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**'94 TRUCK
BUYERS GUIDE**
All The New Pickups,
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Popular Mechanics

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MARCH 1994
VOLUME 171
NO. 3



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THE NATIONAL AUTO QUIZ

1. One of the hottest production engines of the early '60s was this:



A) Chevy 409 dual-quad. B) Chrysler "Max Wedge."
C) Oldsmobile "J2." D) Ford "Police Special."

2. What popular rock 'n' roll song of the 1960s contained the lyrics "three deuces and a four-speed?"

A) "Little Deuce Coupe." B) "Little Old Lady From Pasadena."
C) "Little GTO". D) "Hey Little Cobra."

3. What is the essential performance difference between DOT 3, DOT 4 and DOT 5 brake fluid?

A) Lubrication and sealing of rubber parts in the brake system.
B) Viscosity. C) Corrosion resistance. D) Boiling point.

4. Which of the following can cause engine overheating:

A) Idle speed too low. B) Late ignition timing. C) Defective water pump.
D) All of the above.

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5. The first automobile to climb Pikes Peak was a:

A) Locomobile. B) Ford. C) Cadillac. D) Durant.

6. The first American car to offer a V6 engine in production models was the:

A) Chevrolet Corvair. B) Buick Special. C) Dodge Dart.
D) Pontiac LeMans.

7. What car did the Addams family drive in their television series:

A) 1929 Packard. B) 1932 Chrysler. C) 1934 Buick.
D) 1930 Cadillac.

8. Which of these overseas car manufacturers had assembly plants in America?

A) Fiat. B) Mercedes-Benz. C) Rolls-Royce. D) All of the above.

9. An engine is called "oversquare" when its:

A) Bore is larger in dimension than its stroke. B) Stroke is larger in dimension than its bore.
C) Overall width is greater than its length. D) Power output exceeds one horsepower per cubic inch.

10. What 30-year drag racing veteran is retiring after the 1994 season?

A) Don "Big Daddy" Garlits. B) Bob Glidden. C) Don "The Snake" Prudhomme.
D) Kenny Bernstein.

ANSWERS
1. B 2. C 3. D 4. D 5. A (August 12, 1901)
6. B (1962) 7. B 8. D 9. A 10. C.

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EDITOR'S NOTES

● Yes, baseball is still America's pastime. And on an autumn Sunday afternoon or a Monday night, nothing beats the NFL. But baseball and football are mostly spectator sports these days. And expensive, too. The participant sports such as golf, tennis, basketball, skiing, rowing, volleyball, curling, whatever,



Bob and Jayne Fusco and the gang at Sheridan Lanes.

are all small potatoes. Yes, small potatoes compared with the number of people who bowl every week. In fact, more people will go bowling this week in America than will participate in any other sport. And no wonder. First of all, bowling is still an excellent value. With a courtside seat for an NBA game approaching \$50 (if you can get one), it's no wonder bowling is the most popular way to spend a sporting evening with friends. Spend an evening at a bowling alley like the Sheridan Lanes in Mineola, New York, and watch the good times roll. People are out there enjoying themselves. Talk to lounge manager Jayne Fusco and her friends and customers. There is no pretension here. Just real people having fