet you'll quickly notice dramatic results. Just brush normally. Shuts off automatically after 3 minutes. Recharges in its own base. Try UltraSonex. Then check with your dentist. You'll both be amazed at the results. \$99.95 (\$10.95) #3100. UltraSonex and 6 Replacement Heads \$129.95 (\$11.95) #3300.

Comfort, warmth, quiet and safety... a remarkable heater!

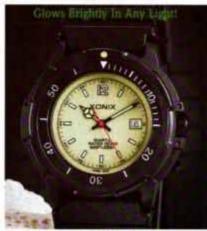


The Vornado EVH (Electronic Vortex Heat) is the discriminating buyer's space heater of choice. It automatically responds to your every need with

Constant Comfort Control continuously delivering the precise amount of heat you require. Simply set the desired temperature on the calibrated, easy access, temperature-control panel and EVH goes to work, raising the room temperature to the exact setting. Once the temperature is reached, EVH "throttles back" both fan speed and heat output to maintain it efficiently and effectively. No annoying hot blasts or cold spots typical of other heaters controlled by an on/off thermostat. Just set it and

forget it! The EVH features a non-glowing heating element, maximum 120° exit air temperature and a cool-touch cabinet making it completely safe - even around kids and pets. Two energy-saving power settings, essential over-heat and tip-over protection make the EVH virtually foolproof. No other heater warms the air more evenly or more safely. Its compact size, flat back and angled air inlets allow you to tuck it close to a wall or under a desk and out of the way. Lighted power switch. Mfr.'s 1-year warranty \$109.95 (\$11.95) #3800.

Sport dive watch with glowing dial!



This amazing professional sport dive watch has it all. It's strong, durable, and water resistant to 600 feet. It features a high quality Japanese quartz movement that is protected by an impact-resistant Kelvar based resin case and a thick scratch-resistant mineral glass crystal. It has a click-stop bezel and a silver oxide battery that will last for at least 2-years. Best of all, this

watch features a dial that glows brightly in any light for high visibility and easy reading. And, you don't have to push any buttons to illuminate the dial. A sweep second hand, date calandar, fashionable black adjustable watch strap and a five year warranty make this watch a big winner on land, too! \$69.95 (\$7.95) #4240.

To the thief, this is rather alarming!



The parking lot is dark. You can't find the car. You're all alone -with the baby. But in an instant, you're able to light up the inside of your car and safely find your way with the help of the Safe Entry Alarm System. Not only does it provide excellent personal and property protection, but complete peace of mind, as well. Mounted prominently on the

dash board, it has a flashing LED that alerts criminals to the fact that your auto is alarmed. If challenged by motion or vibration, it emits a deafening 110dB, alarm. You can even arm and disarm via remote control from up to 25 yards away. It's completely portable and can be used in any car by simply plugging it into the cigarette lighter. A 9-volt battery back-up with low-power indicator ensures it will work even if unplugged. What's more, Safe Entry Alarm System is manufactured by the makers of The Club, so you know it's a high quality and dependable piece of security equipment. It's your family's best defense against car thieves and muggers. FCC approved. \$69.95 (\$7.95) #4020.

> The Magellan Ultimate Gu 're not completely satisfied with yo simply return it for a full refund.

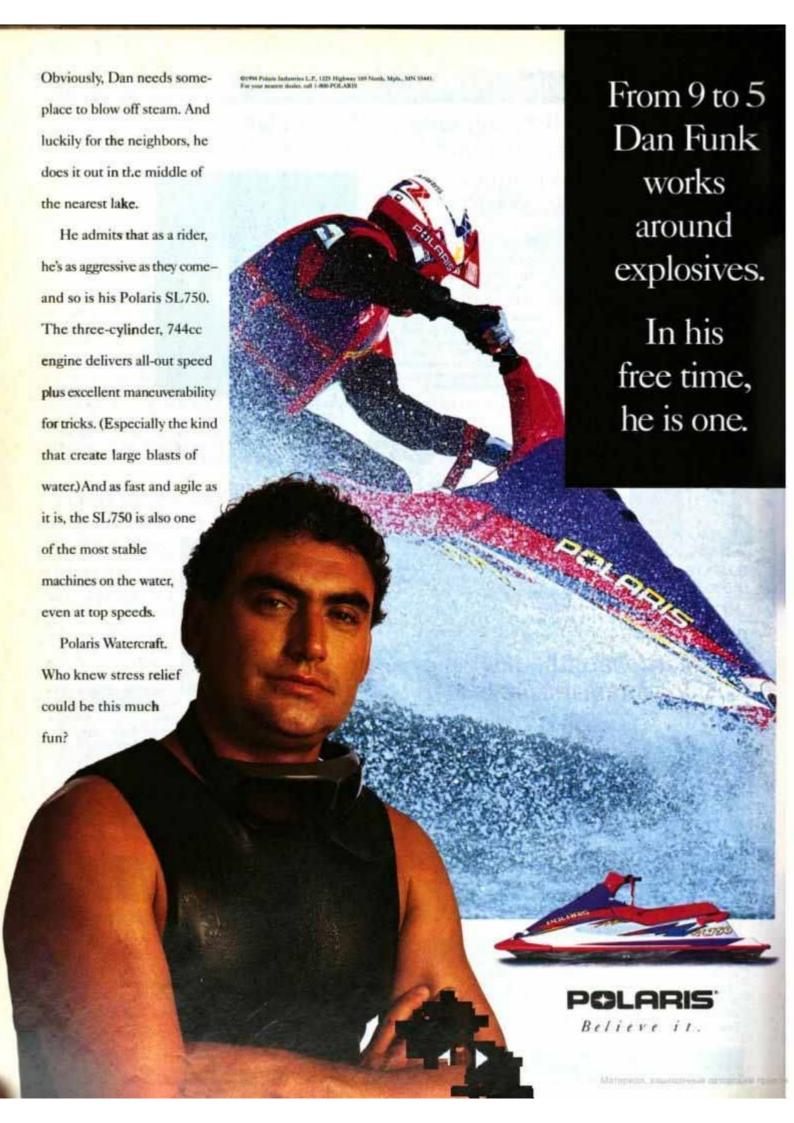
ORDER TOLL-FREE 24 HOURS A DAY 800-644-8100

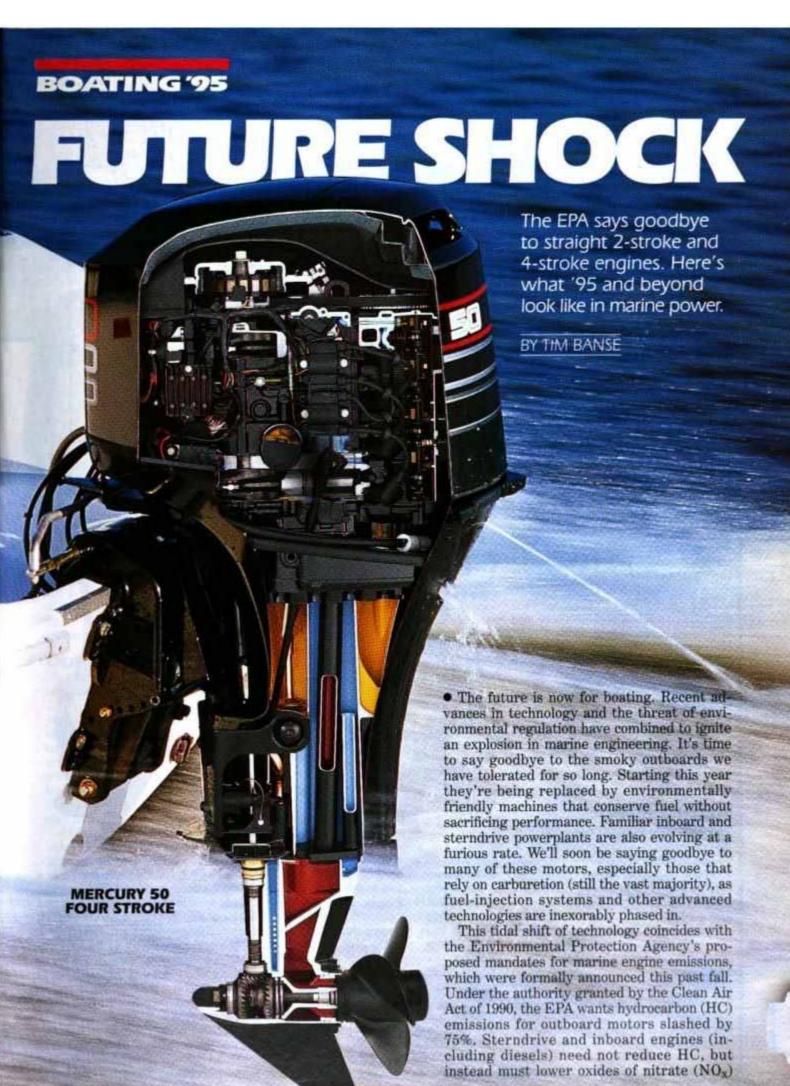
TO ORDER BY MAIL: Send check or mo order for the total ount (including 5 & H) credit card nu



The Magelian Group Dept. PMB05 2515 Fast 43rd St. P.O. Box 182236 Chattanooga, TN 37422







BOATING '95

(see "Dawn Of The EPA Age In Boating" on page 52).

It's no secret that a 2-stroke outboard employs relatively dirty technology. The main reason is that a 2stroke motor leaves the exhaust port open while fresh fuel and air flow into the combustion chamber. This results in a calculated overfilling of the cylinder, with the excess spilling out with the exhaust. This process is often called "scavenging" by engineers, and it makes sure that spent exhaust gases are completely evacuated from the cylinder and only fresh fuel and air remain for combustion. Depending on rpm and load, a 2-stroke outboard wastes as much as 40% of its fuel through the scavenging process. This is not only inefficient, but highly polluting. Even at peak efficiency the loss still measures about 8%. For this reason, 2-strokes are the prime target of the EPA.

Given the new EPA standards and the state of the art in marine engines, the future of outboards up to about 150 hp will probably be in 4-stroke technology. Besides treading more lightly on the environment, 4-stroke outboards promise big dividends in fuel economy. When comparing equivalent horsepower, a 4-stroke outboard will consume about 30% less gasoline than a 2-stroke at WOT (wide-open throttle). At idle, the figure can be as much as 80%.

Like most things in life, there's a downside to all this cleanliness and efficiency—higher cost. Four-stroke outboards promise to cost more money than equivalent 2-strokes—as much as \$1500 in the 50-horse range. But similar to the case with diesel engines—another option for boaters—the more hours you log on the water, the quicker fuel savings add up and offset the steep initial price tag.

With this background out of the way, let's look at the new clean machines for '95.

Mercury Marine

The new Mercury 50 Four Stroke, Mercury's first 4-stroke outboard, is the net product of a joint venture with Yamaha Marine. The agreement between rivals that produced this model calls for Mercury to build the lower unit and short block while Yamaha supplies the cylinder head. (Models offered by Yamaha under this agreement use only the short block from Mercury.)

The new 50-horsepower Four Stroke outboard (available in both the Mercury and the Mariner lines) features an inline 4-cylinder motor that displaces 57 cu. in. and has an automotive-style overhead camshaft with two valves per cylinder. The mo-



an enrichment circuit that offers instant starting when the engine is either hot or cold.

As expected, the motor is no lightweight at 215 pounds. But in its defense, that's only about 8 to 10 pounds heavier than an equivalent 2-stroke, Also as expected, the motor runs noticeably smooth and quiet for an outboard. Perhaps best of all, there are no oily exhaust fumes and no premixing oil with gas.

On the downside, boaters using a 4-stroke outboard for the first time need to prepare themselves for regular oil and filter changes. One interesting operational note: 4-stroke outgoing down a step in propeller pitch.

Also new from Mercury for '95 is a

Also new from Mercury for '95 is a 9.9-hp 4-stroke outboard. This engine, too, is a collaboration with Yamaha Marine and features an imported 2-cylinder powerhead, fitted to a Mercury midsection and lower unit. Weight is clearly an issue in 4-strokes of this size, since the Merc 9.9 weighs 99 pounds and a comparable 2-stroke weighs about 75 pounds. But clean performance and better fuel economy more than make up for any drawbacks. It's a safe bet that this small 4-stroke 9.9 will soon be followed by a 15-hp model patterned on the same

Материах завишение асториям право

14.2-cu.-in. powerhead.

Beyond the new line of 4-stroke models that will probably extend to about 150 hp, Mercury and Mariner will likely keep 2-stroke powerheads in the higher ranges. These new-generation 2strokes will run a direct fuel-injection technology that is yet to be announced. The candidate technologies include a direct injection system developed by the Orbital Engine Co. of Australia, which Mercury licensed some time ago, and a system born of a joint agreement with Chrysler when the automotive giant was researching the use of 2-strokes in cars, a plan it has since dropped.

MerCruiser sterndrives aren't scheduled for drastic changes, at least not immediately. They will continue to be built of cast-iron automotive blocks that increasingly breathe through EFI (electronic fuel injection) systems. As EFI spreads throughout the sterndrive product line, expect to see early models equipped with the relatively unsophisticated (but inexpensive) throttle-body injection systems. However, look for a continual evolution in EFI itself as it increasingly uses multiport injection and is backed up by more sophisticated microcomputer management systems.

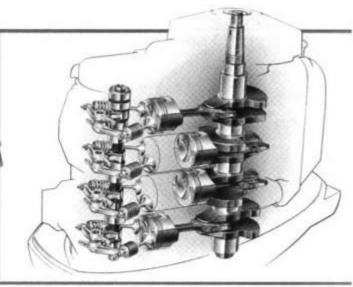
Outboard Marine Corp.

The future of OMC's clean motors is tied to a program the builder calls LEAP (for low-emission advanced propulsion). While the program includes some 4-stroke outboards, the upper limit of OMC's 4-bangers is only 15 horsepower. As a result, unlike the plans of other outboard builders who are gravitating toward 4-cycle motors, the future at OMC is still largely 2-stroke.

OMC's future 2-strokes, which are scheduled to debut next year for the 1996 model year, are divided into two separate categories: LEAP2 (for outboards rated at more than 200 hp) and LEAP3 (for outboards rated from 20 hp through 200 hp). Since LEAP3 applies in the most popular range of outboards on the market, let's look at

this technology first.

LEAP3 is at least partly based on the direct fuel-injection system developed by the German firm Ficht GmbH, which OMC licenses and has modified for marine application. The Ficht method of direct fuel injection uses technology that pressurizes gasoline up to 200 pounds per square

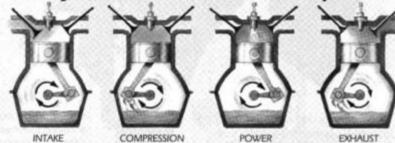


Yamaha's new Four Stroke outboard (left), with cam and valves (above

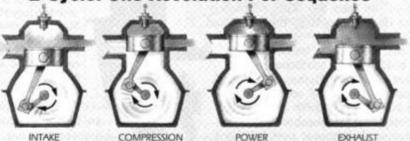
inch, then hammer-pulses it through an injector nozzle that transforms it into a fine, combustible mist. The key to making

LEAP3 a viable 2-stroke alternative in the new EPA era is the way its m crocomputer precisely pulses the fu charge (up to 100 times a second) in the combustion chamber while th

Different Strokes: 2-Cycle Versus 4-Cycle 4-Cycle: Two Revolutions Per Sequence



2-Cycle: One Revolution Per Sequence



 Two-cycle engines, often called 2-stroke engines, are mechanically simple, compact and light. The differences between them and engines used in cars, which are 4-cycle (or 4-stroke) engines, are significant and frequently confusing to many people.

One difference shows up in how the engine uses oil. In a 4-stroke, two separate systems are used to deliver fuel to the cylinders and lubricant to the crankcase. In a 2-stroke, a single system is used. This provides 2strokes with a distinctive trait-the familiar premixing of a gas-oil cocktail.

Another difference is found in the handling of the cylinder operations (intake, compression, combustion and exhaust). A 4-cycle engine requires four individual strokes (and two revolutions of the crankshaft) to accomplish the sequence. A 2-cycle does it in two strokes (and one revolution of the crankshaft).

The final difference between the engines is how they handle air movement. All the vital air movement in 4strokes takes place through valves on top of the piston. In 2-strokes it's handled by ports in the walls of the cylinder that are fitted with one-way reed valves. The problem with this system is that the intake and exhaust ports are open at the same time, which enables raw fuel and oil to be discharged into the atmosphere with the exhaust. Eliminating this discharge is one of the main goals of the new EPA regulations.

Joe Skorupa



OMC's other star technology for '96 is LEAP2, a variation on the direct injection theme. In LEAP2, pressurization is not only applied to fuel but to air, as both are injected directly into the combustion chamber after the exhaust port is closed. This process assists the atomization of the gasoline and the efficiency of the burn. LEAP2 is based on a system

first developed by the Australian engineering firm Orbital Engine Co.

Prototype versions of LEAP2 and LEAP3 motors are already up and running, and they have proven to be very quiet. In fact, the sound is eerily reminiscent of a car engine. There's no hint of 2-stroke whine or rough stuttering at idle. Gone, too, is the need to premix oil. OMC's 4-stroke LEAP outboards are limited to smaller horsepower ratings, and the new Evinrude/Johnson 9.9 displaces only 18.61 cu. in. But that number is significant, because it represents more cubes per horsepower than competitive 4-strokes. This motor will be available this year, and interestingly,

(left). Every other component is all Merc. OMC developed it in-house without a Japanese partner. Features include a lost-foam

cast, closed-deck cylinder block and an optical ignition that runs without any moving parts.

Honda Marine

Enviro-friendly machines are nothing new to Honda. In fact, Honda Marine was already a multi-unit 4-stroke outboard manufacturer by the mid-1970s. In the new EPA era, this head start has paid off handsomely for the Georgia-based builder, which currently offers the broadest line of 4-stroke outboards on the market. Its newest unit is a 50-horse 4-stroke that will directly compete with Mercury's and Yamaha's new 4-strokes.

In a move somewhat uncharacteristic of the close-to-the-vest company, Honda is currently trumpeting a new 90-hp 4-stroke that is scheduled for a '96 release. Reflecting the competitive tenor of the times, Honda is already showcasing prototypes of the 90 and offering test rides. What's interesting about the 90 is that it is the largest 4-stroke outboard planned for immediate production.

The new 90 4-banger is not only bigger than Honda's previous 4strokes, but it is also more technologically advanced. Honda engineers broke the proverbial mold by moving the flywheel from its traditional position atop the powerhead to a midline position beneath the crankshaft. This elegant maneuver effectively lowers the motor's center of gravity and promises to improve boat handling and stability. The radical placement also reduces vibration, and gives cowling stylists some freedom to get aerodynamically fancy.

The 4-cylinder powerhead breathes

through 12 valves—three per cylinder with two for intake and one for exhaust. Two intake valves channel a massive volume of air, which is necessary for high-horsepower output. But because valve diameters are reduced (by dividing intake duties between two valves instead of one), intake port velocity is high, and this ensures a smooth idle and razor-sharp acceleration. Also worth noting, the block is fitted with proven automotive pistons, rings, connecting rods and bearings from the ultrareliable Honda Accord.

As already mentioned, Honda is adding a 50-horsepower outboard this year to compete with Mercury and Yamaha. The new 50 is based on the old 45, with the bump in power coming from a reconfiguring of valve timing, carburetor jetting and air intake. Like the 45, the new 50 uses a 3-cylinder powerhead.



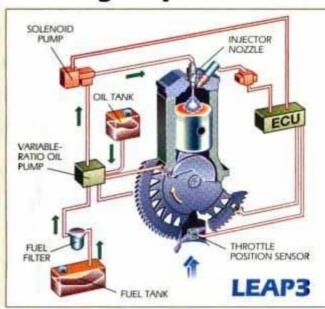
Yamaha Marine

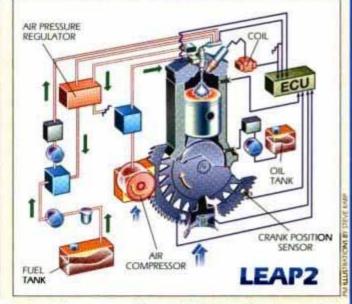
Similar to Honda, Yamaha has many years of experience in building 4-stroke engines, both in outboards—a 9.9-horse 4-stroke has been in the product line for some time—and in motorcycles. Yet it wasn't until the dawn of the EPA era and the joint venture with Mercury that Yamaha turned its full engineering attention to this technology of the future.

Like its related outboard at Mercury, the new Yamaha F50 uses four cylinders (the units share Mercury's short block but little else) to generate its horses instead of the 3-cylinder configuration used by Honda. The benefit of having the extra cylinder in the powerhead can be found in improved balance while under way, which is achieved by setting up a symmetry of reciprocating mass of pistons, rods and crank action.

Consequently, the Yamaha F50 is a

Big Leap For 2-Strokes: Direct Fuel Injection





 Faced with strict EPA regulations in the late 1970s, motorcycle builders abandoned 2-stroke engines for 4-strokes. Today, outboard builders are faced with similar regulations. Does this mean the end of 2stroke outboards? Not necessarily.

Two-stroke outboards can comply with the new emissions standards if

OMC's 2-stroke fuel injector in action.

they can do one simple thing: prevent unburned fuel (a gas-oil mixture) from escaping with the exhaust. In standard 2-stroke technology, this is impossible because both the intake and exhaust ports are open at the same time. The solution is to inject the fuel under pressure into the cylinder after the exhaust port is closed. Easier said than done.

While all outboard builders have experimented with the fundamentals of direct fuel injection, only OMC has announced it is ready to produce it—in the 1996 model year. OMC intends to use two different versions of this technology, and has labeled its program LEAP (for low-emission advanced propulsion).

In its most popular outboards, ranging from 20 hp to 200 hp, OMC will use LEAP3 technology, which uses a high-pressure pump to blast precisely timed bursts of fuel directly into the engine's combustion chambers at pressures exceeding 200 pounds per square inch. This technology is based on a pioneering concept developed by Ficht GmbH and modified by OMC.

In engines of 200 hp and higher, OMC will use LEAP2 technology, which is a more complex system that injects both fuel and air into the cylinder under high pressure. This system is based on technology developed by the Australian engineering firm Orbital Engine Co.

boards won't be like your father's

firm Orbital Engine Co.

As you can see from the schematics above, the new generation of out-

2-stroke motor.

-J.S.

BOATING '95

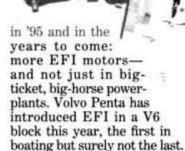
smooth and quiet operator even among 4-strokes. In fact, Yamaha claims sound levels measure 50% quieter than competitive 2-strokes and 24% quieter than other 4-strokes. While some of the quiet running is attributed to the nature of 4-stroke technology, it's also because

of a 2-stage expansion chamber that damps intake noise, an exhaust expansion chamber and a water-jacketed muffler.

Currently being tested in Japan by Yamaha are a 200-hp 4-stroke outboard and a 4-stroke outboard that's equipped with a catalytic converter. These are considered to be research-and-development workhorses, but there's little doubt that cutting-edge engines such as these are not far beyond the horizon.

Volvo Penta

On the sterndrive front, Volvo Penta's latest engine is a good example of what we'll be seeing across the board The first V6 EFI sterndrive: Volvo Penta's 4.3 GI/DP.



Called the 4.3 Gi/DP, this new model is built on the ubiquitous General Motors V6 block with marine-spec throttle-body injection. Although the 180-hp rating is modest, the motor is mated to a Duoprop Drive (with twin counterrotating props) to maximize top-end performance, acceleration, fuel economy and control of the boat while under way. With two props in the water (which doubles the biting power) and EFI providing ultraprecise fuel delivery,

the 4.3 Gi/DP package promises to have nearly comparable pushing power as a current single-prop small-block V8. Plus it delivers the added bonus of having the

fuel economy of a V6.

In addition to revolutionary changes in marine hardware, software (so to speak) is also moving forward into the EPA age. Oil, that politically incorrect substance which currently discharges unburned in outboard exhaust, is now being reformulated.

Quicksilver, Mercury's parts and accessories division, has recently introduced Bio-2 2-Cycle Outboard Oil, which is a synthetic TC-W3 certified biodegradable lubricant. The big news about Bio-2 is that 91% of it breaks down into nonpolluting substances within three weeks.

Unlike regular lubricant, which is made by pumping crude oil out of the ground and then refining it, syn-

Dawn Of The EPA Age In Boating

• After a 2-year reprieve, the EPA has finally taken boating (and other off-road engines) under its regulatory wing. Further delays are unlikely, since the recent announcements were mandated by a court order. So, boaters, get ready for a new era in boating. This is the real thing.

Unlike the automotive industry's adversarial relationship with the EPA, the marine industry has taken a cooperative stance and willingly participated in shaping the new guidelines. In fact, most manufacturers see quick compliance with the mandates as offering a marketing edge and an opportunity to inject life in sales. Because of industry-led eagerness, boaters can expect to see clean machines (mostly outboards) long before EPA requirements take effect.

The goal of EPA guidelines is to reduce levels of HC in gasoline outboard and PWC engines by 75% and NO_x exhaust emissions in diesel engines greater than 50 hp by 37%.

A cap on carbon monoxide emissions (CO) is contained in the new plan, but since CO emissions are primarily a wintertime problem, it is not expected to affect boating. Snowmobiles and other off-road engines, however, will feel the regulatory pinch. A reduction is also being sought in NO_x emissions for outboards, but the target level (6.0 g/

kilowatt-hour) is not expected to adversely affect current technological planning. The same is true for the plan's levels for sterndrive and inboard engines: HC, 8.0 g/kwh; NO_x, 6.5 g/kwh and CO, 400 g/kwh.

The EPA is amending its current rules for off-road diesel engines, and the amendments will be written to include marine diesels above 50 hp. It is in marine diesels that the sharp 37% reduction in NO_x (to a level of 9.2 g/kwh) will be achieved. Other diesel reductions will be achieved in HC (1.30 g/kwh), CO (11.4 g/kwh) and particulate matter (0.54 g/kwh).

According to the EPA plan, builders will begin complying with the announced standards for gasoline engines in the 1998 model year. At that time, a phase-in period will begin that will include product-line averages and inter-industry trading of credits. The phase-in will be completed in 2006. Standards for diesel engines will be phased in from 1999 to 2000.

To the relief of many boaters, the EPA plan will not affect existing engines, nor will it force owners to give up what they are currently driving. While the new engines will run more smoothly, quieter, more economically and cleaner, the downside is they will certainly cost more. There had to be a catch.

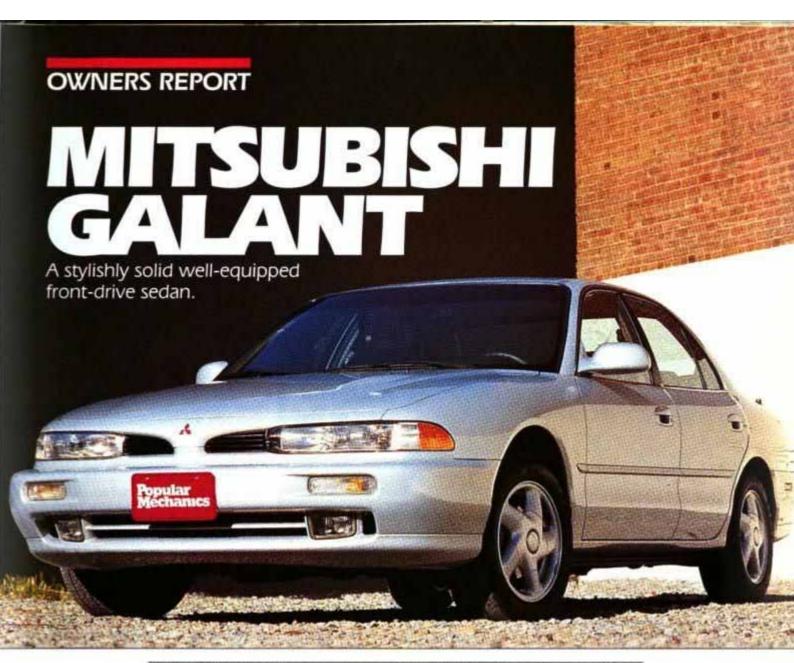
—J.S.



Quicksilver's Bio-2 oil is biodegradable.

thetic oil is made by using a base stock of ester-type hydrocarbons (alcohols and acids) and then combining them with other compounds. The only problem with politically correct oil is price: A case (six 16-ounce bottles) of Quicksilver Bio-2 2-Cycle Outboard Oil costs about \$41.70.

Despite the bold changes announced for '95 and beyond, don't be surprised to see even more radical enviro-technology in the not-too-distant future. Every engine manufacturer is currently working on a host of secret weapons, and confidently promising we ain't seen nothing yet.



BY MICHAEL LAMM, Contributing Editor; PM Photos by George Olson

 Bell for bell and whistle for whistle, the 1994 Mitsubishi Galant impressed most owners in our survey as a good-looking value. Many had test-driven comparably equipped Camrys, Accords, Altimas and 626s, and found the Galant to be the most desirable combination, dollar for all-important dollar.

Following a total redesign in 1994, the Galant now looks like a cross between the sporty Eclipse and the

more elegant Diamante. So, not surprisingly, styling topped our owners' list of reasons for choosing the Galant, with price/value ranking second. Interestingly, nearly 20% had owned Mitsubishis before.

Several respondents told us they'd stepped out of an Eclipse coupe and had chosen the Galant for greater

space and comfort. The Galant's trunk volume measures 18 cu. ft., nearly 1 cu. ft. more than the Buick LeSabre's, and the Mitsubishi's rear seatback folds down for added capacity. Compared with 1993's Galant, this model stands 3 in. longer, slightly wider and taller, yet weighs only 43 pounds more. And with its 1994 redesign, the Galant's coefficient of drag improved from 0.35 in 1993 to one of the best in the

business, 0.29, for better fuel economy and less noise.

The Galant has been Mitsubishi's top-selling nameplate for several years now. It comes in four series but only one body style: a 4-door sedan. The series start with the base Galant S, which a mere 6.9% of our sample chose. Above the S, there's the ES and LS. Both come with a 4-speed automatic, air conditioning, power windows and door locks, cruise control and

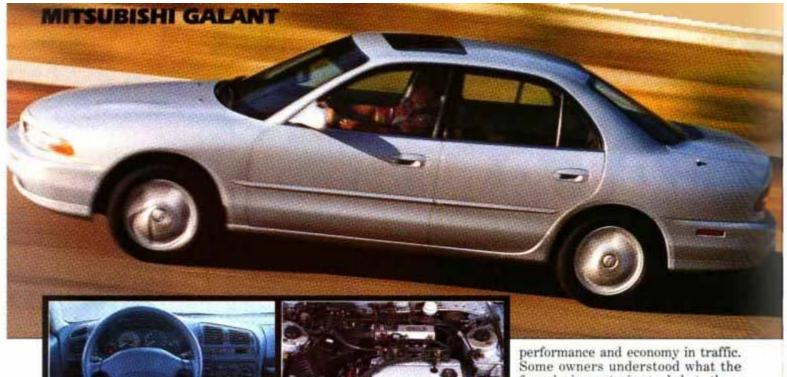
AM/FM/cassette stereo. The LS adds a sunroof, alloy wheels and more. At the top of the list sits the Galant GS. The GS brings a twincam version of the 2.4-liter Four that produces 160 horsepower instead of the 141 hp of the others. The GS also comes with 4-wheel disc brakes, firmer suspension, front and

rear stabilizer bars and a compact-disc player.

The 141-hp engine uses a single overhead cam but has four valves per cylinder (the same number as the GS dohc engine). The Galant S and GS come standard with a manual 5-speed, but both are available with the fuzzy-logic automatic as well (at no cost in the GS).

And therein lies a tale. Not everyone liked the fuzziness of the logic. A few owners questioned its habit of





downshifting when coasting downhill and at other unexpected times. The algorithms programmed into this transmission's electronic brain are intended to deal with such things as mountain driving and stop-and-go traffic. Most automatics simply stay in whatever range they happen to be

The view forward and controls are good.

in or, at borderline speeds, "hunt" up and down between gears.

All Galants have very smooth Fours.

Fuzzy logic, though, tries to make sense out of random data and then maximize the outcome. The microprocessor is programmed, for instance, to downshift on long descents and to choose the ideal range for performance and economy in traffic. Some owners understood what the fuzzy logic was trying to do but others didn't. "Transmission sometimes shifts for no apparent reason," sniffed a miffed Minnesota retiree.

Another complaint with the automatic cited jerky First-Second and Second-First shifts. This was mechanical and had nothing to do with fuzzy logic. Also, going from Reverse to Drive or vice versa without coming to a full stop—as in backing out of a parking space—produced a jarring clunk. Most of our survey Galants were equipped with the automatic versus only 8.5% that came with the 5-speed.

Our owners voiced their loudest

SUMMARY OF MITSUBISHI GALANT OWNERS REPORTS*

Total miles driven	1,265,150	Good	26.3	Needs more power	7.6	Outside mirrors	12.3
Average miles driven	6990	Average	2.1	Ride too firm	7.0	Power door locks	8.2
Purchase price:		Poor	0.5	Rough/odd shifting	6.3	Automatic transmission	8.2
Average	\$17,529	Braking:		Suggested changes:		Repair it yourself?	
	,000-\$24,060	Excellent	68.4%	Make car quieter	22.9%	No	97.39
Why did you choose the		Good	27.4	Better lumbar support	11.1	Yes	2.7
Mitsubishi Galant?		Average	3.7	More engine power	7.6	Dealer repairs satisfactory?	
Styling	53.5%	Poor	0.5	Make seats more adjustable	6.9	Yes	69.29
Price/value	40.6	Overall performance:		Smoother ride	6.3	No	30.8
Mitsubishi reputation	18.7	Excellent	60.2%	Better defroster system	5.6	Dealer service opinion:	
Previous ownership	18.2	Good	36.1	Simpler radio controle	5.6	Excellent	45.39
Generous standard equip	ment 12.3	Average	3.1	Overall convenience:		Good	37.1
Handling	11.8	Poor	0.5	Excellent	55.4%	Average	12.6
Model choices:		Control layout:		Good	43.5	Poor	5.0
Galant ES	48.1%	Excellent	54.0%	Average	1.1	Dealer sales policy:	1 - 0 - 0 - 0
Galant LS	39.2	Good	41.3	Poor	0.0	Excellent	40.19
Galant S	6.9	Average	4.2	Workmanship opinion:	0.00040	Good	44.0
Galant GS	5.8	Poor	0.5	Excellent	62.6%	Average	12.1
Engine choices:	11.54466-14	Instrumentation:	. 10.10	Good	31.3	Poor	3.8
141-hp 2.4-liter Four	94.2%	Excellent	54.3%	Average	6.0	Number of vehicles owned:	
160-hp 2.4-liter Four	5.8	Good	40.4	Poor	0.0	This vehicle only	31.99
Options/Accessories:	10000	Average	4.8	Comfort opinion, front seats:		Two vehicles	45.0
Air conditioning	95.5%	Poor	0.5	Excellent	58.7%	Three vehicles	17.3
Premium sound system	64.6	Driver sightlines:	140000	Good	37.2	Four or more	5.7
Antilock brakes	53.7	Excellent	57.9%	Average	8.0	Principal driver:	45.4
Keyless entry	29.0	Good	36.3	Poor	1.1	Female	58.49
Avg. mpg, city/hwy:		Average	4.7	Comfort opinion, rear seats:	-	Male	39.9
141-hp Four	23.4/28.8	Poor	1.1	Excellent	36.9%	Equal	1.7
160-hp Four	21.0/28.5	Specific likes:	414	Good	51.4	Age distribution of owners:	***
5-speed manual	22.9/29.1	Styling	65.7%	Average	11.7	Under 29	18.69
4-speed automatic	18.8/23.4	Handling	34.9	Pour	0.0	30-49	53.7
Engine power:	Attack and 4	Comfort	27.8	Any mechanical trouble?	0,0	50-phs	27.6
Excellent	52.6%	Ride quality	18.3	No	62.0%	Based on your experiences,	
Good	38.4	Performance	17.8	Yes	38.0	you buy a Mitsubishi Galant	if you
Average	7.4	Specific dislikes:	11.0	What type of trouble?	90/0	had it to do over again?	in you
Poor	1.6	Excessive noise	27.2%	Electrical system	26.0%	Yes	53.29
Handling:	1.89	Lack of comfort					
Excellent	71.1%		11.4 8.9	Power windows	20.5	Maybe No	39.2
CACEBERL	3.17.17.00	No complaints	0.0	Warped brake rotors	4-3-1	200	7.5

complaint against the Galant's overall noisiness. According to 27.2% of our surveyees, the car puts out high levels of engine roar and tire noise. "It's not as refined as the competition," they told us loudly.

Galants are built in Normal, Illinois, in the Diamond-Star assembly plant joint-ventured with Chrysler Corp. Mitsubishi points out that 65% of Galant's material content comes from U.S. suppliers, and the labor force is apple-pie American. And the car's workmanship was rated excellent by 62.6% of our Galant owners. "Not a loose screw or a stitch out of place in the whole automobile," beamed a Texas counselor. "This is an excellent, well-built car, especially for the money," agreed a New Yorker.

A fairly high 38% of our respondents, however, had experienced mechanical trouble in some form. Of those surveyees, the most common problems had to do with the electrical system: headlights dimming on deceleration, power windows sticking, power mirrors not working and the ABS light coming on for no apparent reason. According to a Mitsubishi spokesperson, these malfunctions have been acknowledged and were corrected in later production. Afflicting another 13.7% were warped brake rotors, a problem covered for only one year or 12,000 miles of Mitsubishi's 3-year/36,000-mile warranty. After that it's a dealer call.

In terms of performance, handling and braking, most people seemed more than happy. "Good power to flatten out the hills," said an Arizona materials coordinator. A New York office manager: "Handles very well on all surfaces, hugs the road, has plenty of power for trips as well as

city driving."

Of overall comfort and interior appointments, the vast majority praised the seats, although a few owners would have liked more lumbar support. The Galant's nonpower 5-way adjustable driver's seat comes standard in the S and ES, with the LS and GS adding a bottom-cushion tilt adjustment. The Galant cabin has loads of pockets and storage nooks. Except for the cruise-control switch hidden behind the steering wheel and too many tiny buttons on the radio, the controls, instruments and sightlines received high marks.

Most of our respondents were female, and many told us that the Galant's safety features helped them make their purchase decisions. A Wisconsin pharmacist summed it up this way: "The price! For a car of this caliber, there's no better deal around. It's like getting a luxury car for a compact-car price."



The strong resemblance between the Galant and more expensive Diamante is not a coincidence. Most of our owners appreciated the car's distinctive Mitsubishi appearance.

EDITORS REPORT

Gallantly Carrying The Banner

• Through no fault of their own, the cars that carry the 3-diamond logo of Mitsubishi just have not gained the broad popular success of some of their Japanese cousins. Given its relatively limited resources—as compared to juggernauts Toyota and Nissan—Mitsubishi has had to take to some fairly aggressive, yet carefully aimed, marketing techniques to help push its vehicles to the forefront of potential buyers' consciousness. And in the auto business, you spell aggressive marketing "incentives."

Therefore, Mitsubishi's cars tend to be as technologically packed as—if not more than—the competition, yet priced a few bucks less. As our respondents noted, when you're shopping for a well-engineered, well-equipped front-drive family sedan, you discover that the Galant is an excellent value.

That is, if you even discover the Galant at all.

But even if you haven't been blitzed by Mitsubishi hype and may have to drive to the next county to find a Mitsubishi dealership, it's worth your effort. The Galant was redesigned for 1994 and is a worthy competitor to the horde of already superlative compact-size family sedans. Like most others in the field, the Galant is powered by an overhead camshaft 4-cylinder engine. Unlike most of the others, the Galant's Four benefits from Mitsubishi's patented, dual counterrotating balance shaft technology, which results in an exquisitely smooth 2.4-liter

powerplant. The engine—in sohc or preferably in dohc form—works best, in our opinion, with the 5-speed manual. We seem to be at odds with our respondents, who overwhelmingly opted for the 4-speed automatic. Of course, many of them seemed to be at odds with the transmission's fuzzy logic, however.

Few are at odds with the Galant's distinctive styling. Mitsubishi has done a fine job of creating a family resemblance throughout its model line, and though the individual cars share cues with each other, they look like few others on the road. The Galant's shape is more than simply distinctive, it's super aerodynamic, with a 0.29 Cd, which helps high-speed stability, fuel economy and passenger-cabin noise levels. Unfortunately, the Galant needs as much help as it can get in keeping the noise down-between road noise and engine noise, the Galant just seems noisier and maybe a tad buzzier than many of its competitors.

Now that brings us back to the Galant being priced somewhat less while offering as much or more than the pack. You have to wonder how they do that. And maybe some of it comes out of that hard-to-quantify entity "refinement." The Galant definitely represents a trade-off. You get more tangible neat stuff for your money but a bit less of the intangible. It's your money—take the test drive and make up your own mind. We think you may be happily surprised.

-Don Chaikin



HEALD TIRE

Dive into an immersive video experience with virtual-reality eyewear.

BY JAMES K. WILLCOX: PM Photo by Michel Tcherevkoff

 True virtual reality—the ability to create realistic, computer-generated 3-dimensional worlds in which people and objects can interact—requires a significant amount of technological muscle; extremely powerful computers with vast amounts of storage and formidable graphics capabilities, next-generation software that can fully render an artificial world, and a variety of peripheral devices, such as VR helmets and gloves, that enable a participant to interact in the virtual world.

Despite the considerable advances that have been made in computer technology, software programming and consumer electronics manufacturing, virtual reality still remains almost exclusively within the province of big-budget government agencies and giant corporations or within the boundaries of Disney theme parks. And even within such well-funded environments there are still technological hurdles to be cleared.

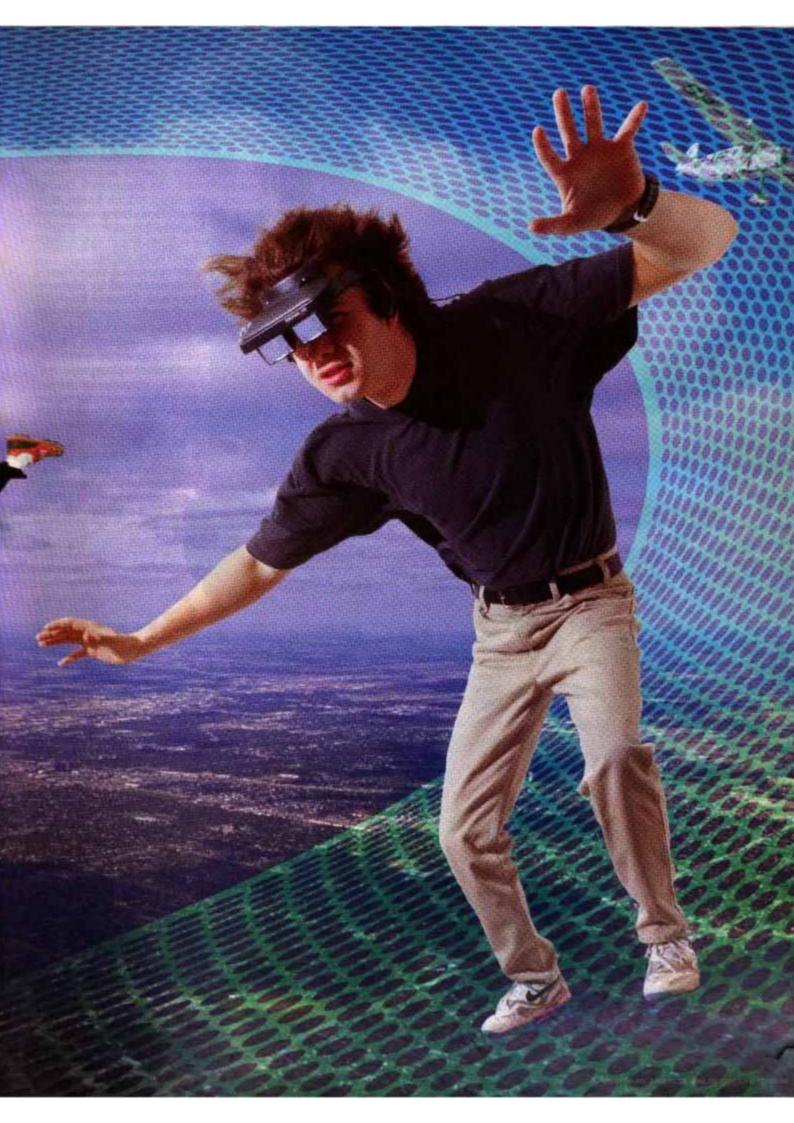
While full-blown VR activity remains out on the horizon, several companies are adapting the concept of a VR head-mounted display (HMD) for home use. Though some call the experience virtual reality, what they are really offering is a personal display device for viewing conventional program sources such as TV,

video and games. And by adding 3-dimensional audio and video to the mix, they are creating an immersive, compelling experience that can be enjoyed at home.

At the heart of most of these HMDs is a pair of small (under 1 in.), color liquid-crystal displays (LCDs)—like those found in Sony and Casio handheld TVs—which are used to produce the picture. Because LCD screens are comprised of extremely small dots—called pixels—that are visible to the eye, many HMDs also contain depixelization filters to improve the quality of the picture. Picture sharpness is measured by counting the number of pixels.

When used with regular source material—a videogame, television show or VHS movie, for example the HMD produces a conventional 2-dimensional image. However, when filmed or created with special stereoscopic programming—in which a separate picture is produced for each eye—a 3-dimensional image with added depth can be seen. This is the first step toward producing a virtual world.

To heighten the VR-type experience, most HMDs add head-tracking capability, using sensors to track the head's movements and moving the on-screen policy.





just under 2 pounds. Two adjustable headbands allow the unit to be fitted to any head size. The visor can be switched from clear to dark, offering a view similar to looking through a pair of sunglasses. Also included are high-fidelity in-ear stereo headphones equipped with the company's Quiet Sound technology, which keeps the headset's sound from being heard by others. A head-tracker module, which provides for roll, pitch and yaw orientation, is offered as an option.

Another system, called the Cyber-Maxx, is being marketed by Victor-Maxx, of Deerfield, Illinois. The 16-ounce Cyber-Maxx headset features twin 0.7-in. LCDs, individual eye focus adjustments, depixelization filters and adjustable stereo earphones, providing an immersive 3D experience when used with a computer or videogame system with stereoscopic-compatible software. Yaw, pitch and roll head-tracking capabilities are included, so the game environment re-

sponds to head movements.

Cyber Maxx comes with
three bundled games,
including Synthetic

including Synthetic Dimensions' "Ghost Train," a virtual train ride through a horrific fun house. Software is expected to be priced at about the same level as computer or videogames. The company is working on the next generation of CyberMaxx products, which will incorporate a wider field of view, a crisper picture and a lower price. Also in the works is a PowerMaxx joystick (\$40 to \$50), which will allow games to be con-

trolled via natural hand movements.

A slightly different approach is being taken by Forte Technologies, a Rochester, New York, company. Its entry is VFX1 Head-Mounted System (HMS), a slightly larger, more substantial computer-based system consisting of an HMD, an interface card for connecting to a computer and the CyberPuck, a handheld controller that frees users from having to use a desk-bound mouse or joystick.

The VFX1, which will be available during the first quarter of 1995 at a price just under \$1000, features a large immersive headset with two 0.7-in. color LCDs—with no depixelization filters—high-fidelity stereo headphones and a microphone for communicating with another player. The company says the system produces an image the equivalent of a 35-ft. screen viewed at a distance of 35 ft.

trix LCDs to create a picture equal in size to

a 57-in, projection TV

tance of 8 ft., the com-

The Video Visor

is made of molded

plastic and weighs

when viewed at a dis-

pany claims.

Included is the Forte Interface

(Please turn to page 113)

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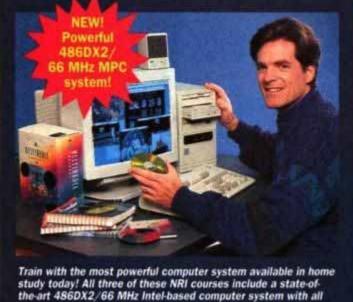
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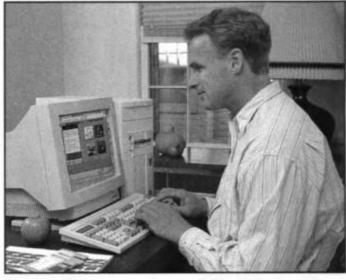
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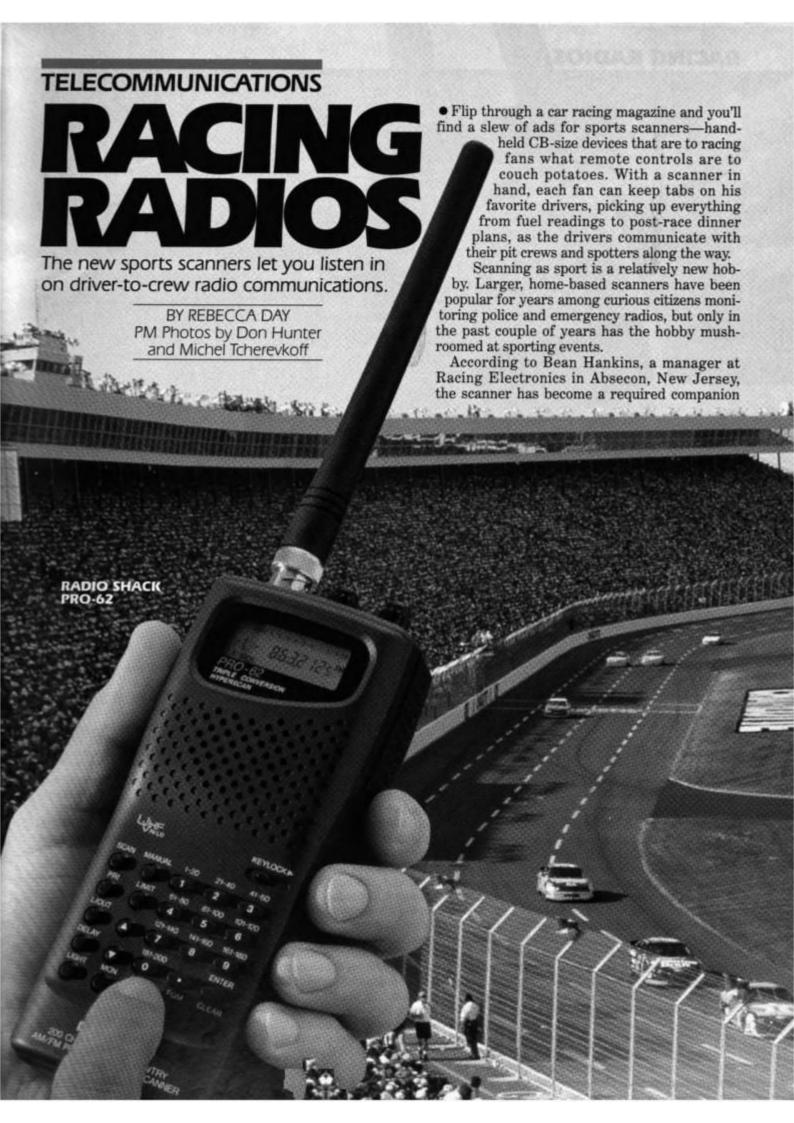
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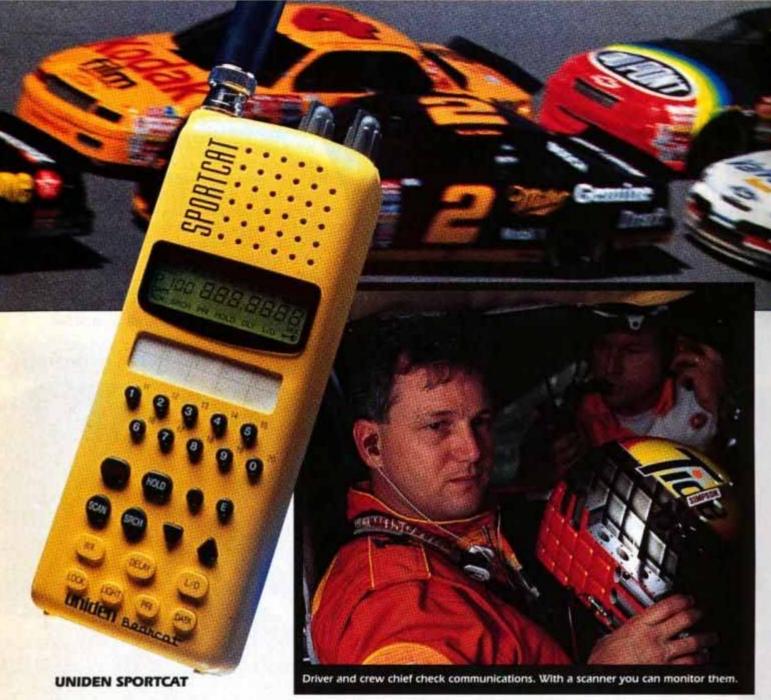
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among racing buffs, who can tune in for strategy, emergency updates and general information they wouldn't know from just watching a race. The drivers and crews aren't always comfortable with their communications being picked off the airwaves, Hankins says, but given the fact that car racing's revenues are largely driven by fan participation, most crews have learned to live with the intrusion. Those that haven't scramble their signals, but the good news for fans is that the cost of equipping as many as 30 radios for scrambling and descrambling can get prohibitively pricey.

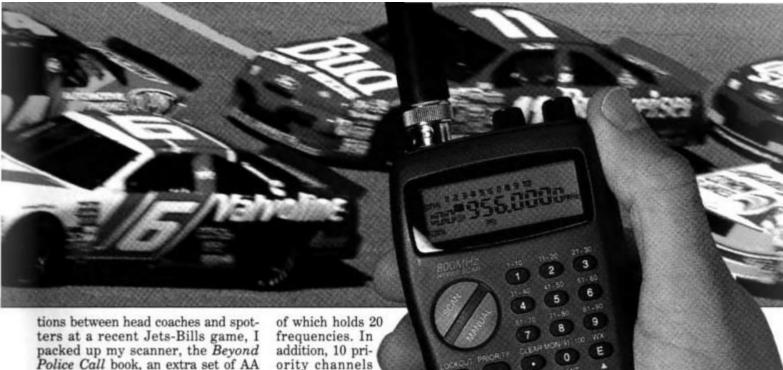
Companies like Racing Electronics, which sells scanners at retail and via mail order, provide frequency directories that list the precise frequency each driver uses. Racing Electronics bundles a directory with each scanner it sells. Purchased separately, subscriptions to frequency directories cost \$20 annually. The frequency directory is the scanner user's bible. Without a directory, finding a frequency is like trying to place a local call to a particular person without knowing the phone number. And you can't call Directory Assistance.

Other sources are also available to help identify certain frequencies. Radio Shack publishes Police Call and Beyond Police Call, which is a guide to radio frequencies used by security companies, schools, governments, utilities, stadiums and media companies, for example. Beyond Police Call also provides an extensive listing of drivers' radio frequencies according to racing tour: NASCAR, IMSA, ARTGO, ASA and others. Even when you do know a frequency at any given

time, chances are it will change four to six weeks later, according to Hankins, although some never change.

Sports scanners start at about \$100 and go up to \$360. At the low end are basic models with a limited number of channels and selected frequency ranges. Popular frequency ranges are VHF low band at 30 to 50 MHz, VHF high band at 150 to 174 MHz and UHF band from 450 to 512 MHz. Most racing team frequencies are in the 461 to 469 range.

Stadiums are also assigned a number of frequencies as are National Football League teams and NFL officials, according to the 1994 edition of Beyond Police Call. The National Football League is not NASCAR, however, and it doesn't like eavesdropping. Hoping to pick up lastminute play changes and conversa-



batteries, headphones and a Y connector so my friend could listen, too.

Bad luck struck quickly. I punched in every frequency assigned to the NFL and then scanned that range, but all I came up with were poor-quality transmissions of radio and TV broadcasts. After punching a lot of numbers and striking out, I began watching the football game 13 minutes and 49 seconds into the second half.

This experience illustrates how difficult and time-consuming frequency searches can be unless you prepare in advance. Preparation for an auto race is particularly important simply because there are so many cars participating. That's why many people program frequencies before they go to an event. And a smart way to do it, experts say, is to program the car number so you don't have to keep checking the number you've assigned to a particular driver.

The radio spectrum ranges from 30 to 960 MHz, with each frequency range assigned to a group of similar users. The FM broadcast band, for example, is from 88 to 108 MHz. weather satellites from 136 to 138 MHz, civilian and government highband frequencies from 150.8 to 174 MHz, and civilian aircraft from 108 to 136 MHz. There are thousands of frequencies assigned, and it would take you a very long time to find one that interested you if there were no operating features to simplify your search.

Frequency selection features are the primary selling points for scanners. At the high end of the market, the Uniden Bearcat 3000XLT (\$359) stores 400 channels in memory. To help you organize the frequencies, there are 20 memory banks, each

ority channels are available so that you can keep track of important channels while monitoring other frequency transmissions. The scanner's automatic sorting feature sorts programmed frequencies within each bank for faster scanning, and its TurboScan feature lets you scan up to 100 channels per second. TurboSearch lets you select either 100 or 300 steps per second when searching frequencies in the VHF band. This radio covers virtually every frequency from 25 MHz to 1.3 GHz, excluding the cellular band.

A big name in racing circles is the Uniden SC150 SportCat scanner (\$219), which offers 100 programmable channels including 10 onetouch direct-access channels. The SportCat offers 12 bands and 10 banks of 10 channels for simple organization of important frequencies. A Data Skip feature lets you get to the frequencies you want faster, and manual access takes you to a desired frequency instantly.

Radio Shack's Pro-62 scanner (\$300) uses a triple-conversion circuit to eliminate image interference in areas with lots of radio traffic. The Pro-62 has a lot of other useful features as well. A high-speed search mode finds new and unlisted frequencies. HyperScan provides 50channels-per-second search and 25-channels-per-second scanning. Covering seven bands, the Pro-62 offers 200-channel programming, RADIO SHACK SC 150XLT

which can be organized into 10 banks of 20 channels for selective scanning.

Radio Shack

00 CHANNEL DIRECT ENTRI PROGRAMMABLE SCANNER

Scanners at the budget level are less fully featured, as you might expect. The Radio Shack Pro-149 (\$120), for example, stores up to 10 channels and offers one-touch access to National Weather Service communications.

Whether you're a racing aficionado, a news hound, or just plain nosy, a scanner can provide a fascinating hobby. Operating a scanner isn't plugand-play simple, however. You'll need to set aside a few hours of programming time so you can access channels quickly and easily. And since assigned frequencies change fairly often, you have to be willing to update the scanner as necessary. If you are willing to commit the time and money, you'll be amazed at how busy and interesting the airwaves can be.



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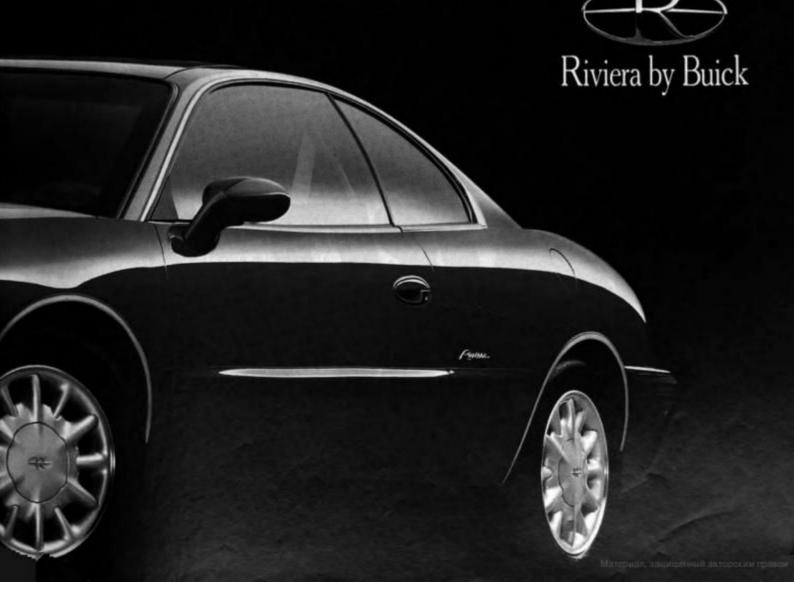
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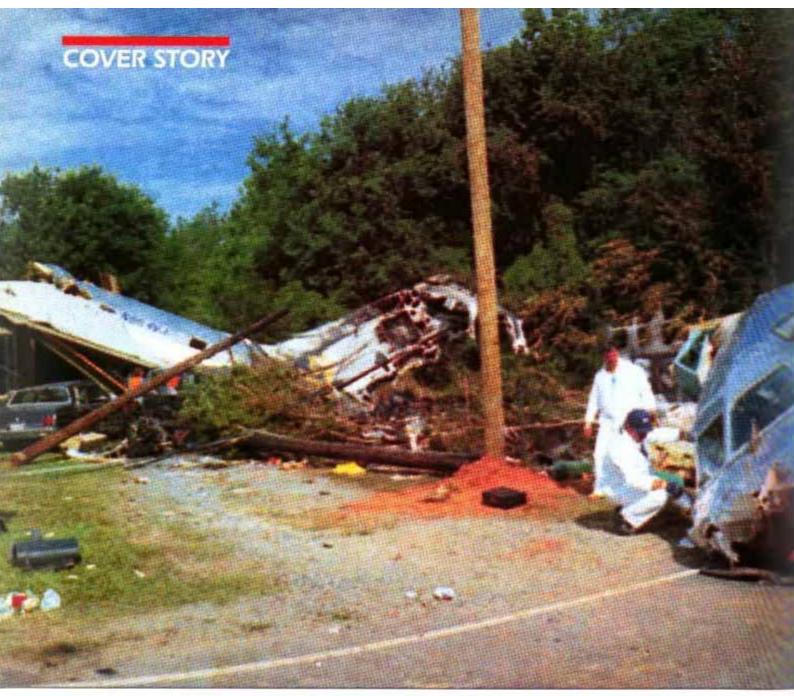
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HARD LESSONS

New technologies help us learn from the horrific riddle of an air disaster.

BY ABE DANE, Senior Correspondent

• As seconds ticked past, a vague sense of unease rapidly coalesced into outright alarm among controllers in the Charlotte/Douglas International Airport tower. Last they'd heard from Flight 1016, it was executing a missed approach: "USAir 1016's on the go...

up to three. We're taking a right turn here," called the captain. Nothing out of the ordinary. A minor stumble in the complex choreography of a busy airport.

But now they couldn't find the plane on radar. Out the windows of the tower cab, visibility was obscured

farming and annexed arrestone many



by a dark summer storm that seemed to have blown up out of nowhere. Then, as quickly as it had set in, the storm let up. No more than a minute after Flight 1016's last transmission, the skies began to clear, and controllers spotted a black plume of smoke rising beyond the airport perimeter.

Ground controller Bruce Tarbert activated the crash phone, rolling Aircraft Rescue and Fire Fighting trucks. As they screamed and hydroplaned across the wet tarmac, 911 calls were coming in from a neighborhood northwest of the airport. What was left of the USAir DC-9 lay in burning pieces spread across Wallace Neel Road and lodged in the carport of a suburban home.

Flight attendant Richard Demary remembers a moment of eery quiet when the fragment of the fuselage he was strapped into skidded to a stop. Then he shouted "Release seatbelts! Get out!" Dazed survivors began to emerge. Others were trapped. Hot metal groaned and popped as flames spread.

Fire equipment began to arrive within 9 minutes and unleashed a blanket of foam. In a few more minutes, the billowing smoke rising from the scene turned from black to white. The worst of the fire was out.

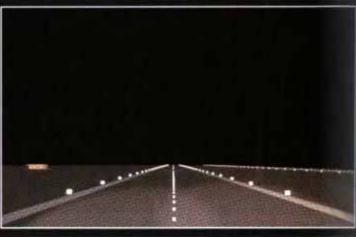
But for 37 of the 55 souls on board, it was too late. The July 2 crash of USAir Flight 1016 marked the first time in more than two years that the complex interweaving of strict regulations, sophisticated systems, rigorous training and skilled personnel that makes U.S. airlines the safest in the world had come so badly unraveled.

Before the wreckage cooled, the race was on to find out why. That question would be asked again, and with increasing urgency, in coming months as USAir Flight 427 went down near Pittsburgh, killing all 132 aboard, and American Eagle Flight 4184 came apart over an Indiana soybean field killing its 68 occupants.

More than at any time in recent years, the flying public is now looking to the National Transportation Safety Board (NTSB), the independent U.S. agency in charge of investigating air crashes, to make sense of what seems senseless. PM decided it was time to see where the technologically sophisticated art of aircrash detective work now stands.

HARD LESSONS





On the go

As always, the first step in investigating a major crash is to get there. Each Monday morning, a Go Team of about 10 specialists is put on call for the week. When their beepers go off, they

have 2 hours to gather equipment and be ready for launch aboard an FAA plane from Washington National Airport. At the scene, each will marshal a field team in his area of expertise, drawn from businesses and institutions all over the country.

Top priorities on arrival are to document perishable clues, such as ground scars or evidence of icing, and to recover the plane's flight data recorder (FDR) and cockpit voice recorder (CVR).

Dr. Bernard Loeb, director of the NTSB's Research and Engineering office, told us that improvements in the latest generation of CVRs and FDRs represent "the single most important technical advance in terms of speeding up the accident investigation process and giving us confidence in our conclusions."

The recorders now being installed on new jets store more information than earlier models, and they store it in nonvolatile flash memory chips, rather than on magnetic tape. CVRs now pack 30 minutes of high-quality digital audio from four cockpit mikes into about 600 megabytes of memory. FDRs can store more than 100 aspects of an aircraft's performance and configuration (magnetic tape models

stored 5 to 17 parameters) over a period of 25 hours.

Of course none of this matters unless the data can survive a crash. The chips are somewhat easier to protect because they take up less space and can withstand higher temperatures than tape. But the real key is in the armored cells that surround them.

One major manufacturer, Allied Signal, encloses the chip module in an

TASS CLT MICROBURST SIMULATION
HORIZONTAL WIND VECTORS AT 90 M AGL

TIME=22:42:15 UTC

NORTH

6000

25 M:S

2000

-6000 -4000 -2000

Vector field generated on NASA-Langley computers shows dramatic variations in wind direction and speed created by the microburst that hit Flight 1016. The aircraft (flight path shown in orange) experienced a 70-knot wind shift as it approached the runway (green).

outer casing of precipitation-hardened stainless steel 1/16 of an inch thick. Inside that is a 1-in. layer of molded, low-conductivity thermal insulation. As a last line of defense, the memory module is surrounded by ¾ of an inch of wax, which maintains a constant temperature as it changes phase from solid to liquid.

The result is a $6 \times 4 \times 4$ -in. box that can stand up to almost anything.

Tests have exposed it to a 4800-g impact, temperatures of 2000° F for 2 hours and water pressures equivalent to 20,000-ft. ocean depths for 30 days—with no loss of data.

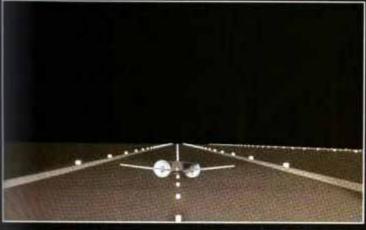
As we saw on a recent visit to the NTSB labs, these tests, which in some ways exceed current standards, are by no means overkill. Although rare, there are still instances where data is destroyed, or the recording medium is damaged to the point where extracting information requires extraordinary effort.

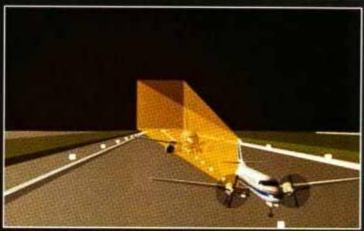
Usually heat, rather than impact, poses the threat. On a table in the room where the FDRs are read out, recorder specialist Dennis Grossi showed us a badly singed memory module from a crash last year. Recorder manufacturer Loral had to microscopically and electronically check all the circuit-board connections, then resolder those that shorted out or broke. When that was done, however, the NTSB was able to get 100% of the data.

Evidence of impact resistance was on view in the CVR lab, where we saw the mangled armor of a magnetic recorder that had hit the ground at the speed of sound, but still yielded its full store of data.

Playback time

While manufacturers have beefed up the capacity and survivability of their recorders, the NTSB has focused on





Simulation created by Eye Witness Animations shows why a 737 (shown right, after the crash) was not able to avoid a Fairchild Metro that a controller had erroneously left in the way. With lighting and atmospheric conditions recreated, it's clear the 737 pilot saw nothing as he landed. The Metro comes into view only in the third frame, 1 second before impact. Why? The Metro's tall beacon was located below the top of the vertical stabilizer, blocking view between the two yellow panels in the fourth frame.



Canada's Transportation Safety Board developed software that translates FDR data into detailed simulations (left). Recorders from Flight 427 (below) survived its 6000-ft. vertical dive. Only the outer sheetmetal was damaged. new ways to wring all they can out of the data. In the case of CVRs, preparing a transcript of cockpit conversation and radio transmissions is just the beginning. The recording is then fed to a computer in digital form so that key portions can be teased apart frequency by frequency with sophisticated spectrum-analysis software.

Engineering-applications programmer Vaclav Slovak demonstrated with



HARD LESSONS



a recording of radio transmissions from a crashed police helicopter. Initially, weather had been suspected as a cause, but based on a knowledge of the number of teeth on the powertrain gears, lab workers were able to correlate gearbox noise with engine rpm. A slight decline in the sound's frequency provided evidence of power loss. The finding persuaded the engine maker, which had originally been reluctant, to tear down the powerplant and find the problem.

Across the hall in the FDR lab, computing advances are also making themselves felt. At a workstation, Grossi showed us by punching up a detailed simulation of a recent China Airlines crash. The simulation software, developed by Canada's Transportation Safety Board, converted raw FDR numbers into a 3D, chaseplane view of the ill-fated aircraft moving in real time. Framing the im-

hazard gear (left) to protect

against blood-borne diseases like AIDS

age were flight-instrument readings, flight-control positions and indications of control-surface responses. They gave a complete, synchronized picture of what the pilots saw and what they did as the plane got into an uncontrolled climb, stalled and eventually crashed.

Simulations such as this certainly

make FDR data easier for the uninitiated to understand, but according to Grossi even trained eyes gain a better sense of the timing and sequence of events from them. Also, Grossi says, the software is well enough integrated with the new FDRs that under ideal circumstances it can produce animations the same day a recorder comes in. Preliminary conclusions reached this way

could help focus field investigations from their earliest stages. The ultimate payoff may come, however, in heading off repeats of an accident by incorporating the real-life scenarios into pilot training programs.

When complex meteorological factors enter the picture, heavier-duty simulation tools are called for. In the case of USAir Flight 1016, the NTSB asked Fred Proctor, a research meteorologist at NASA's Langley Research Center, to apply a computer code called the Terminal Area Simulation System (TASS). Running on a Cray supercomputer, TASS was originally developed to test concepts for aircraft-mounted wind-shear warning systems.

After initializing TASS with weather readings from the Charlotte airport at the time of the crash, Proctor was able to produce a detailed scenario that matched up well with the available data. The scenario indicated a powerful microburst—an intense form of wind shear—moving right across the path of the airliner. Using

(Please turn to page 114)



OWNERS REPORT

CHEVROLET CAVALIER

Genuine small-car fun and value.



• The Cavalier has been Chevrolet's price leader since spring of 1981 and has sold more than 3 million copies by now.

In September 1994, Chevrolet launched the secondgeneration Cavalier, which is featured in the photos accompanying this report. However, at the time of our survey, there simply weren't enough '95s on the road to get meaningful statistics, so the information here focuses on the 1994 model.

Before we plunge into our findings, though, we must note that the '95 Cavalier has been totally reengineered and restyled. Except for the 2.2-liter Four, it's an entirely different car—upgraded in a number of ways. Many of the suggestions made by owners of the 1994 Cavalier appear in the 1995 model, not the least of which are dual airbags. The suspension is entirely changed, and the rear seatback of all 1995 models folds down for added cargo capacity.

One change that our respondents did not suggest, though, was the dropping of the station wagon model. The '95 Cavalier isn't available as a wagon, nor is the car available with the torquey V6 engine as it used to be.

Now, as when our respondents bought their cars, the Cavalier stands in a field filled with choices, among them Saturn, Ford Escort, Dodge/Plymouth Neon, Honda Civic, Toyota Corolla, Nissan Sentra, Hyundai Excel and several others. The 1994 Cavalier, like its rivals, is packed with standard equipment: antilock brakes, power automatic door locks, variable-ratio power rack-and-pinion steering, 5-speed manual, tinted glass, halogen headlamps, stainless-steel exhaust system and Scotchgard-protected reclining bucket seats—all that and more at a suggested price of \$9445 for the 1994 Cavalier VL coupe. That's the base car, VL standing for Value Leader.

Next up, the RS (for Rally Sport) adds standard air conditioning, a 3-speed automatic, AM/FM radio, intermittent wipers and a handful of additional goodies. At the top of the 1994 Cavalier pyramid stands the sporty Z24 coupe and convertible. The Z24 comes with firmer suspension, alloy wheels, tilt steering wheel, 4-way adjustable driver's seat, AM/FM/cassette stereo and upgraded trim. The Z24 convertible also

CHEVROLET CAVALIER







Interior is all new, ergonomics improved.

Seats now offer more contour and support. All Cavaliers now have a 4-cylinder engine



has standard power windows. The 1994 Cavalier station wagon carries mostly RS equipment but isn't badged an RS and does not, for some odd reason, have power steering.

Price, not surprisingly, proved the

1994 Cavalier's strongest purchase motivator. Women made up 60% of the owners in our survey, each paying an average of \$11,324 for her new car. The coupe won out over other body styles, as did the base VL, so this is a price-conscious group of buyers.

Only 12.3% chose the 3.1-liter V6, an engine that offers 55 ft.-lb. more torque than the 2.2-liter Four (185 versus 130). The V6 comes standard in the Z24 and bumps up the price of

SUMMARY OF CHEVROLET CAVALIER OWNERS REPORTS*

Total miles driven	1,120,329	Handling	30.8	Good	44.0	No	75.5%
Average miles driven	8299	Price/value	20.8	Average	2.8	Yes	22.5
Purchase price:		Economy	20.1	Poor	0.0	What type of trouble?	
Average	\$11,324	Engine power	18.3	Control layout:		Nothing statistically significan	nt
Range	\$8500-\$15,500	Color selection	17.5	Excellent	42.0%	Repair it yourself?	
Why did you choose the	e Cavalier?	Comfort	17.5	Good	39.9	No	96.9%
Price/value	56.2%	Specific dislikes:		Average	7.2	Yes	3.1
Styling	31.5	No complaints	12.5%	Poor	10.9	Dealer repairs satisfactory?	
Owned Cavaliers before	e 26.9	Column/instrument panel		Instrumentation:		Yes	57.7%
Economy of operation	9.2	switches	9.6	Excellent	43.5%	No	42.3
Chevrolet's reputation	6.9	Not enough interior space	9.6	Good	42.8	Dealer service opinion:	
Size	6.2	Lacks comfort	7.7	Average	9.4	Excellent	53.8%
Body style choices:	34550	Paint chips too easily	7.7	Poor	4.3	Good	31.2
2-door coupe	64.5%	Lacks pickup, passing power	6.7	Driver sightlines:	5,800	Average	11.8
4-door sedan	24.1	Suggested changes:		Excellent	46.4%	Poor	3.2
4-door station wagon	10.6	No changes	11.8%	Good	46.4	Dealer sales policy:	30/65
2-door convertible	0.7	Relocate column/instrument	THE STATE	Average	5.8	Excellent	55.0%
Series choices:	1927	panel switches	11.8	Poor	1.4	Good	29.0
Cavalier VL	71.4%	Make airbags available	7.1	Overall convenience:	10000	Average	11.5
Cavalier RS	24.6	Better noise control	7.1	Excellent	38.2%	Poor	4.6
Cavalier Z24	4.0	More interior space	7.1	Good	49.3	Number of vehicles owned:	1
Engine choices:		More comfortable belts	7.1	Average	11.8	This vehicle only	34.5%
2.2-liter Four	87.7%	Engine power:	100	Poor	0.7	Two vehicles	33.8
3.1-hter V6	12.3	Excellent	42.6%	Workmanship opinion:	364.75	Three vehicles	20.4
Transmission choices:	140.0	Good	44.7	Excellent	55.1%	Four or more	11.2
3-speed automatic	77.1%	Average	12.1	Good	39.9	Principal driver:	
5-speed manual	22.9	Poor	0.7	Average	5.1	Female	60.0%
Options/Accessories:		Handling:	444	Poor	0.0	Male	28.1
Air conditioning	87.3%	Excellent	56.3%	Comfort opinion, front seats:	(99)99)	Both equally	11.9
Premium sound system		Good	40.1	Excellent	50.0%	Age distribution of owners:	
							37.2%
							34.3
	40.0		2.00				28.3
9.9. liture Force	24.7/20.6		56.9%		49,49		
					31.9%		
							a you
						Vos	55.0%
	44,400.0		W. F				31.4
	42.7/%		53.2%		06.1	No	13.6
Power windows Sunroof Avg. mpg, city/hwy: 2.2-liter Four 3.1-liter V6 5-speed manual 3-speed automatic Specific likes: Styling	14.5 3.6 24.7/30.8 24.0/29.1 25.4/31.7 24.4/30.3 42.5%	Average Poor Braking: Excellent Good Average Poor Overall performance: Excellent	2.1 1.4 56.3% 39.4 3.5 0.7 53.2%	Good Average Poor Mechanical trouble?	41.4 8.6 0.0 31.3% 41.8 20.1 6.7	Under 29 30-49 50-plus Based on your experiences, you buy a Chevrolet Cavalier had it to do over again? Yes Maybe	34 20 wif 53

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

an RS or wagon by \$834. Most of our respondents, though, felt that the Four delivered all the performance they needed, plus fuel economy in the 25- to 31-mpg range.

Handling came in second in our best-liked features column, right behind styling. A Michigan machine operator told us, "Drives great. Handles curves and bumps like a champ." Owners also praised GM's ABS-IV antilock brakes, several commenting that ABS had saved them from sure collisions on slippery surfaces. And the electric door locks gave Cavalier owners a feeling of security. These automatically lock all doors when the ignition is turned on and unlocks them when the driver shuts off the engine. For those who worry about being locked in after an accident, the system can be deactivated by removing one fuse from the fuse box.

Workmanship and quality were judged excellent by 55.1% of our respondents, the main problem area being easy-to-chip paint. As for mechanical ills, only 22.5% reported any at all, and there weren't enough in any category to be statistically significant. According to repeat customers—and 26.9% had owned Cavaliers before—not much seems to go wrong with this car. Several surveyees reported well over 100,000 troublefree miles on previous Cavaliers. "Quality car at a low price," opined an Illinois housewife.

Most owners judged front-seat comfort acceptable and the rear seat a lot less so. But many owners were single, and for others this was a second or third car used to haul children and not adults.

Ergonomics, however, won no prizes but also didn't evoke any 4-letter words. The one thing a lot of drivers didn't like was the proximity of the two stalks on the steering column to the rotary switches for the panel rheostat and the dome light. The switches are just too close together. We also heard some squawks about neck-rubbing shoulder harnesses, something remedied on the 1995 Cavalier via adjustable positioners. And several respondents said the car needs to be quieter.

But these were minor complaints in relation to most people's satisfaction with their 1994 Cavaliers. "It fits my needs as a commuter," remarked a Massachusetts designer. "Best car for the money, and it has everything I wanted: a V6 and power everything for less than \$13,000," added a Maryland supermarket stocker. And finally, a receptionist from Maine observed, "I looked at used cars first, but they were all in the same price range as the Cavalier. Why buy used when you can get a new car?"



Workmanship and quality were Styling was the second most oft-cited reason for buying the older Cavaller. The all-new diged excellent by 55.1% of our re-

EDITORS REPORT

Value At Any Cost

 We remember the old Cavalier vividly. Well, not vividly, as the car was hardly a memorable addition to the automotive universe. Bland comes to mind.

For those who appreciated low cost of ownership above all else, Cavalier was extremely adequate to the task, and our readers have reinforced that. But the driving experience was hardly thrilling, and the interior and exterior screamed cheap. Cavalier was a 12-year-old vehicle in a market segment where every other competitive vehicle was only a few years from the designer's CAD/CAM workstation.

That was then, this is now. Chevrolet has taken the important things, like the cost-of-ownership concept and the thrifty, venerable 2.2-liter 4-banger, and built an entire new car around them.

And a pretty good car it is, too. Pivotal to the rest of the improvements was a new, stiffer chassis. Stiffer in the structure, that is. The stiffer structure is less prone to squeaks and rattles because the parts bolted to it aren't constantly being flexed and twisted as the car traverses bumps and potholes. A stiffer vehicle has a higher resonant frequency, which means that the suspension settings-like spring and shock absorber rates-can be chosen for the best handling, rather than used to tune out unwanted resonances in the structure.

When they designed the chassis, they gave it a 3-in.-longer wheelbase and a 2-in.-wider track as well as a 2-in.-shorter curb length. Careful planning and packaging allow for more interior room, as well as dual airbags. Interior perks include heater/air-conditioner ducts for the rear passengers, B-pillar (instead of door-frame mounted) seatbelts and rear child safety locks.

ABS is standard. Other features include: battery rundown protection, theater-style auto-dimming interior lights, zoned rear defroster, 100,000-mile spark plugs, permanent transmission fluid, warning lights for low oil and coolant level, and a removable foam plastic tray for the jack and lug wrench.

We drove two different flavors of drivetrain, a 2.2-liter with a manual and a balance-shaft-equipped dohc Quad 4 with 4-speed auto tranny. We recommend stepping up from the base model to the LS trim level just to be able to specify the 4-speed transmission.

However, the 2.3-liter Quad 4 has new balance shafts this year, cleverly chain-driven—along with the oil pump—in the oil pan below the engine. The power-steering pump is bolted directly to the engine and coupled directly to the camshaft. This eliminates a bracket or three, a belt, two pulleys and a lot of potential vibration. The bottom line is a 4-cylinder engine that has the idle quality of a V6. For the minor loss in fuel mileage and the big increase in passing performance, it's the best option.

-Mike Allen



WIN A NEW BUICK ROADMASTER WAGON

• Big station wagons are a lot like whales: They're huge, and they're on the endangered species list. While whales are protected by law, wagons are not. They are getting squeezed out of existence by minivans and sport/utility vehicles. And the few manufacturers that still make big wagons don't know if they will continue to do so in the future.

It's a shame, too, because nothing performs quite like a big wagon. With room to stretch out in comfort and pack in half your house, you can still tow the boat or trailer—up to 5000 pounds. The big wagon's forte is luxury touring while hauling everything you need for a great vacation or trip. That's versatility in anyone's book. And big wagons still come out on top in carlike ambience and handling com-

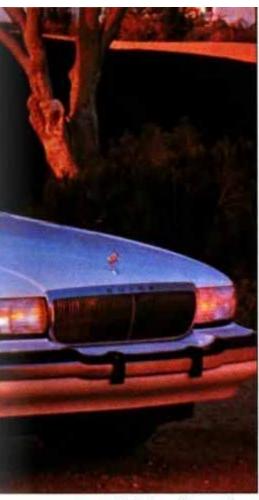
pared to vans and sport/utes. Add a high-performance engine and upgrade the suspension, and you can transform a Clark Kent machine into a hauler with Man of Steel capabilities.

As a matter of fact, we did just that with a 1993 Buick Roadmaster wagon, in our Workahaulic (page 27, Nov. '93; page 64, April '94). We swapped the stock 180-hp V8 for a 300-hp Corvette LT1 engine, beefed up the 700R4 automatic for brisk, tire-chirping shifts, and we stiffened up the stock, rather relaxed suspension with Bilstein police shocks. We rounded out the package

wagon, in our shocks. We rounded out the package with a new exterior look.

Reader response to our project Buick Roadmaster wag-

PM's Project Workahaulic Buick wagon with reworked exterior and Corvette power.



on was overwhelming. Seems there are a lot of big-wagon fans out there, and they liked the approach that we took with our Buick.

Buick must have liked our approach, too, because it incorporated many of our ideas into its 1994-95 Roadmaster wagon package.

Which brings us to our contest. If you like big wagons as much as we do, you can do your part to preserve the species—and win yourself a luxury 1995 Buick Roadmaster Estate Wagon—by entering the POPULAR MECHANICS Save The Wagons Contest. All you have to do is tell us, in 50 words or less, why auto manufacturers should continue to make big wagons. It's that simple.

The '95 Buick Estate Wagon comes loaded with a 260-horsepower LT1 V8, 4-speed automatic, seating for eight, 5000-pound towing package with self-leveling suspension, dual airbags, antilock brakes, dual 6-way power seats and gobs of additional luxury features. It's a great prize.

The coupon at right must accompany your entry, which should be typed on a separate piece of paper. Only entries accompanied by original coupons will be judged. No photocopies of the coupon will be allowed. You can enter more than once if you like. But each entry must be accompanied by an original coupon.

If you've always wanted a big luxury wagon, here's your chance. Read the rules, get out your thinking cap and enter our contest now.



SAVE THE WAGONS CONTEST OFFICIAL RULES

 On a separate piece of paper, tell us why auto manufacturers should continue to make big wagons. Entries must be written in 50 words or less. All words count. Entrant's name and address must appear on the essay.

Each entry must be accompanied by an official printed coupon, such as the one on this page. No
copies or facsimiles of the entry form will be accepted, except for entries from Maryland and Vermont.
 You may enter more than once, but each entry must be accompanied by an original, official
coupon.

4. All entries become the property of Popular MECHANICS and will not be returned. Entry into the contest constitutes permission for The Hearst Corporation to use entrant's name, photograph or other likeness, biographical information and essay for any advertising or promotional purpose without further compensation. The winner further agrees to be photographed with various members of the Popular Mechanics staff, and consents to their name and photographs being used in a future issue of Popular Mechanics.

5. Entries will be judged on originality, imagination and sincerity. Preliminary judging will be done by a panel of Popular Mechanics automotive editors. From initial selections, the final winner will be selected by Vice President and General Manager of Buick Motor Division Ed Mertz and Popular Mechanics Editor-In-Chief Joe Oldham.

The decision of the judges is final. No correspondence or telephone calls regarding the contest will be accepted or entered into.

The winner will receive a 1995 Buick Roadmaster Estate Wagon. There is no cash equivalent.There are no other prizes. All taxes are the responsibility of the winner.

The contest is open to anyone residing in any of the 50 United States, except employees of The Hearst Corporation and their families, and employees of Buick Motor Division of General Motors Corp.

 Entries should be mailed to: Save The Wagons Contest, Popular Mechanics, 224 W. 57th St., New York, NY 10019. Entries must be postmarked before June 30, 1995, and received by July 5, 1995. Incomplete, late, illegible or misdirected entries will not be considered.

10. The winner will be notified by Sept. 11, 1995, and will be asked to execute and return an affidavit of eligibility and release within thirty (30) days of attempted delivery of same. Noncompliance within that time period will result in disqualification and an alternate winner will be selected.

 After the winner is notified, Popular Mechanics will provide the winner's name to anyone who wishes it and who sends Popular Mechanics a stamped, self-addressed envelope with the request.
 This contest is void where prohibited by law. All federal, state and local regulations apply.

Mail To: Save The Wagons Contest Popular Mechanics 224 W. 57th St. New York, NY 10019

Here is my official entry to the POPULAR MECHANICS Save The Wagons Contest. I promise to abide by all official rules.

Name			
Street			
City	State	Zip	

HOME&SHOP

JOURNAL

HOME IMPROVEMENT

Rock Solid

New concrete forming methods make better basements.

BY ROY BERENDSOHN, Assistant Home Improvement Editor

Fill a plastic foam coffee cup with concrete and you
have demonstrated what many builders see as the next
great wave in construction technology; using polystyrene as a lightweight, insulating concrete form.

That's right, polystyrene, the same lightweight plastic that has made millions of coffee cups, can just as easily be molded into interlocking blocks, planks and panels into which you pour concrete. The best part is, when the concrete cures, you leave the polystyrene forms in place. This results in a wall with an R-20 to R-25 insulating rating that is ready to accept both interior drywall and exterior finish. A typical 8-in-thick concrete wall has an R-value of approximately 1.3, and even a well-insulated wood-frame wall is usually no more than R-15 to R-18.

There are many people in the construction industry who say this method of forming concrete will usher in a new era in building, the scope of which has not been seen since sawed lumber replaced hewn timbers in the 19th century. Furthermore, because of the high R-value that these systems deliver, some builders advocate it as a method to build anything from a foundation to an entire house.

Are these methods accessible to people building their own house? The answer is a limited "yes." Several manufacturers we spoke with say their dealers have sold their products to do-it-yourselfers who have built a foundation, a house or a structure such as a garage. A professor at Boston University who studied these building systems found that even his 10-year-old daughter could assemble the forms. He and a co-author, also of Boston University, wrote a book in conjunction with the Portland Cement Association on these systems (see the Source List on page 78).

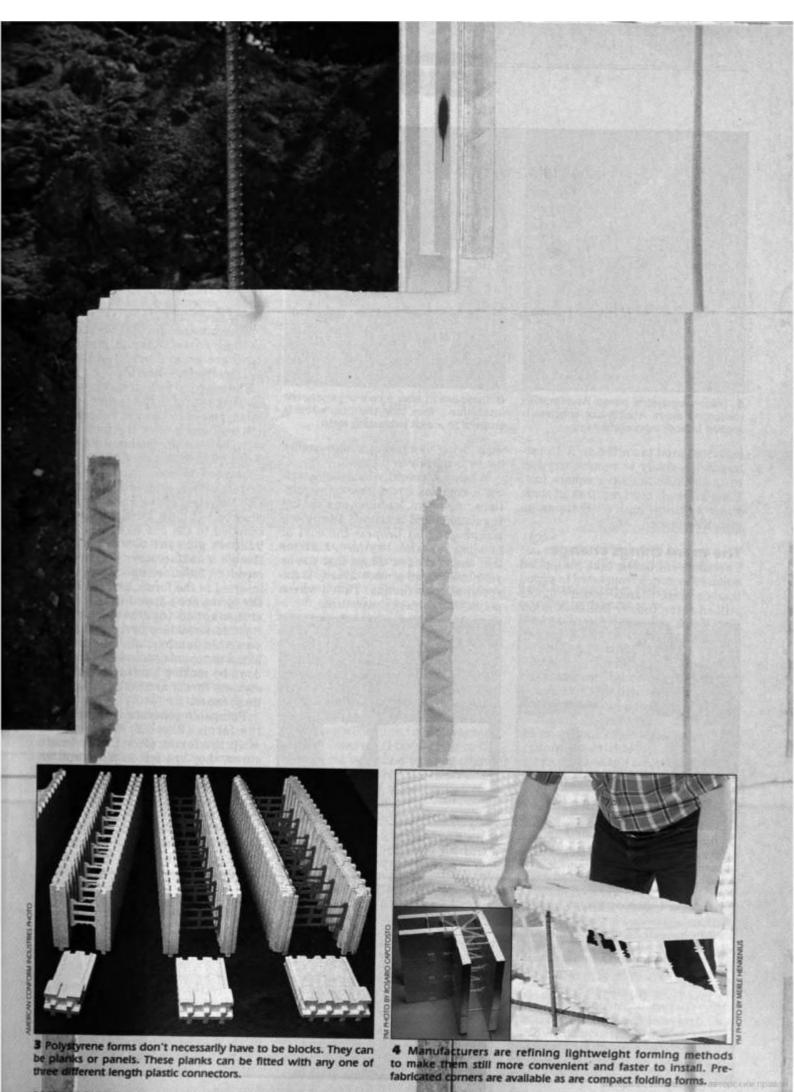
It's tough to nail down a specific price for these systems, but they appear to be competitive with standard concrete. Using these methods, an 8-in.-thick concrete wall ready to receive interior drywall costs about \$5.50 to \$7 per square foot of foundation wall. Our research indicates a standard 8-in.-thick concrete wall that has



1 The first row of polystyrene blocks is set into a wet concrete footing or on top of dry concrete. The forms are set level and plumb. Subsequent forms snap onto the top of the first row.



2 When the blocks are built up to a sufficient height, they are braced with framing lumber. Next, concrete is pumped into the forms, and when the concrete hardens, the braces are removed.



POPULAR MECHANICS • FEBRUARY 1995

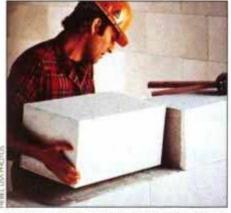


5 These polystyrene panels have built-in reinforcing mesh. A sprayable concrete is applied to both sides of the forms.

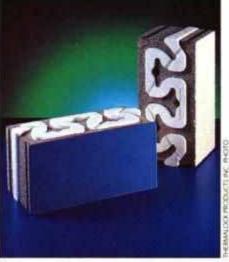
been insulated to an R-5 to R-15 rating and is ready to receive drywall costs about \$8 to \$9 per square foot. Keep in mind, however, that in some markets there may be little or no price difference.

The more things change...

The same influence that compelled builders to switch from hewn to sawed lumber more than a century ago is still in force today. Builders make



7 These lightweight, aerated concrete blocks are bonded with thin-set mortar, as opposed to 3/2-in.-thick mortar joints.



6 These blocks have a core of polystyrene insulation. Note that the insulation is grooved to accept reinforcing mesh.

their living by making a high-quality house as quickly as possible.

When you consider increasing land costs, complex environmental regulations, stringent building and zoning regulations and a manufacturing environment that propels the cost of building materials skyward, it seems that one of the few things that you or your builder can control directly is the speed of construction. That's where polystyrene enters the picture.



The blocks can be sawed to length with a crosscut saw from the manufacturer. They're finished with stucco or thin-set tile.

The polystyrene connection

Polystyrene is an odd material, part plastic and part air. Chemical manufacturers mix its components and blow gas or air through it, causing it to foam. Once cured, the plastic is lightweight, easily cut and a good insulator. You can extrude the foam into sheets, or expand it into molds to make blocks, panels and planks.

If you mold polystyrene components so they interlock, they form a quickly assembled and surprisingly sturdy structure.

Here are the specifics on how this method works. Bear in mind that there are several variations to the basic method we describe.

The concrete footing is poured, and the first row of polystyrene forms is either placed in the wet concrete, or it is positioned after the footing has set. The lead photo shows Polysteel forms, distributed by 3.10 Insulated Forms (see Source List). Other form systems work in a similar manner. The Polysteel forms are leveled and plumbed (Photo 1). Each block is snapped to the one next to it (some builders glue the blocks together, though manufacturers don't recommend it). Reinforcing steel bars are inserted in the forms, and the rest of the forms are slipped over the bars and snapped together. The polystyrene forms are braced with construction lumber, and the builder forms the openings for doors and windows by making lumber boxes. Polystyrene forms are installed around these boxes.

Pumpable concrete is flowed into the forms (Photo 2). Rather than strip the forms after the concrete cures, they are left in place and no further insulation is needed. An added benefit to this system, say the manufacturers, is that since the forms are left in place, the concrete is kept moist longer and thus cures more slowly. This increases the concrete's strength. With this in mind, many

SOURCE LIST

Below are company addresses listed in order of appearance in this article.

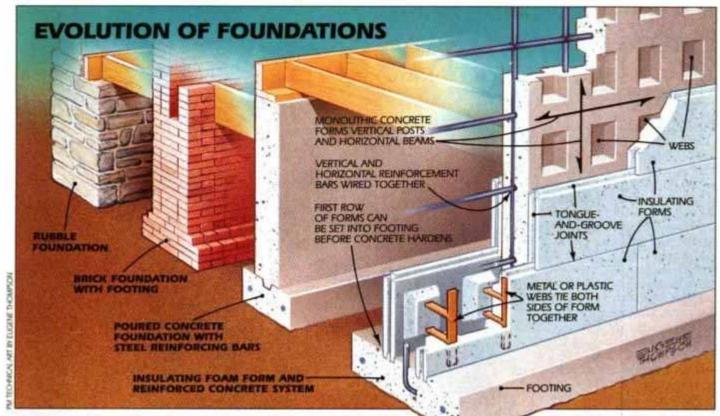
- 3.10 Insulated Forms, L.P., P.O. Box 46790, Omaha, NE 68128; (800) 468-6344.
- American ConForm Industries, 1820
 S. Santa Fe St., Santa Ana, CA 92705; (800)
 266-3676.
- Lite-Form Inc., P.O. Box 774, Sioux City, IA 51102.
- Insteel Construction Systems, 2610
 Sidney Lanier Dr., Brunswick, GA 31525;
 (800) 545-3181.
- ThermaLock Products Inc., 162
 Sweeney St., North Tonawanda, NY 14120.

 Hebel USA, P.O. Box 767220, Roswell, GA 30076.

The Portland Cement Association teamed up with Boston University School of Management professors Pieter Vander-Werf and Keith Munsell to produce a 300-page book: The Portland Cement Association Guide To Concrete Home Building Systems. The authors visited 100 job sites, interviewed about 200 builders and spoke to building-code officials. They talked with homeowners who live in houses built with these methods. Munsell even built a concrete addition to his house.

At press time, the book was projected to cost about \$45, and it should be available by the time you read this. Contact The Portland Cement Assn., Dept. HB, 5420 Old Orchard Rd., Skokie, IL 60077.

There is a fledgling trade association covering the lightweight-polystyrene concrete-form industry. At press time, half a dozen companies were charter members, although others may have joined since this article was written. For a member list, write The Insulating Concrete Form Assn., 960 Harlem Ave., No. 1128, Glenview, IL 60025.



polystyrene forms shape the concrete into posts and beams, rather than a thick, rectangular slab. That way, less concrete is used.

Inside the house, plumbing and electrical services are run in channels cut into the polystyrene foam. Outside the house (or foundation), stucco is applied over the insulation or siding is attached to furring strips that are fastened directly to the concrete. Another method is to attach the siding or its furring to the plastic or metal webs that are part of the forms.

As for the polystyrene scrap that's left over from the forming process, it's returned to the form dealer, who then sends it back to the manufacturer for recycling.

Variations on the theme

Polystyrene doesn't have to be confined to making blocks. It can be shaped into planks that are snapped together with plastic tie bars, such as with American ConForm's product (Photo 3). Lite-Form Inc. makes forms that fold open on plastic hinges to form blocks (Photo 4). To further speed construction, Lite-Form prefabricates corners and wall jogs (inset, Photo 4).

Up to this point, we've discussed polystyrene as a form and an insulator that surrounds the concrete, but it can work in reverse, too.

For instance, the Insteel 3-D building system consists of an expanded polystyrene sheet with reinforcing wire mesh around it

(Photo 5). It comes in 4-ft.-wide sheets in lengths up to 26 ft. After it has been stood on its footing and braced, a sprayable concrete is applied to both sides of it. Insteel says it delivers an exterior wall that costs about the same as brick siding (\$5 to \$8 per square foot) with an R-value in the R-11 to R-18 range, depending on the thickness of polystyrene you choose.

Insul Block from ThermaLock Products also centers the polystyrene between concrete (Photo 6). Here the polystyrene is limited to an insulator and does not form the wall—the block is mortared together like conventional block.

An 8-in.-wide Insul Block costs in the \$1.85 to \$2.15 range, while a standard 8-in.-wide concrete block costs from 60 to 96 cents. However, the Insul Block delivers an R-15 rating whereas a concrete block is in the R-1 to R-2 range.

It has several interesting features. Note that it maintains a thermal break by completely separating the concrete block faces from each other. Also, the insulation is raised ¾ in. above the block face. That way, horizontal and vertical mortar joints are insulated.

Grooves in the insulation allow for reinforcing mesh to be installed in the mortar joints, much like how standard concrete block is reinforced. Finally, the block is available with pre-applied exterior finishes. The block on the left has a tile-like glazed surface.

Self-insulating thin-set concrete block

The previous systems use polystyrene as an easily installed concrete form, an insulator or both.

Hebel, a German concrete-block manufacturer, takes a different approach. It makes lightweight concrete blocks, panels and lintels that are self-insulating because each component has thousands of tiny air pockets. It accomplishes this by adding aluminum paste to the concrete mix. The paste sets off a chemical reaction in the mix that forms hydrogen gas bubbles. The still-wet concrete is formed into large blocks that are cut into smaller blocks. The cut blocks are cured in a pressurized steam vessel called an autoclave.

The blocks are installed on thin-set mortar beds, as opposed to %-in.-thick mortar joints (Photo 7). Further, the blocks can be cut and drilled with hand tools. The manufacturer even supplies a large crosscut saw for cutting the block to length (Photo 8).

In the southeastern United States, an 8-in.-thick Hebel wall costs in the \$3.85 to \$4.10 per square foot range while delivering an R-11 rating. For the time being, outside the Southeast, the product is more expensive owing to freight costs to ship it outside its area of manufacture.

TOOL TEST

Bosch Corner/Detail Sander

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO, Contributing Editor

• Until recently, sanding in corners and confined places were jobs that simply had to be done by hand. These days, however, you have a choice. A new type of sander brings these tedious and painstaking chores into the power-assisted realm. And the list of manufacturers jumping on the bandwagon is growing.

This new breed of sander features an oscillating triangular pad that reaches into corners better than conventional orbital sanders. We tried one of the latest in this innovative class of power tools, the Bosch model No. B7000 Corner/Detail Sander, to check out its features and effectiveness.

The tool has an easy-to-grip cylindrical body with a conveniently located top-mounted sliding ON/OFF switch that permits left- or righthanded operation. It's powered by a 1.1-amp motor that provides 13,000 opm (orbits

per minute) to the 3½-in. triangular sanding pad. The rubber pad accepts hook-and-loop (Velcro-type) sanding sheets (Photo 1), and the pad can be rotated to distribute wear to each corner of the sanding sheet (Photo 2).

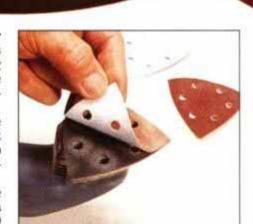
To keep your job site clean, the Bosch B7000 features an integral dust port that connects the tool to a shop vacuum via the optional Bosch Airsweep hose and adapter accessory.

To test the tool's performance, we sanded a piece of wood joined to a plastic-laminate surface. The B7000 smoothed the wood right up to the inside corner without damaging the laminate (Photo 3). It also worked well cleaning up dried glue on the inside of a frame (Photo 4).

In all situations, this 2-pound tool is easy to handle and maneuver. And, the small 1/16-in.-dia, random-orbit motion keeps vibration down while producing relatively swirl-free results.

In addition to the dust-collection accessories, Bosch offers an optional extension plate. This accessory extends pad reach for sanding tight areas such as between louvers.

The Bosch Corner/Detail Sander has a suggested retail price of \$122. It's available at home centers, hardware stores, lumberyards and other outlets that sell power tools. Contact S-B Power Tool Co., 4300 W. Peterson Ave., Chicago, IL 60646.



1 Triangular hook-and-loop sanding sheets feature dust-collection holes that align with holes in rubber sanding pad.



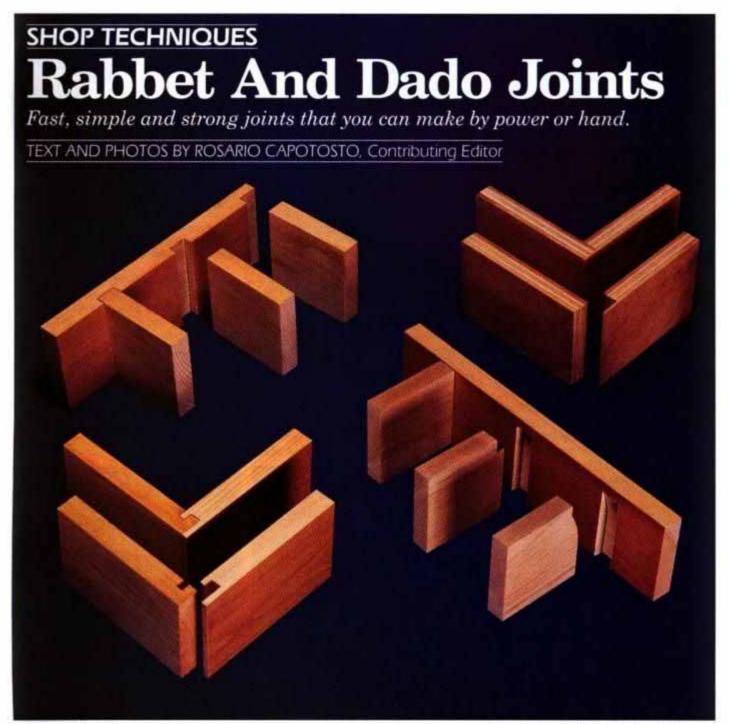
Sanding to a corner between wood and plastic laminate leaves the laminate unmarred while smoothing the wood.



2 To rotate pad, press button at front, remove pad, turn and reinstall. Rotating pad distributes wear on sanding sheet.



4 Dried glue on inside corner of frame is quickly removed. Small 1/16-in. orbit action produces swirl-free surface.



 Next to butting and gluing two boards together or driving a few nails, making rabbets and dadoes are among the simplest ways to join wood. Simple as they are, however, you'll find them in all aspects of woodworking—from finish carpentry to advanced cabinetmaking.

The dado is a rectangular channel cut across the grain on the face of a board. It's normally used to house the end of an adjoining board. If the cut is made parallel to the grain, it's called a groove. For the most part, making dadoes and making grooves involve the same techniques. Both offer increased glue surface area over butt

joints, as well as help in alignment and provide mechanical strength.

The rabbet is essentially an opensided dado on the edge of a board, either parallel to or across the grain. The resultant notch, or step, is a useful joint for cabinet or box corners, and also serves to house recessed components such as cabinet backs, panels, glass and mirrors.

Both dadoes and rabbets may be through joints, where the cut extends completely across the stock, or blind, where the cut stops short of one or both edges of the work. Dadoes that are blind, or stopped at both ends, are actually shallow mortises.

Handcut Dado Joints

The first step in making a dado is to mark the cutting lines. Make the width of the cut equal to the thickness of the mating member and make the depth about one-third to one-half the stock thickness.

Use a backsaw to make the dado shoulder cuts with the kerf on the waste side of the layout line. To ensure square aligned cuts, clamp a square block of wood to the work so it's aligned with the center of the cutline. Then, hold your backsaw against the block to guide the cut. Ensure consistent cut depth by allowing the backsaw spine to touch the top of a



1 Cut dado shoulders with a backsaw. Use a block to keep the saw aligned. A second block acts as depth stop.

second block when the appropriate depth has been reached (Photo 1). To determine the height of this stopblock, measure the distance from the backsaw teeth to the spine and then subtract the dado depth.



2 After cutting the shoulders, remove the waste with a chisel. Work from the ends toward the center to avoid splintering.

After the shoulder cuts are made, use a sharp chisel to clean out the waste. Work from both edges toward the center to prevent tearout at the board edges (Photo 2).

Because rabbets are open-sided



3 To cut a rabbet, first make the shoulder cut. Then, rest the saw horizontally on a quide block and saw away waste area.

dadoes, you can usually finish the job with two saw cuts—one starting from the face and the other from the board end (Photo 3). When the cut is finished, fine-tune it by paring with a sharp chisel.

Power-Tool Dadoes

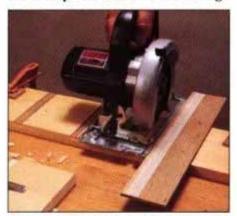
The most popular power tools for cutting dadoes are the router, table saw and radial-arm saw. However, you can do the job with a portable circular saw, as well.

To cut a dado with a circular saw, first clamp a straight guide strip to the work so it's parallel to the dado layout lines and offset by the distance from the edge of the blade to the side of the saw base. After making the first shoulder cut by guiding the saw against the strip, readjust the strip so the opposite side of the blade aligns with the other layout line and then make the second shoulder cut. Next, make a series of passes in between the shoulder cuts and remove the waste with a chisel.

For accurate repetitive work, modify the guide strip to make both shoulder cuts without readjustment. Cut a second guide strip the same length as the first, but equal in width to the width of the dado less the blade thickness. Tape this strip to the first strip to create a hinging guide. Make the first cut with the narrow strip folded out of the way, then lay it down on the work for the second cut (Photo 4).

While you could use a similar guide for routing dadoes with a straight bit, a frame-type jig prevents the router from drifting off course and helps eliminate tearout (Photo 5). Make the frame out of 1 × 3 stock. Space the two parallel side strips a distance apart equal to the router base plus the difference between the bit diameter and dado width. Screw two crosspieces near the ends of the parallel side pieces.

Clamp the jig over the work, and nail a third crosspiece in place to back up the open edge of the work. Before routing the workpiece, remove the jig and rout a dado through the middle crosspiece. Use this cut to align



4 Set circular saw to depth of dado and then cut dado shoulders. Strip with hinged section guides both shoulder cuts.



6 To rout a stopped dado, tack a stopblock to the frame Jig crosspiece. After cutting dado, square blind end with a chisel.

the jig with the dado layout lines.

To make a blind dado, nail a stopblock to the middle crosspiece and square the finished cut with a chisel (Photo 6).

For cutting grooves parallel to the



5 Frame-type jig guides router and constrains dado width. Initial cut through jig crosspiece helps in aligning jig.



Rout grooves parallel to the grain with a router fence. Where a fence won't reach, clamp a guide strip to the work.

grain and parallel to the work edge, use a router fence (Photo 7).

To cut dadoes and grooves on a radial-arm or table saw, use a dado blade. On the radial-arm saw, first adjust the dado blade width and set the saw height for the appropriate depth of cut. Then, install a new wooden fence on the radial-arm saw table and make a cut through it. Align the dado layout lines on the workpiece with the cut in the fence (Photo 8).

To make blind dadoes on a radialarm saw, simply clamp a stopblock to the table to limit the forward travel of the motor housing (Photo 9). Finish each cut by squaring the ends with a sharp chisel.

Grooves parallel to the grain and stock edge can also be cut on a radial-arm saw. First, pivot the motor housing to the ripping position. Set the dado blade at the correct width and height, tilt the blade guard back so it shields the rear of the blade and bring the anti-kickback pawls into contact with the wood. As with ripping, always feed the stock against the rotation of the blade (Photo 10).

To align the work with the dado blade on a table saw, mark the lines of

10 Turn radial-arm saw to rip position for cutting grooves and long-grain rabbets. Adjust anti-kickback pawls for safety.

To cut crossgrain rabbets with a circular saw, construct an L-shaped platform jig out of two pieces of ³/₄-in.-thick × 4-in.-wide plywood. Make these pieces equal in length to the length of the saw base. Glue and screw the pieces together to form an L. Then, secure the jig to the saw base with bolts and wingnuts. Use slotted holes in the jig so the saw's po-

make the first cut (Photo 13). Then,

Rabbet Joints

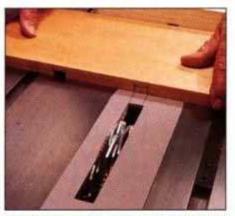
sition can be adjusted.

the cutting path on the table saw insert (Photo 11). Then, use the miter gauge to guide the workpiece. An auxiliary fence attached to the miter gauge provides extra support and helps reduce splintering. Cut longgrain grooves by guiding the work along the rip fence.

If you don't have a dado blade, you can still cut dadoes and grooves on either a table saw or a radial-arm saw. Simply make the shoulder cuts first with a standard blade, then re-



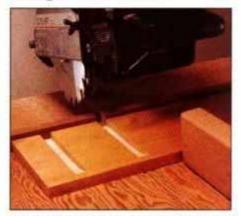
S Install dado blade in radial-arm saw and make initial cut through new fence. Use resultant notch to align work.



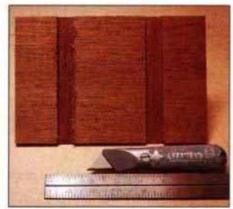
11 When cutting dadoes on table saw with dado blade, mark exact cut position on table insert to aid in alignment.

move the remaining waste with successive passes.

If you experience grain tearout along the edges of the dado, it may be because of a misaligned motor housing on a radial-arm saw or a misaligned arbor assembly or fence on a table saw. However, some species of wood are particularly prone to splintering. With these types of wood, use a straightedge and a utility knife to score along the dado cutlines before making the cut (Photo 12).



To cut blind dadoes on a radial-arm saw, clamp a stopblock to the saw table. Motor housing contacts block to stop cut.



12 For woods that are prone to splintering, use a utility knife to score the shoulder cutilnes before cutting dado.



13 Build an L-shaped jig and attach it to saw base to give extra support when making rabbet cuts from stock edge.



14 Use a rip fence accessory to guide portable circular saw when making rabbet shoulder cuts parallel to the grain.

With the work held end up in the vise, hold the side of the jig against the face, adjust the saw position so the blade is aligned correctly and

remove the jig and use a guide strip clamped across the workpiece to make the shoulder cut that removes the waste. You can use the same L-shaped platform jig for cutting rabbets with the grain. However, use a rip fence instead of the guide strip to make the shoulder cut (Photo 14).

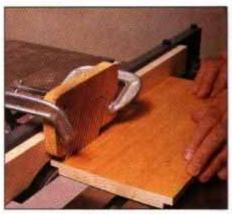
Routing small rabbets is best done with a piloted rabbet bit. Bits with an interchangeable bearing allow you to vary the width of the rabbet up to about 3% in. Solid-pilot bits are also available. To use a piloted bit, simply hold the pilot against the edge of the work while making the cut (Photo 15). If the cut is short, clamp scrap stock next to the workpiece to support the router base. To rout wider rabbets, use the router guide fence or a guide strip and an ordinary straight bit.

To cut a rabbet on the long edge of a board using a table saw with a standard blade, first set the blade height for the depth of the rabbet and make the shoulder cut with the stock



15 For fast rabbeting along straight and contoured surfaces, use a router and a rabbeting bit with ball-bearing pilot.

face down on the table. Next, reset the fence so the distance from the blade equals the depth of the rabbet less the stock thickness. With the workpiece on edge, make the second cut. Always arrange the cut so the waste falls on the open side of the blade. For a faster job, use a dado



16 Use a wooden auxiliary fence when cutting rabbets on a table saw with dado blade. Featherboard holds stock down.

blade mounted in the table saw and an auxiliary wooden fence (Photo 16).

For rabbets on narrow stock and most crossgrain rabbets, use the miter gauge to guide the work. With a standard blade, make several passes to remove the waste. Or, use a dado blade to complete the cut in one pass.

Combination Joint

This combination dado/rabbet joint is often used to secure drawer sides to the front panel in lieu of dovetails. In drawers, it provides additional mechanical strength and glue surface area over an ordinary rabbet joint. This is because of a short, locking tongue that extends from the inside surface of the drawer front panel into the sides (see lead photo, bottom left). As with an ordinary rabbeted front panel, the joint hides the endgrain of the drawer sides. Because this joint demands precision, it's best to do the job on the table saw.

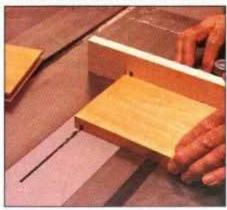
Begin by cutting a groove in both ends of the front panel. Use a dado blade to make the cuts, and guide the workpiece with a jig that straddles the table saw fence. Secure a vertical stop to the back of the jig to hold the wood perpendicular to the table. Clamp the workpiece to the sliding jig for stability.

Adjust the dado blade cutting width so that the workpiece thickness less the cutting width is no less than twice the thickness of your standard-blade saw kerf. Set the depth of cut to be slightly greater than the thickness of the side pieces. Then, adjust the fence for a centered groove and make the cut in each end (Photo 17).

Next, hold an end of the front panel against each side piece to mark the positions of the small dadoes. Align the inside of the front tongue with the end of the side piece, and mark the dado with a sharp pencil (Photo 18).



17 Begin combination joint by cutting grooves in end of the first workpiece. Clamp work to Jig that straddles saw fence.

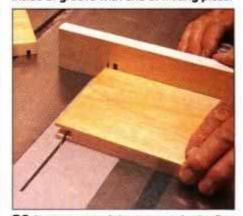


19 Cut narrow dado on second piece with standard blade. Auxiliary fence on miter gauge reduces splintering.

Install your standard blade in the table saw and cut the small dadoes to a depth of about one-third the stock thickness (Photo 19). Finally, cut the rear tongues on the front panel pieces



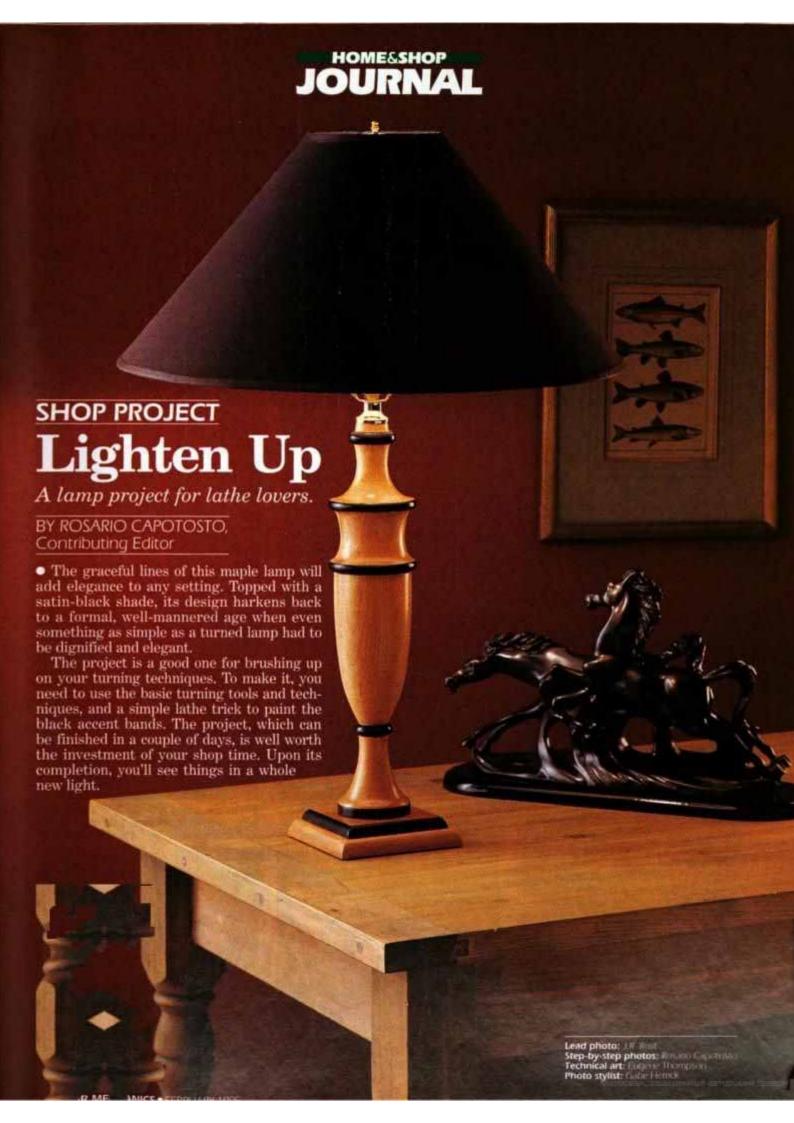
18 Use the grooved piece to lay out narrow dado in second mating piece. Align inside of groove with end of mating piece.



20 Shorten one of the tongues in the first piece so its length matches the depth of the dado in the second piece.

to match the depth of the small dadoes (Photo 20).

After the joint is assembled, trim the thin exposed endgrain of the front panel flush with the sides.



Making The Blank

The turning blank is made by gluing and clamping two pieces of stock after a groove is cut down the center of each piece. This creates the hole for the pipe and power cord. Start by cutting two pieces of 12/4 stock (2¾ in. thick × 20 in. long × 4¼ in. wide). Use a dado blade to cut a ¼-in.-deep × ½-in.-wide groove through the center of the inside face of each piece (Photo 1).

Bore holes for alignment nails, one at each end, in the waste area of each workpiece using a 364-in.-dia. drill bit. Use 3-in.-long 10d finishing nails for alignment. Drive the nails so their heads stand slightly above the surrounding surface. This will make it easier to remove them after the glue has set.

When you clamp each half of the turning blank together, glue will run into the hole in the blank's center. If left there, the glue will harden and prevent the lamp pipe from being inserted. To prevent this, make a ½ × ½ × 24-in.-long ram cut from scrap wood. Also cut two 3-in.-long filler blocks for plugging the hole ends. The blocks permit the work to be mounted on the lathe centers.

Apply glue to both surfaces, then insert the alignment nails. Leave



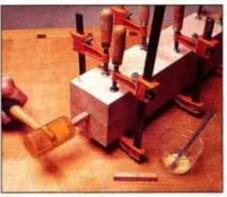
1 Use a dado blade in the table saw to cut the groove in the center of each half of the turning blank.

some of the nailhead exposed so it can be removed later. Next, use the ram to clean the glue out of the hole (Photo 2). Follow this by gluing in the filler blocks (Photo 3). When the glue has set, remove the alignment nails. Next, square the block so it is 4¼ in. wide on each side. Then use the table saw or band saw to cut 45° chamfers at each corner in preparation for turning. Also, cut the excess off the filler blocks.

The next step is to draw the fullsize profile of the lamp by enlarging the grid on the drawing. Include the sizing groove marks, and number them in sequence to avoid confusion.



2 Push a ramrod down the center of the turning blank. This pushes out the glue that has squeezed into the hole.



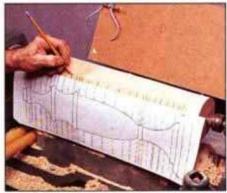
3 Tap short filler blocks into the hole in the center of the blank. Trim the blocks flush after the glue has set.

Turning The Lamp

The first turning step is to make the roughing cut to form the cylinder. Mount the blank between the lathe centers, and run the lathe at low speed. Using a gouge, start the roughing cut near one of the blank's ends, and continue the roughing cut right off its opposite end. To remove lots of material quickly, roll the gouge in the direction of the feed to produce a cutting action. For lighter cutting, hold the gouge perpendicular to the blank to produce a scraping action.

Now tape the drawing to the roughed-out cylinder, and transfer the locations for the sizing grooves by marking with a pencil (Photo 4). Next, remove the drawing and mount it on a board positioned behind the lathe for easy visibility and reference.

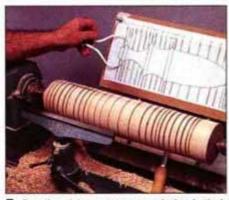
Hold an outside caliper against the drawing, and adjust the caliper to the diameter. Push a parting tool into the blank to cut the sizing groove, and check the groove's depth using the caliper (Photo 5). The diameter of the turning is kept about ½ in. oversize at each groove. The turning will be finished to exact size later in the turning process. Widen each groove slightly when making deep cuts to prevent the tool from overheating (Photo 6).



4 Rough cut the turning blank into a cylinder with a gouge, and tape the drawing to it. Mark sizing-groove locations.



6 A parting tool can get quite hot when cutting deep sizing grooves. Widen these grooves to avoid overheating the tool.



5 Cut the sizing grooves and check their depth with a caliper. Note that the drawing is positioned so it can be easily reached.



7 The gouge quickly removes waste between the sizing grooves. Once the waste is removed, the turning is roughly formed.



Use the round-nose chisel to dress concave curves. Move the chisel in an arc by pivoting it against your thumb.



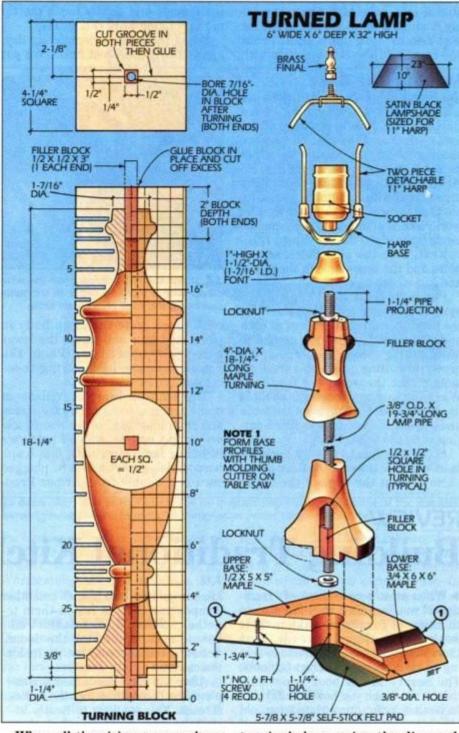
9 The diamond-point chisel forms smallradius beads. The convex curves can be formed with this tool or a skew chisel.



10 Sand concave areas with sandpaper backed by a flexible pad. Work the strip in a shoeshine fashion on convex areas.



11 Run the lathe at low speed, and use a foam brush to apply acrylic paint on the beads. Steady the brush with both hands.



When all the sizing grooves have been cut, the contours of the turning are nearly formed. The basic form emerges after you remove the waste between the grooves.

Use the gouge for heavy stock removal (Photo 7), and use the roundnose chisel to form concave contours (Photo 8). Pivot the chisel with your thumb to swing the tool in an arc. Next, use the diamond-point tool to form the bead profiles (Photo 9), and use the skew to cut the large convex bulb. The bulb can also be shaped by scraping with the diamond-point chisel.

Cut the 11/4-in.-dia. tenon on the

turning's base using the diamondpoint tool, then switch to the skew chisel to true the tenon sides parallel.

Increase the lathe speed to 2400 to 3000 rpm for sanding. Start with 120-grit abrasive paper and then work through 150-, 180- and 220-grit abrasive papers. Wrap a strip of sandpaper around a flexible pad to work concave curves (Photo 10). Hold the strip across the turning, shoeshine fashion, to sand convex curves.

After the turning has been sanded, paint the beads, which are called accent bands after they are painted. Use black water-based acrylic paint, avail-

able at arts and crafts stores, and apply it with a 1-in.-wide foam brush for best results. Run the lathe at about 350 rpm, hold the brush steady with both hands and lightly touch the tip to the rotating work (Photo 11).

When the paint is completely dry, apply the clear topcoat finish. We put on three coats of Deft Semi-Gloss lacquer. This is a brushing lacquer which doesn't require sanding between coats.

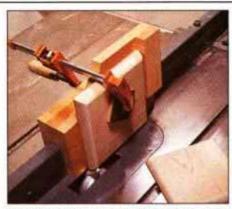
Making The Base

Cut both base pieces to size, then use a %-in.-dia. brad point bit to bore the lamp cord hole in the edge of the lower member. Bore this hole before shaping the edge. Note that the edges do not form a quarter round but instead form an elliptical shape. They are created with a thumbnail molding cutterhead on the table saw. The workpiece is clamped to a shopmade tenon jig to make the cut (Photo 12).

Next, bore the pilot holes, screwholes and the tenon hole in the upper and lower base pieces.

Put aside the base while you remove the turning from the lathe. Use the parting tool to cut grooves at each end of the turning. Be very careful to avoid cutting completely through the groove or cutting it to such a small diameter that the workpiece fractures. When the parting diameter is about ¾ in., remove the turning from the lathe and use a small handsaw to finish cutting away the waste.

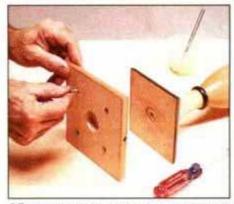
Finish the lamp body by boring a 3-in.-dia. hole through the filler plugs. Now, paint the edge of the upper



12 Shape the elliptical edge on the base pieces with a molding cutter in the table saw or cut the edge on a router table.

base piece, glue the lamp body in place, and glue and screw the lower base to the upper base (Photo 13). Finish the base by applying three coats of the lacquer finish.

The lamp hardware is available at home centers, some hardware stores and from most mail-order woodworkers' supply outlets. A kit of hardware including lamp pipe, nuts, font (cap), harp, finial, socket and 8-ft. plugged cord is available from Armor Prod-



13 Paint the edge black on upper base piece. Attach lower base to it with glue and screws, then apply finish to both.

ucts, P.O. Box 445, East Northport, NY 11731. Order Lamp Kit No. 1093. It costs \$11 postpaid.

Next, apply a square of self-stick felt to the base. This is available through woodworking catalogs and hardware stores. Although we couldn't locate a mail-order source for the lampshade (shades are easily damaged in shipping), it shouldn't be very difficult to find one at a lighting showroom.

REVIEW

Building Traditional Kitchen Cabinets

• When most people think of "traditional" woodworking, they are usually thinking of furniture making. This book makes clear, however, that there's a lot of traditional woodworking to be done with kitchen cabinets. The beauty of this book is not only that it can teach you how to build cabinets that look appropriate in an old house, but also that it can teach you a great deal about kitchen cabinets, in general, along the way. For that matter, you can learn quite a bit about general woodworking from this book.

It starts off with a good discussion of kitchen design principles and how to apply these design principles to your kitchen.

From there, it shows you how to lay out kitchen cabinets in an empty space and how to transfer that layout information to the materials you will use to build the cabinets. It's the most thorough discussion of woodworking layout we have seen.

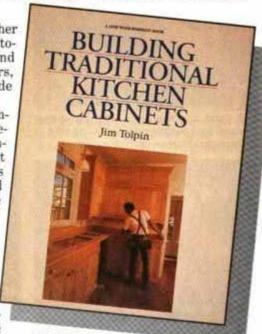
The book then explains how to cut

kitchen cabinet face frames and other components, how to fasten them together so they form a cabinet and how to make and install the doors, drawers and shelves that go inside the cabinets.

After the aforementioned is complete, the book comes into the homestretch. You see how to neatly install the cabinets. It doesn't neglect the fact that these components have to fit around plumbing and electrical services. You also see how to trim the cabinets, how to finish them and how to build and install a plastic laminate counter.

The full scope of this review can't really do this book justice, since the book is so well prepared and dense with good information. We can conclude, however, by saying that if it left something out, we don't know what it is.

Building Traditional Kitchen Cabinets costs \$19.95 plus \$3 for shipping from the Taunton Press, 63



S. Main St., P.O. Box 5506, Newtown, CT 06470, or call (800) 888-8286.

-Roy Berendsohn

Homeowners Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Ice Dams

Many homes in the mid-Atlantic region experience property damage because of wall leaks resulting from thick ice in the gutters. I heard that some new homes have gutter heating elements. Are they available for existing homes?

ALBERT GONZALEZ

BERKELEY HEIGHTS, NJ

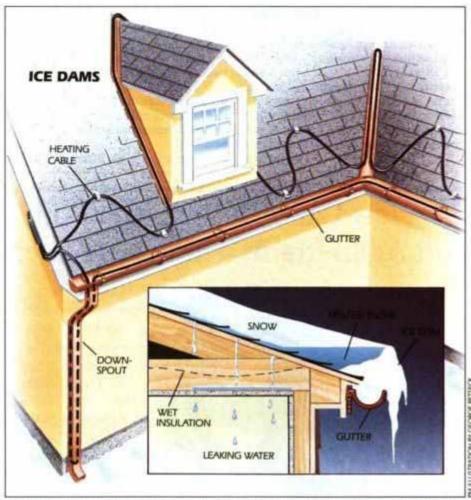
The problem that you refer to is called an "ice dam." Because of the severity of the winter last year in the Northeast, many homes that never had roof leakage resulting from ice dams suffered considerable water damage. Ice dams begin when a layer of snow next to the roof melts. When this water freezes, a dam is created that causes further melted snow to accumulate in a pool. Pitched roofs are designed to shed water, not to protect against standing water. As the melted snow accumulates, the water backs up under the shingles and leaks into the house.

A fairly common practice for avoiding ice dam problems is to have the snow removed from the roof. In some areas, roofers do this work. Although this is a recurring expense, it may be preferable to annually repairing interior drywall and painting.

Another method is to use electrical heating tapes along the eaves, valleys, gutters and downspouts. This may not solve the problem completely. However, it is somewhat effective. The heating tapes (also known as de-icing cable) reduce the ice dam buildup by creating heated channels that allow water to drain into gutters and downspouts.

Two companies that manufacture roof de-icing cables are: Easy Heat Inc., 10 Executive Dr., Farmington, CT 06032, (800) 523-7636, and Raychem Corp. (see the next question). You can contact these companies for information on heating tapes and the name of your nearest distributor.

One method used when houses are built, or when they are reroofed, is to install Grace Ice and Water Shield along the lower roof edges. This is a rubberized polyethylene membrane with an adhesive backing. It is installed from the edge of the roof deck to at least 2 ft. inside the wall line of



ice dams often lead to roof leaks. The ice may actually push up the edge of the shingles, allowing melted water to enter, or it may enter under curied and cupped shingles.

the building. To find a distributor of Grace Ice and Water Shield, contact: Grace Construction Products Co., 62 Whittemore Ave., Cambridge, MA 02140; (800) 472-2365.

Frozen Sewer Line

Our sewer line, from the house to the 1250-gallon septic tank, froze. We had the tank pumped, and the sewer line opened using steam. But it closed up again. To prevent freezing in the future, can the pipe be dug up and wrapped with heating coil and in some way be insulated?

ANONYMOUS ST. CLOUD, MN

Wrapping the sewer pipe with heat tape and then covering it with a jacketed insulation is an effective way to prevent an ice buildup that clogs the interior of the sewer pipe. The Raychem Corp., 300 Constitution Dr., Menlo Park, CA 94025, has a number of different types of heat tapes. The company has different tapes for wet and dry conditions and for metal and plastic pipe.

The people at Raychem told me

you should use their XL-Trace System. Call the company at (800) 542-8936 for design information or the name of the nearest supply house. In order to determine the number of coils per foot of pipe, and the length of heat tape needed, you need to know the pipe length, its diameter and the approximate temperature to which the pipe will be subjected.

Paint Tile

Is it possible to paint ceramic tile that is used in a bathtub/shower area? We recently installed new flooring, sink top and vanity in our bathroom and now the orchid tile (circa 1960s) looks terrible.

MYRA K. MATTHEW MONTOURSVILLE, PA

I'm sorry to tell you that there is no way to permanently change the color of tiles by painting them, especially tiles located in a bath area. An epoxy paint will form a reasonable bond with the glazed surface. However, after repeated cleaning, which is usually necessary to remove mildew and soap scum, the surface will begin to wear or peel.

GFCI Vs. Circuit Breaker

Our house is conventionally wired with 3-wire Romex, a 200-amp service panel and circuit breakers. Over the last 28 years, there have been some electrical modifications to the house. There is a duplex outlet serving a washing machine (a possible lethal shock hazard) that apparently is not protected by a circuit breaker—at least with every breaker switched

OFF this outlet is still energized. The wiring of the duplex outlet itself is correct: a black wire, white and ground are present, but somehow it is not connected to a circuit breaker.

If I replace the present outlet with a Ground Fault Circuit Interrupter (GFCI), will this give the outlet the same or better protection as a circuit breaker?

E.A. CORFAR

ST. PETERSBURG, FL

A GFCI outlet and a circuit breaker serve different functions and are mutually exclusive. The only thing these devices have in common is that when they trip, they open the circuit. The GFCI's function is to prevent a fatal electric shock. It will trip (open the circuit) in a fraction of a second when there is an imbalance in the current between the "hot" and "neutral" lines that is as small as 5 milliamps.

The function of a circuit breaker is to provide over-current protection and thereby prevent a fire. The typical appliance circuit will trip when the current exceeds 20 amps. However, if there is no imbalance in the circuit, an excessive current will not

trip the GFCI circuit.

A little knowledge can be a dangerous thing, as demonstrated by the person who modified your electrical system. All electrical appliances must have over-current protection, and the lack of it is a definite fire

Installing a GFCI outlet for your washing machine for shock protection is worthwhile. However, some GFCIs might trip every time the motor is activated. To prevent this type of nuisance tripping, the Leviton Manufacturing Co. indicated that you should get the Hospital Grade GFCI outlet rather than the regular commercial grade. The catalog number of this part is 6598-HG, and it's available at electrical supply stores.

Damaged Thermopane

Is there any way an insulated glass window can be repaired when the seal has broken, and moisture has gotten in between the panes? I'd like to repair it rather than replace the entire window.

ROSE A. PREY

OGLESBY, IL

This is a frequently asked question. Unfortunately, the problem cannot be corrected by the homeowner. In many cases, not only is there moisture between the panes, but there is also a discoloration that obstructs visibility through the pane. Even with this condition, the window will still serve an energy-saving function. It is more effective than a single-glazed window and is probably comparable to a storm window.

Service Tip: Water Heater Timer

Installing a timer on your electric water heater can cut your utility bill

Q: How Can A Mattress Be Both Soft And Firm At The Same Time?

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by preventing the appliance from heating water when there is no demand for it.

To understand this, some background is helpful. Whether or not a water heater can supply an adequate amount of hot water will depend on both the capacity of the heater and the amount of hot water generated in one hour, known as the recovery rate. An electric water heater has a low recovery rate, generally on the order of 18 gallons per hour. As a result, in order to supply adequate hot water, the tank capacity is usually a minimum of 52 gallons and often can be as large as 80 gallons.

On the other hand, an oil-fired water heater can supply a comparable amount of hot water with a 30-gallontank. These appliances have a high recovery rate, often on the order of 80 to 120 gallons per hour.

Homeowners who have electric water heaters can save energy and money by installing a timer that turns the water heater off during periods when hot water is not needed. The water heater will heat the water during the times of day when it is needed, such as for morning showers and evening dishes. The timer prevents energy from being wasted on storing a large quantity of hot water. Thus it helps the water heater match supply to demand.

A study conducted by the Illinois Institute of Technology showed that this approach can reduce the cost of heating water by 26%. Electric water heaters are among a household's biggest electricity users. In many cases, the timer could pay for itself in less than one year.

We know of two companies that make electric water heater timers, though there are almost certainly others. They are: Intermatic Inc., Intermatic Plaza, Spring Grove, IL 60081, and First Alert, 780 McClure Rd., Aurora, IL 60504.

Intermatic's residential electric water heater timers cost about \$25. They are sold at hardware stores, home centers and electrical supply houses. First Alert's digital timer costs about \$35 at home centers.

Gas Heat Roundup

If winter weather has convinced you that it's time to replace your old natural-gas furnace or boiler, send a note to the American Gas Association and ask for: "Buyer's Guide: Efficient Gas Space Heating Equipment." This excellent booklet is a summary of modern gas-heating appliances. It discusses high-efficiency furnaces and

combination water heater/space heating systems. It also provides worksheets to calculate the payback period when you buy a furnace.

The AGA also recommends that you hire a qualified contractor or authorize your utility company to check your heating system once a year.

However, you can do the following yourself:

1. Remove dust or lint from vents

and registers.

2. Clean or replace the air filter.

Visually inspect your furnace flue for cracks, gaps, condensation and rust.

 Check that the burner is firing with a bright blue flame. A yellow or orange flame can be a sign of incomplete combustion.

5. Oil the blower and pump motors that require it (not all do).



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HOME&SHOP III JOURNAL

For the pamphlet, send a stamped, self-addressed, business-size envelope to: American Gas Assn., 1515 Wilson Blvd., Arlington, VA 22209, Attn: Consumer Information Dept.

The National Propane Gas Association also recommends that you have your propane system checked once a year by a service technician. It refers to this as a Gas Check. The association offers a free pamphlet explaining what the technician checks for and another pamphlet that pitches the advantages of propane heat. Both are available by calling (800) 457-4272 or writing: NPGA, 1600 Eisenhower Ln., Suite 100, Lisle, IL 60532.

Regarding winter rigors, the association says you should do the following to keep your propane gas tank and

appurtenances trouble free:

1. If your area gets a lot of snow, use a protective cap or dome above the tank to keep snow and ice off the regulator, relief and fill valves. Systems with more than one regulator should be checked to make sure that the exposed regulator vent faces down to keep out moisture.

2. If the system is not covered by a dome, carefully brush snow from the

tank, piping and valves.

3. Check regulator vents to be sure they are free of condensation. Frozen condensation can block the vent and cause the regulator to malfunction. If you find the vent clogged, contact your propane supplier.

4. Clear snow in a 4-ft.-radius around intake and exhaust vents for any propane-fired appliance, such as a furnace, water heater or clothes dryer. This prevents high winds from funneling into the vents. Check that the vents are clear of snow and ice.

As for space heaters, the NPGA

recommends the following:

1. Schedule a yearly checkup by a qualified service technician. The technician should clean the control compartment, burner and circulating air passageways.

2. Maintain adequate clearances around the appliance. A space heater should have a 6- to 12-in. air space on both sides, 4 to 12 in. of space above and at least a 36-in. space in front.

3. If the heater is in the garage, it should be mounted where it won't be backed into or hit accidentally with a car door. -R.B.

DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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

Humidifier Maintenance

 Humidifiers either use one of several types of water pads, or they use other methods to create water vapor (ultrasonic waves, heat



APPLIANCE CARE TIP

coils that produce steam, or a spinning impeller).

The most popular types of humidifiers are those that use a water pad. The pad may be stationary-a wick-or it may rotate through a water reservoir. Rotating-pad humidifiers require the most maintenance because they have the most moving parts, but the procedures here apply to humidifiers generally.

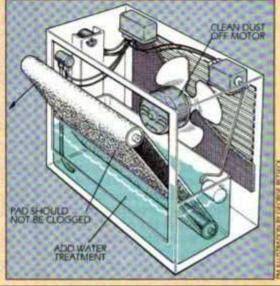
A common problem with rotating-pad humidifiers is that dust collects on and around the motor. You need to clean out the motor once a year using a vacuum cleaner or a shop vacuum with a crevice attachment. Vacuum the

dust out of the motor.

Also, if oil ports are visible on the motor, you can add two to three drops of Three-In-One oil. Be sure to use the oil in the blue-and-white can. The type in the red-and-white can is used for sewing machines, clocks and fishing reels. Next, check the belts and pulleys and replace any part that looks worn. Next, clean or replace the air filter.

Finally, if the water pad is clogged with mineral deposits, it should be replaced. Also use humidifier water treatment. This is sold in bottles at smallappliance repair shops.

-Sterling Frey



REVIEW **Appliance** Repair Book

This appliance repair book does something that few books of its kind do: It zeroes in on identifying a problem and fixing it. It doesn't give you background on how electricity works or the fine points of appliance repair. It assumes you have a working knowledge of electricity and that you aren't interested in becoming an appliance repair technician.

It approaches repair jobs this way: Homeowners want to know quickly whether a repair is within their means or whether to call a technician. Because of this, the book examines only basic problems and basic repairs. You can test quickly for this stuff, and if it looks like a complex repair, you can call a technician.

The book covers water heaters, washers, dryers, refrigerators, ice makers, dishwashers and electric ranges. If that sounds like a lot to cover in a 130-page book, it is. Still, it successfully plays the odds that, given the similarities among appliances, you'll be able to do the job armed with some brief diagnostic and repair information. Even if it

won't enable you to do every repair job, you should be able to handle many, and because it costs only about \$11, the book will pay for itself with the first repair.

The book's diagnostic and repair procedures are shown in black-and-white drawings with important parts pictured in aquamarine blue. Each repair is divided into diagnostic procedures for one or more malfunctions, followed by explanatory text on

how to replace the part. To make the repair process as easy as possible, the drawings are large, and the book has a lay-flat binding, so it will stay open when you press it flat, allowing you to glance at the book as you go. No book can make appliance repair fun, but at least this one makes it easier.

The All Thumbs Guide To Repairing Major Home Appliances is sold at bookstores or through McGraw-Hill, Blue Ridge Summit, PA 17294, Attn: Customer Service, or call (800) 822-8158.

—Roy Berendsohn

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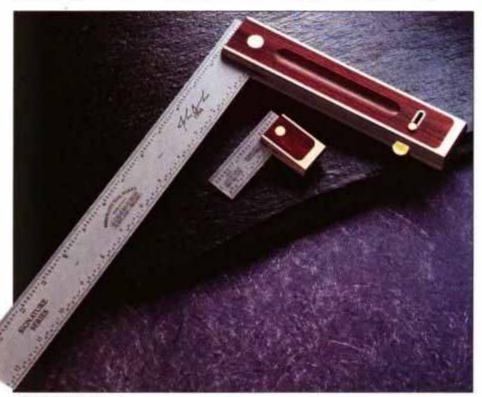
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NEW TOOLS

Problem Solvers

Today's tools aim at greater utility through design innovation and refinement.

BY THOMAS KLENCK, Associate Home Improvement Editor



Square Deal

When almost square isn't good enough, Bridge City Tool Works has the answer. The new AS-3 (3-in. blade, \$52) and AS-14 (14-in. blade, \$129) try squares combine factory-calibrated .001-in. accuracy and superb craftsmanship with a patent-pending adjustability feature—you can easily recalibrate the tools with an Allen wrench. In addition, the blades are graduated for accurate measurement from the inside and the outside of the handle. Both squares are available directly from the manufacturer. For more information, write Bridge City Tool Works Inc., 1104 N.E. 28th Ave., Portland, OR 97232.



Measuring By Laser

The Disto handheld laser meter brings new levels of accuracy and convenience to routine measuring and space calculations. The laser beam can be visually targeted to measure distances up to 100 ft. with an accuracy of ½ in. at maximum distance.

In addition to linear measurement, this digital-display tool handles addition and subtraction and even calculates areas and volumes. With a suggested retail price of \$1400, Disto isn't exactly aimed at the homeowner's market. However, it's ideal for medium-scale applications in the building trades. It's sold by laser-equipment dealers and by industrial suppliers. Contact Sonin Inc., Milltown Office Park, Suite B201, Route 22, Brewster, NY 10509.

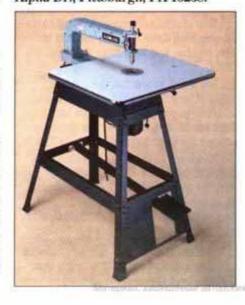


Shock Treatment

Not every improvement is electronic or expensive. The Vaughan Steel Eagle hammer's claim to fame is a rubber/hickory Shock-Blok that fits in the head. The manufacturer claims it helps to keep shock waves from reaching the handle. The integral steel handle is air cushioned for further vibration damping. The Steel Eagle costs about \$20 at home centers and hardware stores. Contact Vaughan & Bushnell Manufacturing Co., P.O. Box 390, Hebron, IL 60034.

Stationary Router

Pin routers have long been favorites in professional woodworking shops. Now Delta offers a version to meet more modest requirements. Model No. 43-156 features a 3-hp motor -mounted under a 24 × 36-in. tablethat drives both 1/4- or 1/2-in. collets. The arm has a 20-in. throat capacity. Three double-end guide pins supply six pin diameters ranging from 1/8 to 1/2 in. Guide pin travel is 1 in., and cutter travel is 2½ in. A foot pedal controls both cutter and guide pin travel. The Delta pin router is available through woodworking tool distributors and costs about \$1600. Contact Delta International Machinery Corp., 246 Alpha Dr., Pittsburgh, PA 15238.



HOME&SHOP **JOURNAL**

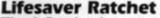
Two From Makita

If you've been watching the plate joiner market and found yourself wondering when Makita would jump on the bandwagon, well, wait no longer. The new model No. 3901 (about \$240) has all the bells and whistles, including six slot-depth settings, 0° to 90° fence, rack-andpinion adjustment and dust collection. It

is powered by a 5.6-amp motor and features an easy-open cover for quick blade changing. For something completely

different, Ma-

kita has introduced a Backpack Dust Collector, model 420S (about \$480). Designed to work with sanders, hammer drills and other types of power tools, this 42.2-cu.ft.-per-minute, 6.4-pound vac goes where you go for more convenient operation. Both tools are available at tool outlets. Contact Makita U.S.A. Inc., 14930 Northam St., La Mirada, CA 90638.

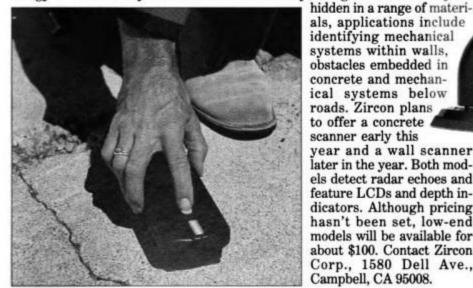


The O-Ratchet bypasses the need for deep sockets by incorporating a hole in the ratchet handle head. To make it work, the system uses hollow hex-drive sockets instead of the squaredrive type. A metric and English set with an adapter for square-drive sockets, hollow extension and spark plug inserts costs about \$70. Smaller sets are available. The O-Ratchet is sold at all Sears stores and selected hardware stores. Write to O-Ratchet Inc., 512 W. Hickory, Suite 100, Denton, TX 76201.



Hot Off The Press

Still in development at press time, Zircon's radar scanners bring defense technology to homes and job sites around the country. Designed to detect objects



als, applications include identifying mechanical systems within walls, obstacles embedded in concrete and mechanical systems below roads. Zircon plans to offer a concrete scanner early this year and a wall scanner later in the year. Both models detect radar echoes and feature LCDs and depth indicators. Although pricing hasn't been set, low-end models will be available for about \$100. Contact Zircon Corp., 1580 Dell Ave.,



Corner Clamp

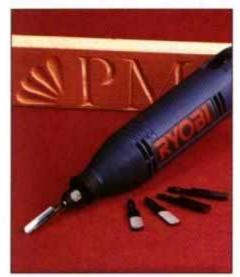
The task of clamping picture frames square is simplified with the Clamp Mate from Adjustable Clamp Co. It's comprised of four extruded aluminum rails and four heavy-duty plastic jaws. The unit can handle work from 5×7 in. to 26×30 in. in size, and it folds up for easy storage. The Clamp Mate (model 88094) costs about \$26. For more information, write to Adjustable Clamp Co., 417 N. Ashland Ave., Chicago, IL 60622.

Affordable Detail Sander

One of the latest hot tools is the triangular-pad detail sander. Skil's model 7200 features a 0.5-amp motor and two speeds of 9000 opm (orbits per minute) and

> 13,000 opm. It uses hookand-loop sanding sheets, and the sanding pad is rotatable for maximum abrasive life.

This 2-pound power tool also has a dust-collection port for attaching a shop vacuum. The Skil model 7200 Corner/Detail Sander is available at home centers, hardware stores and other power tool outlets, and it has a suggested retail price of \$68. For more information, write to S-B Power Tool Co., 4300 W. Peterson Ave., Chicago, IL 60646.



Power Carving

For those who thought carving was one of the last vestiges of hand-tool woodworking, Ryobi now offers its new model DC500 Detail Carver. We tried this tool and found that it replaces muscle work with effortless stock removal.

The tool comes with five carvingtype bits. A compact 40-watt motor drives a bit—in an oscillating backand-forth motion—at two speeds: 10,400 and 12,500 strokes per minute. The higher speed is for rapid stock removal, and both speeds operate very smoothly. The Ryobi Detail Carver costs about \$70 and is available at home centers. Contact Ryobi America Corp., 5201 Pearman Dairy Rd., Anderson, SC 29625.



Neat Cutter

Vermont American's CleanCutter reduces the hassle of cutting thick insulation. It features twin spring-steel runners and a knife that takes utility-knife blades. The runners compress the insulation while it's being cut. This not only makes the work easier, it reduces airborne fibers and does a better job on paper-backed batts. Available at hardware stores and home centers, the CleanCutter costs about \$20. For more information, write to Vermont American, P.O. Box 340, Lincolnton, NC 28093.

Milwaukee Duet

Milwaukee claims its new 12-volt cordless hammer drill is the most powerful tool of its kind. It features a 1.7-amphour battery pack that drives the bit at 0 to 1600 rpm and 0 to 3200 bpm (blows per minute). The motor has replaceable brushes, and the tool comes with a keyless chuck. As model 0421-1,



it's available with a battery pack and charger, and it costs about \$220.

The 15-amp model 6494 10in. compound miter saw handles bevel cutting from -3° to 50° and miter cuts between 51° left and 59° right. It boasts a base extension on the left for additional work support, and the fence can be reversed to provide clearance for beveling

or maximum support during 90° cutting. The miter adjustment has positive stops at the most common angles and a detent override for locking at in-between angles. The model 6494 compound miter saw costs about \$550 at tool dealers. Contact Milwaukee Electric Tool Corp., 13135 W. Lisbon Rd., Brookfield, WI 53005.

Up Against The Wall

If a bulky motor housing keeps you from power-driving screws and threaded fasteners in tight corners, you'll appreciate the cordless EY 6780CQK Corner Master from Panasonic (about \$370). The business end of the tool features an 8-position pivoting head that keeps an offset bit holder nearly flush with the tool housing. With this design, you can drive a screw or bore a hole as close as \(^{1}\text{6}\text{in}\). to an adjacent wall. The 9.6-volt Corner Master also features a 15-minute recharge, electric brake, 22-stage clutch, variable speed and a \(^{1}\text{4}\text{-in.-hex quick-connect chuck.}\) For more information, write to Matsushita Home and Commercial Products Co., Appliance Products Div., 1 Panasonic Way, Secaucus, NJ 07094.

Clamping With Air Pressure

Instead of using cumbersome clamps and cauls for your next veneering project, you might consider a more high-end approach. The Vacu-Press



utilizes a heavyduty 54×54 -in. vinyl bag and pump to apply 1700 pounds of uniform pressure. It's especially useful on curved substrates. The Vacu-Press costs about \$325 from The Woodworkers' Store. 21801 Industrial Blvd., Rogers, MN 55374.

CAR CLINIC

BY MIKE ALLEN, Associate Automotive Editor

Yield Sign Ahead

I just redid the cylinder head on my old beater. When I went to the manual to look up the cylinder head-stud torque, it called for a really low torque rating, and a degree rating. I had no idea what that meant, so I just used the torque specs averaged from some other engines I've rebuilt. Half of the studs broke while I was tightening them. What gives?

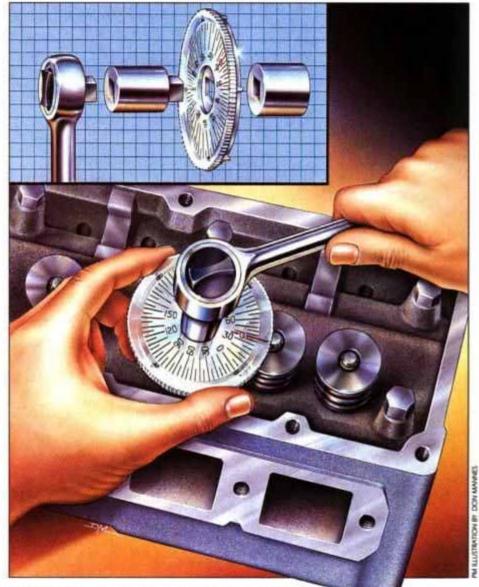
JOHN SMALL KANKAKEE, IL

Your engine, and many modern engines, uses what's called a torqueto-yield fastener. First off, you shouldn't reuse these fasteners. They should be replaced. Some manufacturers say they can be reused once, but unless you are certain they have never been loosened and retightened, don't reuse them at all.

Why replace them? Normally, we tighten a nut, bolt or stud enough to prestress the fastener to some predetermined value. The best way to determine that value is to measure the amount (microscopic amount, at that) that the length of the stud increases as it's tightened. But it's impossible to do that in the field. So we've traditionally approximated the amount by measuring how hard it is to turn the nut. Modern engines ask more of gaskets and sealing surfaces, because they usually have an aluminum head and an iron block with different expansion rates. So the head studs are made to stretch slightly, to just below the point where they yield permanently.

Old-fashioned torqueing isn't accurate enough, as the surface finish of the nut and washer, as well as the amount and type of lubrication on the washer and threads, is too inconsistent. And with the bolt stretched within a few percent of its yield point, sometimes just tight enough is really just a little too tight.

So now you'll see specifications for torque plus angle. Tighten the fastener to a predetermined number



of ft.-lb. torque, a relatively low number at that. Then add another 90° (or whatever is called for) of rotation. The stud will stretch a fixed amount determined by the pitch of the thread.

The inexpensive angle gauge I've illustrated here (from Fel-Pro, a gasket manufacturer) makes that easier, although it's possible to do an accurate job without it. To use the angle gauge, pretorque all the nuts with your torque wrench. The gauge goes on a short extension between the socket and the ratchet. Rotate the outer scale until it reads zero, then hold it stationary with the same hand. Then, in one mo-

tion, turn the ratchet until the inner scale reads the number of degrees desired.

Sludge

I have 46,000 miles on a 1976 Eldorado that's been sitting for several years. Every couple of weeks I start it up and let it run for 10 minutes to charge the battery. It starts and runs fine every time.

A couple of weeks ago I decided to drive it around, so I changed the oil and filter. After I started the engine the oil light came on, and it stayed on for a minute or two. I shut off the engine and let it sit for 10 minutes. I restarted it, but the light stayed on.

and after a minute or so the hydraulic lifters started to clatter.

Two different mechanics have no idea what's wrong. But the service manager at a local dealer tells me I must have used the wrong oil filter, and the minimum charge is \$300.

L.M. HOLLOWAY SWARTZ CREEK, MI

You've got a crankcase full of sludge, caused by running your engine just long enough to get the oil warm, but not hot long enough to boil off the acids and water created when the engine is running cold. The second best way to store a car is to pickle the engine, remove the battery and leave it. The best way is to drive it for 45 minutes or so once a month (see "How To Store Your Car," page 79, Sept. '91).

You may already have damaged your bearings by running them short of oil. Pull the oil pan and valve cover gaskets, and remove as much sludge as possible with a putty knife. Pull the oil pump and flush it with solvent. Install a new filter that you've prefilled with oil, button everything up and refill with 5W-30 oil.

This should get your oil pressure

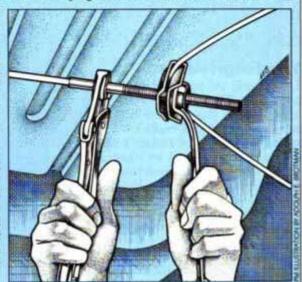
An Arresting Development

 The handbrake on my veteran pickup had lost a considerable amount of its efficacy over the last year or so. This precipitated a manual adjustment of the (ostensibly) automatic adjusting rear drums. No help-although it did seem like they worked somewhat better on the road.

Adjusting the handbrake cable is done by shortening the center of the cable, generally accomplished while lying under a vehicle as mud and rust

flake off into your eyes, nose and mouth. Hardly an appetizing task, compounded by the fact that the nut is also frozen solid to its shaft. This required the application of lots of penetrating oil and a lot more heat from the mechanic's friend, the torch.

Save yourself a lot of trouble later, and coat the threads of any exposed cable connections with Never-Seez or some other antiseize compound whenever you're under the vehicle. Even grease would help, although it washes off more readily.



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back up. You might pull one of the connecting rod caps while the pan is off to look for scoring. At any rate, change the oil again after 100 miles or so, and again in 1000 miles.

Slippery Problem

I'm getting very confused about synthetic motor oils. Now they make blended oils, which is more confusing as to which one I should use. My dealer said that the warranty on my Ranger would be void if I used synthetic oils. Why do they make these oils?

GARY BENKELMAN HAMBURG, NY

In The Beginning, there were conventional mineral-based oils. Then there were high-priced synthetics, most of which promised very extended oil drain intervals. Synthetics are superior oils-but the truth is, most people don't need a better oil. Oil is contaminated by atmospheric dust, wear particles from the inside of the engine, carbon, unburned fuel, water and acids from the combustion chamber. These contaminants need to be removed, and the best way to do that is to change the oil. I've never recommended extended oil drain intervals for this reason.

I do recommend synthetics for hot and cold climates, because the oil is more stable thermally. They are also good for racing, towing and other se-

SERVICE TIPS

 Does your 1993-94 GM J-Car (Cavalier or Sunbird) make a clunking noise as you start away from a traffic light? There's a revised right rear engine mount.

 Many 1991-94 GM cars with Hydra-matic 4T60-E transaxles may experience harsh upshifting caused either by a loose or missing accumulator bushing or by metal shavings in the accumulator valve.

● Some late-model Mazda 626s have been reported to have noisy hydraulic lifters when delivered. This is caused by the sealant used for the oil pan dissolving in the crankcase oil and gumming them up. The fix is to change the oil and filter, and then run the engine at fast idle (2500 rpm) for 10 minutes to flush out the old oil.

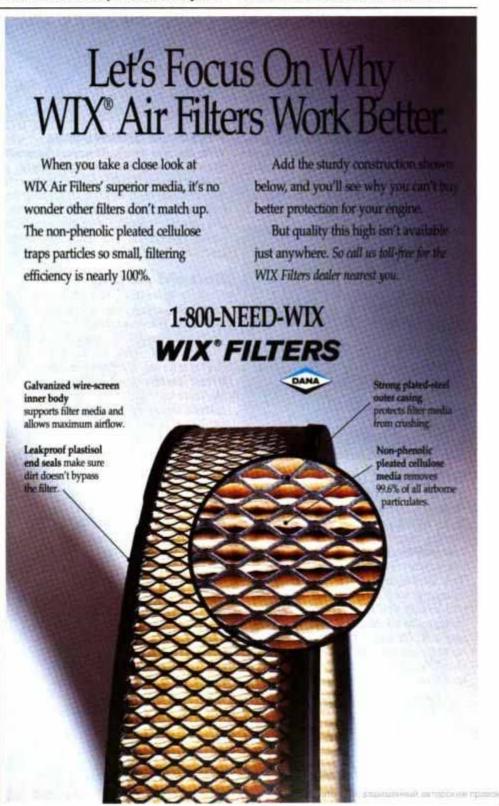
• If your Mercedes-Benz has a problem blowing the ACC fuse when the air conditioner, heated side mirrors and heated windshield washer nozzles are on concurrently, it's no wonder. M-B says it's okay to replace the 15-amp fuse with a 20-amp job. vere service—with regular oil changes.

I admit that at \$4 to \$5 a quart, the temptation to leave a synthetic in a little longer is strong. There's the niche for synthetic blends, which cost more than mineral oils but not as much as pure synthetics. The manufacturers claim most of the benefits of a pure synthetic at about half the cost. And in spite of what your mechanic tells you, any oil that meets the manufacturer's require-

ments (currently American Petroleum Institute SH grade for passenger cars) meets any warranty requirements. That includes synthetics or blends if they carry the SH grade and the starburst symbol.

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.



NEW PRODUCTS

IMPROVE YOUR CAR

Long-Life Battery

There's an old adage in the car battery business: Summer kills batteries, winter merely buries them. Heat and vibration cause the water in battery acid to evaporate and the plates to corrode and disintegrate. Sears' new maintenance-free DieHard batteries -DieHard Gold, Silver and Heat-Handler line—use an enhanced leadcalcium alloy in the battery plates to significantly reduce corrosion and water loss. Redesigned internal construction increases resistance to vibration. The new batteries, available at all Sears Automotive Centers, carry a 7-year warranty and are priced the same as the previous DieHards.



Gripping Clamp

You know what happens when things that are supposed to loosen don't. Your blood pressure rises, you look for the biggest pair of pliers you can find and wind up scratching and gouging whatever you're trying to loosen. The Boa-Constrictor is a universal opening and fastening clamp that will loosen and tighten anything from jar caps to oil filters, pipes, hoses and any odd fittings. The clamp will not scratch chrome or polished surfaces. Boa-Constrictor sells for \$9.95, and is available at auto parts stores. Write

W. Progress Dr., Littleton, CO 80123, or call (303) 973-1011.



Personal Snowplow

With the Farmer's Almanac forecasting an even more brutal winter this year than last, consider this lightweight, easy-mounting and easy-detaching snow-plow a necessity. Made for light trucks, sport/utility vehicles and vans, the Snow Bear uses hidden mounting brackets that bolt to your vehicle with no cutting or welding. The blade sits on a roller dolly, making it easy to position the plow for mounting on the brackets. A remote-control electric winch lift simplifies operation. The snowplow costs \$1198, and is available from Snow Bear Products Inc., 32 Ward Rd., North Tonawanda, NY 14120; (800) 337-2327.

Retrofit Airbag

Nobody questions the effectiveness and safety value of airbags
anymore. However, until now, if
your vehicle didn't come from
the factory with an airbag,
there was no way to get one.
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all that by offering the SRS-40
retrofit airbag system, which includes
sensors, a replacement steering
wheel and the airbag. Application is
vehicle specific, and the system



should be installed by a professional. The SRS-40 system costs \$695, installed. For information on vehicles and location of authorized installers, contact Breed Technologies Inc., P.O. Box 95023, Lakeland, FL 33804; (800) 247-6601.

Fuel Cutoff Switch

Cars may be safer than ever in a crash situation, but fuel spraying from ruptured pressurized fuel lines still poses a real risk of fire, during and after the

crash. While some car manufacturers now incorporate an inertia switch to automatically cut off the fuel pump in a crash, many vehicles still do not have this protection. However, you may now be able to protect your car from this danger thanks to the FIS Fuel Pump Cutoff Switch, which can be mounted in any vehicle that has an electric fuel pump. Easily installed, the switch costs \$69.95, and is available at major auto parts stores. Contact Forecast Trading Corp., 2760 N.W.

63rd Ct., Fort Lauderdale, FL 33309; (305) 979-1120.



SATURDAY MECHANIC

SMOOTHING OUT ROUGH IDLE

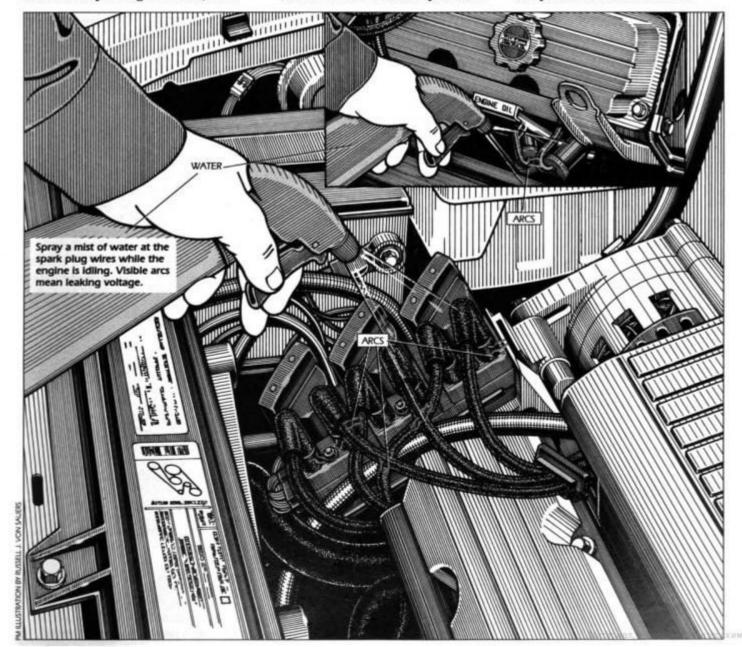
BY PAUL WEISSLER

• You've just handed a young man wearing a paper clown hat your last few coins in exchange for a cup of steaming coffee, which now resides in the cup holder on your dash. You take this opportunity to play that Grateful Dead bootleg cassette tape you found under the seat while bobbing for quarters. Just as you near the tape player, your coffee—shaken to a cappuccino-like froth by the vibration of your violent, roughly idling engine—finally overflows and drips brown, slimy fluid over the Meadowlands concert and your leg. Bummer, man.

When your engine is suffering from rough idle, you may be ready to blame it on the electronics—and you may be right. However, rough idle is a problem that's as old as the automobile engine itself, and although there are many high-tech causes today, there also are many low-tech reasons, like water-logged gasoline. Regardless of the cause of the rough idle, you may be able to trace and correct it with test equipment no more sophisticated than a liquid spray bottle, a piece of heater hose and a pair of sharp eyes.

We don't mean that's all you need.

A good compression gauge (the type with a hose so you can get readings in tight quarters) certainly is helpful, but that should already have been in the Saturday mechanic's toolbox for a long time. A scan tester to read trouble codes also is valuable, although you can get most of the codes with a jumper wire, clip or a low-cost code reader sold for \$20 to \$50 in auto parts stores. A high-impedance (10 megohm or higher) digital multimeter, an assortment of jumper leads and a computer-safe test light—all modest investments—complete the list of essentials.



What's the problem?

One more essential, naturally, is an understanding of what constitutes rough idle. It could be from one cylinder misfiring or from misfiring in all cylinders. It could be the engine shaking because of a mechanical problem.

Start by trying to identify where the problem is. It's likely to be in either the ignition system or the fuel system, or it may be a mechanical or electronic problem. Your first step is determining exactly which area is the culprit. And unless you own one of the few 1994 or 1995 models with the sophisticated OBD-II diagnostics that can actually tell you which is the misfiring cylinder by setting a trouble code, it's your diagnostic problem.

First, take notice of the rough-idle conditions. If the idle is always rough, begin by checking for a computer trouble code, whether the CHECK ENGINE light is coming on or not. (Remember that some problems don't turn on the light.) If there is a trouble code, you should follow the diagnostic trouble tree in the service manual, which should be based on testing with a high-impedance volt-ohmmeter.

If rough idle occurs only after cold start and during warmup, it's likely to be fuel-system related, as engine computers begin to compensate for incorrect fuel mixture once the engine is warm. However, the term "fuel-system related" covers a lot of ground, as you'll see.

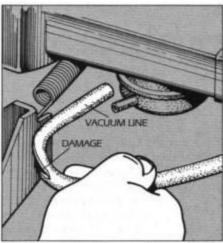
With the hood up, sniff around the engine, and if there's a gas odor, keep that in mind. Look for a leak at the fuel-line connections. Disconnect the vacuum hose from the fuel-injection pressure regulator and see if there's fuel inside, indicating a diaphragm leak in the regulator, which would have to be replaced.

Positive crankcase ventilation (PCV) and the fuel vapor-charcoal canister system are two problem areas where there's a lot of fuel vapor, which could upset idle during moderate ambient temperatures. Whenever there is reason to suspect a rich mixture as a cause, you can temporarily "force" the mixture lean by disconnecting a vacuum hose and seeing if the idle gets any better.

the idle gets any better.

Pull the PCV valve out of its grommet and shake it. If it doesn't rattle, it's defective. It's probably stuck in the open position, allowing fuel vapor flow at idle and thus upsetting the fuel mixture. As a double-check, put your finger over the valve end and you should hear and feel it move.

The fuel vapor system valve also



Chafing can ruin a vacuum hose, causing a vacuum leak and rough idle.

may be stuck open. As a test, disconnect the purge hose (the one with a valve assembly spliced into it) and if the idle stabilizes, the purge valve is likely to be the problem. Refer to a service manual for the how-to-check procedure before you invest in a new part, as it's also possible that a computer system malfunction is involved.

Or some of the fuel injectors may be leaking. Listen to them using a stethoscope or through a length of heater hose. Rest one end of a short piece of heater hose on one injector at a time with the engine running, and hold the other end of the hose to your ear. You should hear the steady-smooth "sewing machine" sound of the injectors opening and closing. If any of the injectors has an uneven sound, or a muffled roughness, it may be leaking. Or you can disconnect the

wiring for a suspect injector (make the disconnect with the engine turned off) and if the idle doesn't deteriorate significantly, that's a strong indication of a leaker.

Lean 'n' mean

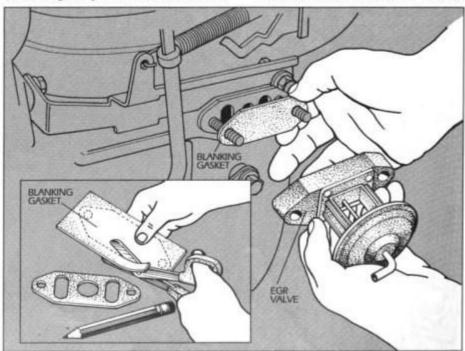
A cold-idle problem also could be caused by a lean fuel mixture, particularly if it occurs at times when the engine is more likely to need a rich mixture, such as in cold winter weather. There are ways to "force" a mixture rich, such as by closing the choke on a carbureted engine or by disconnecting a manifold vacuum hose and carefully metering in some propane on a fuel-injected engine. The latter is a technique to be used only by those familiar with it. If you're not experienced, just look harder to confirm the cause of the problem.

The most common cause of a lean fuel mixture is a leaking vacuum hose. The hose connection may be cracked, or the hose itself may be burned through at a point that is difficult to see. A thorough look, including moving hoses for closer inspection, is your best bet.

Restricted injectors are another possibility. Listen to them with a piece of heater hose or a stethoscope.

Inspect for tears or leaks in any intake air duct with a remotely mounted airflow sensor. Leaks may allow some airflow to bypass the sensor. Any bypass air won't get fuel to match because the computer doesn't know it's there.

A defective thermostatic air cleaner

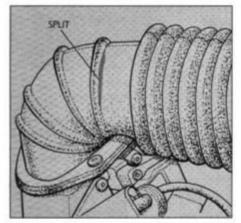


Some aluminum flashing or gasket material can be used to cover over the EGR valve.

can roughen the idle on a carbureted engine. First, see if the hotair hose is connected from the air
cleaner snorkel to the sheetmetal
"stove" on the exhaust manifold.
Next, disconnect the air duct and
probe the snorkel to see if the air
flap is pivoted up to block the cold
airflow. If it isn't, check the thermostatic control operation (if it's
vacuum-operated, a hose may be
loose, the diaphragm unit may
be defective or the thermostatic
vacuum switch may be defective).

It can always be rough

When idle is always rough, and there's no trouble code to guide you for openers, first try to determine if the problem is in one or two cylinders, or throughout the engine. Disconnecting one spark plug wire at a time (or fuel-injector connector if

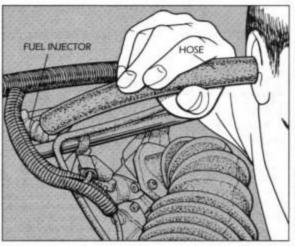


Check the air beliows and pipes for cracks, tears or loose connections.

necessary) is one way. Always make the disconnections with the engine off and use a suitable tool, such as a spark plug wire puller. Each disconnection should produce a significant drop in engine rpm (even if only momentary) and can guide you to the

weak cylinder. If you have a Ford V8, the computer system may have an automatic diagnostic mode that will isolate a weak cylinder.

If you find a weak cylinder, listen to the injector, and if it sounds good, check to see if the spark plug wire is firing, connecting it to a spare spark plug held against a metal part of the engine (use a clothespin or a pair of wooden sticks to hold the wire). If the spark jumps the gap, remove the plug for inspection. If it's fouled, replace the plug. If it isn't, sheek engine compression to



With a piece of heater hose for a stethoscope, listen carefully for a bad or leaky injector.

see if the cylinder itself is mechanically weak, perhaps from leaking valves.

If the plugs and compression are good and the injector sounds okay, it's possible that the plug wires are "leaking" and causing misfire. Spray the wires at each end with water from a washed-out bottle of a household spray cleaner. If you see electricity arcing from one wire to another, that's the problem.

Finally, remove the distributor cap to see if the inside of the cap has black carbon "tracks" or hairline cracks, which can allow the high-voltage spark to avoid the terminal for the correct plug wire.

If the problem seems to be in all cylinders, listen to the idle-speed motor on carbureted engines (and those injected engines that also may have one). If you hear a clicking noise, a tiny gearset in the motor may be chewed up. Or the idle speed may be too low—check with a tachometer and if it is, your service manual should tell you how to reset it.

Or the exhaust gas recalculation (EGR) valve may not be closing, so

the exhaust gas is getting into the cylinders even at idle, when the engine can't tolerate it. EGR circuits vary from car to car, but one basic test you can make is this: Remove the valve and if there are carbon deposits on it, try wirebrushing them off so the valve can close. If there is nothing obvious, check the EGR by installing a blanking plate between the valve and the engine. Blanking plates are available in auto parts stores, or you can make one from a piece of aluminum roof flashing cut to approximate size and installed instead of a gasket. Be sure to remove your blanking plate and repair the EGR system if this really straightens out your idle.

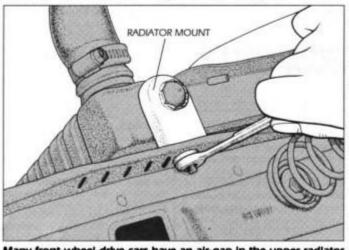
Shake, rattle 'n' roll

The engine may be shaking at idle because accessories and their mounting brackets are loose (tighten bolts with a torque wrench), or the brackets are cracked. Another possibility: bad engine mounts. Modern engine mounts have sophisticated shapes, including air gaps to minimize shake, particularly the inherent shake on transverse 4-cylinder engines. Inspect the mounts, and if you see rubber tears, install new mounts. Also check the "dogbone" engine torque struts on many cars. If you see deteriorated rubber bushings, change the struts. Although they work primarily on acceleration, they also contribute to idle smoothness.

Other potential trouble spots on just about all Japanese cars—and an increasing number of domestics—are the upper radiator mounts. These mounts have rubber absorbers in an "air gap" housing, to absorb engine idle shake. If the air gap is filled with hardened mud (or ice in winter), if the rubber is heat-hardened and cracked

or missing, or if the entire upper mount is damaged or missing, the engine will shake more. And if you have a Chrysler product you should be aware that these vehicles may have "tuned" bushings for the front bumper, so the bumper serves as a shake absorber. If the bumper was replaced after an accident, there's a good chance the proper bushings were not installed.

This basic list of possibilities for rough idle should convince you that expensive electronic diagnostic equipment isn't always the answer.



place the plug. If it isn't, Many front-wheel-drive cars have an air gap in the upper radiator check engine compression to mount that absorbs shake. Check these mounts.



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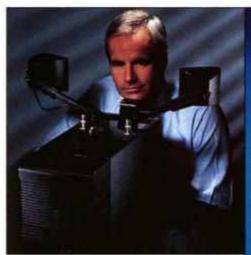
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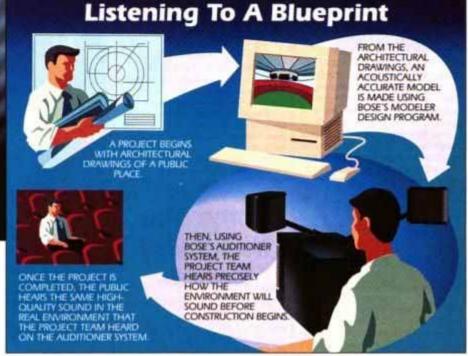
Aural Fixations

BY FRANK VIZARD, Electronics Editor



• Everyone has been disappointed or annoyed with bad sound in public places like airports, stadiums and even concert halls. While architects can let you see how a building will look, they could never anticipate how it will sound. Even with a lot of planning, the results can be disastrous. In late 1992, for example, the German government moved out of a new parliament building after just 24 hours because room acoustics made debate impossible to understand.

Now, however, Bose, the well-known speaker company, has developed a sound tool that probably will be used by building designers everywhere. Called the Auditioner, the product combines a computer software program with a unique personal stereo system. The computer software uses a building blueprint to create an accurate model of how a room or building will sound. The stereo sys-



The Auditioner promises to make public spaces sound better.

tem, which folds into a briefcase for portability, lets you hear the result.

The Auditioner now lets architects examine how structural changes might affect acoustics in public spaces. You can even experiment with different seating arrangements or audience sizes in concert halls and stadiums.

Similarly, the Auditioner can also be used to rectify sound problems in existing spaces. You can instantly hear what happens, for example, if you add some discrete reflective surfaces or dampening materials. Now these changes can be experienced before the manual work begins.

For Bose, the Auditioner is a money-making insurance policy that architects will need. For the rest of us, it means public spaces should be more pleasant sounding in the future.

Read Me A Story

Need an aural fix for those drive times when your compact-disc collection is played out and the radio just isn't doing it for you? Then a new audio subscription service now being developed might be your answer.

Taking the information highway

concept a bit literally is a Cupertino, California, company called Information Highway Media Corp. The company is developing an interesting way of delivering aural entertainment to your ears while you're driving on the highway.

The product is called Listen-Up and it's basically a portable recording device married to a subscription service. Here's how it works.

Each month you would consult a programming guide

Listen-Up connects to a cable TV box.

listing a wide variety of audio material that first appeared in print in newspapers, magazines and books. To make your selection, you would use a





Sound in every direction.

touch-tone phone to dial a processing center. All you have to do is key in the number corresponding to your choices.

Your audio selections are then digitally transmitted via your cable TV system to a small recording device connected to your cable TV box. Since the transmission is digital, it's very quick. About 10 hours of spoken audio can be downloaded in about 6 minutes, for example. Audio quality is actually akin to an FM stereo broadcast.

Once you've received your audio selections, you remove the recording device from the docking bay. You would then use an adapter to play back the material through the cassette well or CD slot on your car stereo system. You can also connect the Listen-Up device to a portable player if you're among those who walk to work or ride public transportation.

Taking a page from the old "Mission Impossible" TV series, the Listen-Up device self-destructs all the recorded material after 30 days. You're then ready for a new round of

recordings.

The rate structure for Listen-Up is similar to cable TV pricing, with costs determined by whether you subscribe to basic or premium offerings. Cost of the hardware is estimated to be about \$250 for the portable unit and about \$500 for a permanent car installation.

Listen-Up is due to be test-marketed in a few cities this year so look for more widespread availability early in 1996.

Radio Recording

You would think that every radio cassette or compact-disc player would have a timer built in so that you could automatically record a program for later listening. What we need is a radio that works like a VCR as far as

time-shifting goes.

Radios with timers seem to be few and far between. One source is an Irvine, California, company called Reel-Talk Inc. (800-766-TALK). Called Reel-Talk, this radio will turn itself on at the designated time and record up to 4 hours of material on a 120-minute cassette. The radio is suitable for a tabletop, being about 6.5 in. square at the base and 12 in. high. Of course, it can double as an alarm clock. List price is \$99, plus \$15 shipping and handling.

A more portable solution is available from Radio Shack. The DX-392 performs the same function and lists

for \$260.

Speaking of Radio Shack, we should bring to your attention a pair of new speakers, the Optimus PRO LX5, being marketed by the store. These small speakers are noteworthy in that they combine a 5-in. woofer for bass reproduction with

a new Linaeum tweeter.

The Linaeum tweeter is not shaped like a traditional cone driver. The tweeter is actually a highly flexible diaphragm that radiates sound in a 360° pattern—as opposed to being highly directional like most tweeters. This makes the speakers very well-suited for situations in which the speakers are placed in the middle of a room, for example. And at \$150 each, they're also a good sound bargain.

Van Notes

You may buy a van more for its ability to transport people and things than a good sound system but there is no need to sacrifice one for the other. Certainly, that's the case with Ford's Windstar.

Our van came equipped with four speakers (two front and rear) backed up by a subwoofer for extra bass reproduction. And since the door speakers were being fed by a 60-watts-per-channel amp and the subwoofer by an 85-watt amp, there was plenty of power.

A unique feature is a headphone jack for the seat behind the driver. This lets a teenager plug into his music without having your ears rattled.

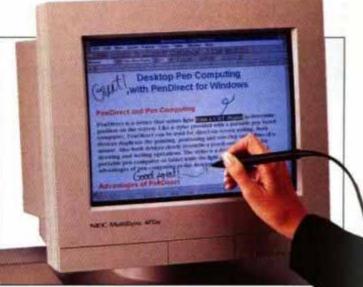


COMPUTERS

Dump The Mouse

BY GEORGE MANNES





 One company has a light pen that writes directly onto the computer screen. Another has a flat pad on which you slide and tap your finger. Both have the same hope: If you build a better mouse, the world will beat a

path to your door.

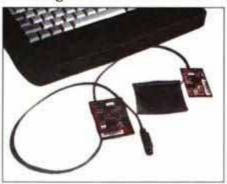
For all the importance that pointing devices play in the graphical world of personal computing, users have surprisingly few hardware alternatives for moving a cursor around a screen. Since the advent of the Apple Macintosh, the mouse has dominated desktops. And it's only recently that portable laptop users had choices other than the ubiquitous trackball: the TrackPoint II pencil-eraser pointer popularized by IBM, and the Trackpad introduced on four Apple PowerBooks last year.

One new and welcome alternative is the TouchPad developed by Synaptics, a high-tech company based in San Jose, California. Originally conceived as an alternative to trackballs for notebook computers, the Touch-Pad is a flat, Mylar-covered pad slightly smaller than a business card. To use it, all you have to do is move your finger around on the pad. Whichever direction you move your finger, the on-screen cursor follows.

In basic design, the TouchPad duplicates the Trackpad on the Apple notebooks. But though Apple's pointing device comes with a separate button you need to push to select items, the TouchPad can operate with no moving parts. To click on an icon, all you have to do is lift your finger and tap it on the pad. To drag an item-an action that on most machines means holding a button down as you move the cursor-you just double-tap, dragging your finger instead of lifting it off the pad after the second tap.

How does the TouchPad work? Contrary to what you might think, it doesn't react to a finger's pressure. Rather, it recognizes a finger's voltage. Underneath the TouchPad's Mylar cover are two thin layers of copper strips-18 stretched over a second layer of 24 arranged in a crosswise pattern. The grid formed by the strips creates an array of 432 electrical capacitors that can store an electrical charge. When a finger touches the pad, the TouchPad measures the change in voltage of the capacitors, determining a location for the finger and following it as it changes.

The basic technology behind the TouchPad is 40 years old, says Federico Faggin, the president of Synaptics. "So it was only a question of how to do it well," he says. Faggin is espe-cially proud that the TouchPad can cut through the electrical noise associ-



TouchPad lets your finger do the operating.

ated with our bodies to electronically sense the pressure a person is putting on the pad. The TouchPad can do this, Faggin says, because of its unique ability to measure the area of contact between the finger and the pad. Once that area is measured, relative pressure is easy to determine, because the harder a person pushes, the more of his finger you can expect will be in contact with the pad.

This ability to detect not only location but pressure could have some interesting applications, Faggin says. For example, Synaptics is developing software that interprets pressure as thickness in a virtual paintbrush application. As you draw a line with your finger, the more you bear down, the

thicker the line becomes.

"[The TouchPad] gives you more information," Faggin says. "You can use it in applications more advanced than what you do with a mouse or trackball."

The Synaptics TouchPad debuted as part of the Twinhead brand Slimnote 5100T. Twinhead, which markets portable computers exclusively, plans to phase in the TouchPad across its entire product line. Epson is another company that has signed up to use the TouchPad. And this year, Synaptics plans to introduce a stand-alone model, expected to sell for less than \$100, that would be usable with any notebook or desktop PC.

Other interesting possibilities are in the works. Faggin says the company is developing a system that combines a larger pad with a brush that

(Please turn to page 113)



changer holds seven discs.

has conductive bristles. "You have a true analogue of painting with a computer," Faggin says.

A brush would be nice as a computer interface. But in the meantime, FTG Data Systems of Stanton, California, is selling a gadget that lets you move your cursor around as if you were actually writing on the screen.

With the company's PenDirect product, you hold a stylus up to your computer screen. Wherever you point the pen, the cursor follows. To click or double-click on an icon, you just tap the pen on the monitor.

Using an on-screen pen instead of a mouse offers several advantages. FTG Data Systems claims that using PenDirect reduces the risk of repetitive-motion syndrome that some peo-

ple get from using a mouse.

"When you're using a mouse, you're moving your fingers back and forth and your wrist is going back and forth," says director of marketing Ron Zayas. "With a pen, you're using your whole arm, so you're not using the small muscles and the small tendons that are most likely to be strained.' That may or may not be the case, but Zayas says the product is most popular with people who have to use a computer for long periods at a time.

A hands-on test of PenDirect quickly revealed that the product is remarkably useful for a certain type of program: painting and graphics. If you've ever tried to draw a circle freehand in a paint program using a mouse, you know how hard it is to coordinate the movement of a mouse with an image in your head. Pen-

Direct makes it easy.

One application that you might think a pen is good for is to input writing that can be converted into computer-recognizable text. After all, PenDirect comes bundled with handwriting recognition software. But, as Zayas readily admits, "It's horrible." He adds, "I think that most people can type faster than they can write. It

doesn't seem to make a whole lot of sense.'

Handwriting recognition aside, though, the pen is useful for word processing programs that permit inked notations on documents. These let you preserve your scribbles as scribbles on a page, letting you preserve your comments in the margins of otherwise conventional pages of text. In addition, if you send someone a letter via your computer's fax/modem, you could conceivably use PenDirect to sign your signature onto the electronic document.

PenDirect works only on conventional glass-tubed desktop monitors, not on laptop screens. The system uses the light generated by the monitor's cathode-ray tube to detect where the user is holding the pen. Unlike a regular pen or pencil, PenDirect works because the pen you hold to the screen receives information; it doesn't transmit it.

PenDirect is available in different versions for Macintosh and Windows operating systems at a price of \$298. An OS/2 edition costs \$60 less. For Windows, a 386 microprocessor and 4 megabytes of RAM are recommended.

CD-ROM Changer

With more and more software shipped on CD-ROMs, it can be all too easy for disorganized computer users to lose their 7th Guest in the Myst. To help people keep track of their CD-ROMs, Mountain Network Solutions of Scotts Valley, California, is now offering a CD-ROM drive that holds seven discs at a time.

Designed for IBM-compatible computers running DOS or Windows, the CD7 Minichanger is a double-speed CD-ROM drive made by Mountain's parent company, Nakamichi-best known in the U.S. as a high-end audio manufacturer. The changer, a nondescript unit about the size of a shoebox, has several features meant to make it easy to use. To play a disc, you don't have to know what numbered tray it is in, and the machine won't be thrown off if someone else uses the CD7 while you're away and rearranges the discs in the machine. The CD7 will still be able to find that Outpost for you. Like other CD-ROM drives, the unit can play back audio CDs and multisession Photo CDs.

Expected to sell for \$500 at retail, the CD7 will soon be joined by similar products from Mountain Network. One of these will probably be a quadruple-speed version of the same

Protocol card, which allows VFX1 to connect with a PC's existing VGA card. This means you don't have to purchase a new video card to get the system's VR images. VFX1 works with 386 or better PCs with standard VGA cards, and it features 53° of horizontal field of view for each eye.

The most impressive of the lowerpriced HMDs we tried was Virtual I/O's i-glasses!, which the company describes as a "personal display system" rather than a virtual-reality headset. Weighing just 7 ounces-the lightest of the group—i-glasses! uses two 0.7-in. LCDs, depixelization filters and reflective surfaces to project a large-screen full-color image on semitransparent lenses in front of the

The price for the base i-glasses! unit is \$599. A PC module, which includes a VGA converter and headtracking capability, is available as a

\$200 option.

Of all the units we tried, the i-glasses! picture was the sharpest, although its field of view was narrower than most. And unlike other VR headsets, i-glasses! could be worn with prescription glasses. According to Linden Rhoads, senior vice president of business development, the company has fixed the unit's focus at 11 ft. to reduce eyestrain. At that focal distance, the image is perceived as an 80-in. TV screen.

Aiming at a slightly more sophisticated market is Liquid Image, the Winnipeg, Manitoba-based maker of the MRG2 and MRG4 virtual-reality head-mounted displays. Though the MRG4 is the company's least expensive model at \$2199, it's still twice as expensive as the other units we saw. The MRG, however, uses some of the same optics and features contained in the company's high-end models designed for arcades and commercial applications. The MRG4 comes with a program called "Superscape Visualizer," a sampling of 20 virtual worlds. Virtual reality will get another

boost in April, when Nintendo introduces a \$200 tabletop VR game system called Virtual Boy. Users look directly into Virtual Boy's eyepiece, which consists of two mini light-emitting diode (LED) displays, to view a high-resolution stereoscopic image that appears in red against a deep black background. The image, created by the LEDs and vibrating mirrors, gives users a sense of watching a TV or computer monitor screen.

We have not had a chance to actually try out Virtual Boy, so we can't report how well the system creates a real VR experience. But is it too far-fetched to imagine Nintendo succeeding where others have fallen short?

FDR data from the DC-9, he then "flew" the airplane through his simulation to see what would happen.

He puts the result in chilling terms: "This aircraft has a maximum climb capability of 2500 ft. per minute. With this kind of shear, even at maximum climb capability, it would have lost 1300 ft. per minute."

The DC-9's manufacturer, Douglas Aircraft, produced its own simulation showing that the pilots could have pulled it out anyway-if they'd performed a perfect wind-shear avoidance maneuver. CVR and FDR tapes show that instead of applying firewall

power right away and leaving the flaps down as the maneuver requires, they at first applied only maximum power and raised the flaps to 15°the normal procedure for a missed approach. Firewall power (basically, pushing the throttles as far as they'll go) didn't come until about 11 seconds before impact.

The question is, could the pilots have known they were in wind shear before it was too late? The two aircraft in front of them had reported a smooth ride down to the runway, and CVR tapes give no indication that Flight 1016's wind-shear warning system ever sounded. We'll have to wait for the NTSB's official report for the final verdict.

In the meantime, new wind-shear warning systems, based on lookahead Doppler radars like the ones TASS tested, are entering the market. They should bring a dramatic improvement. Even when nonradar systems like the one aboard Flight 1016 function as designed, they're notorious for sounding the alarm too late.

Hard evidence

Although the most rapid technological strides have come lately in computerintensive arenas of simulations and data analysis, NTSB conclusions still rely heavily on physical clues found at the scene. The vital questions of how, where and in what condition the aircraft met the ground are often best answered by careful mapping of the debris field.

Members of the aircraft-performance group generally begin by pinpointing the "four corners" of the aircraft-the nose, tail and wingtips. From these, they can begin to work back to the craft's final attitude and flight path. This mapping work has been eased with the introduction of a portable differential GPS (DGPS) system that got its first workout on the wreckage of Flight 1016.

Setup begins by establishing a control site at a known location. There, a laptop computer and multipath antenna are wired into a small GPS receiver mounted on a leveled tripod. An identical setup is moved around to various points that the team wants to locate. By making synchronized recordings of satellite data and then correlating them by computer at the end of the day, accuracies of less than a meter can be achieved. If that's not good enough, a laser transit can refine measurements down to 5mm.

As this is written, the fieldwork is complete on Flights 1016, 427 and 4184, and the NTSB is running flat out to analyze the evidence. Already they've warned about flying ATR-72s like the one on flight 4184 into icing conditions, and the brutal microburst Proctor modeled is looking like a major factor in the loss of 1016. But Flight 427, the 737 that killed 132 near Pittsburgh, still seems a mystery.

In a troubling parallel, the last case the NTSB couldn't crack also involved a 737, the most common plane in airline service today. That was only the fourth time in its 25-year history that the NTSB has come up empty. But as long as such terrifyingly open questions hang over the overwhelmingly safe world of airline travel, you can be sure investigators will keep looking for new ways to make it safer.



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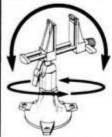
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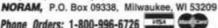
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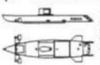




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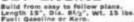
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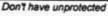






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Automatic and "hands off" operation describes Wells Marine Techonlogy's line of automatic battery systems. These units will replace manual battery selector switches whenever more than one battery is needed. Patented sensing system puts battery in parallel whenever engine is running and automatically isolates each battery when engine is shut down. Perfect for boats, RVs, Commerical Vehicles. 40 to 400 plus AMPS. Emergency start feature included. Free Brochure

Rubbermaid Commercial Products offers a 6-page, 4-color. Inization making the offer, Each company mails the material directly. Your order will be on its way to you within 90 days.

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949 FOR THE LIFE OF YOUR ENGINE

Free WIX Filters' brochure for passenger car and light truck filters. Contains information on WIX oil, air, fuel, and transmission filters, including filter wraps, our magnetic in-line transmission filter and oil filters for imported cars. Free Brochure

950 NEW! INSTANT HIGH PROOF LIQUORS, WINES AND BEERS

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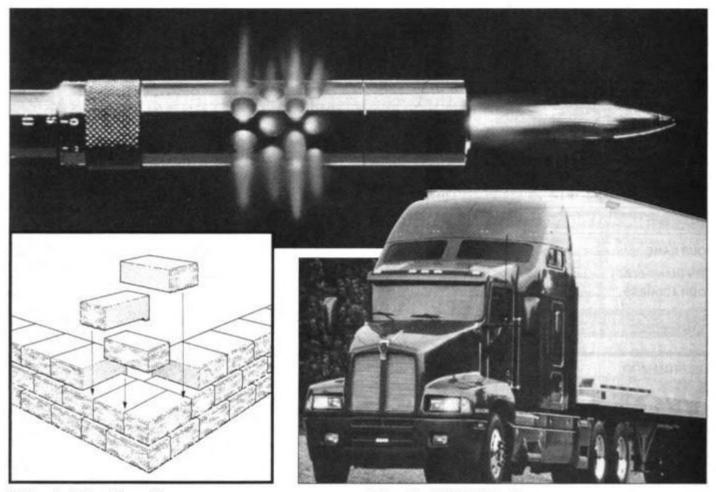
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PLANNING AND DESIGN GUIDE

Let this brand-new 32 page color catalog inspire you with ideas for your home. A complete guide to America's most popular sunrooms, solariums, patio rooms and patio doors. Plus, additional 6-page brochure, "Affordable Outdoor Living Space from Four Seasons", featuring the full range of our patio room products. FOUR SEASONS SUNROOMS. Free. Call 1-800-FOUR SEASONS (1-800-368-7732)

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Stonewalling It

So you want a retaining wall in your yard, but you dread building one? Relax. New dry-laid concrete blocks lock together to look like stone, making the job quick and simple.

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Trucks With Brains

Big trucks are getting smarter, with the same kind of computer-controlled advanced technology now found in cars. Here's a detailed look at these big rigs and how they work.

Heavy Lifters

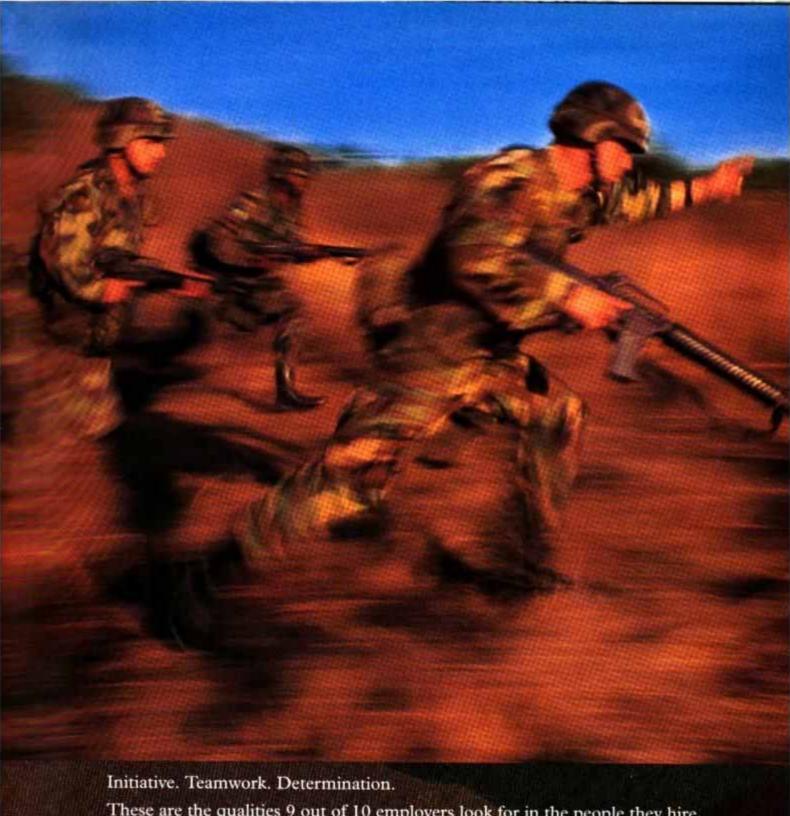
Move a million-pound payload by air? A new breed of giant aircraft makes it a reality. In fact, one of them is already flying.

Big-Bore Outboard Test

Clean-burning big-displacement 4-stroke outboards are the big news for the '95 boating season. We test the hottest of the bunch, and let the chips fall where they may.

Editor's Note—Due to changes in production schedules, an article may not appear when originally planned. We apologize for any inconvenience this may cause.

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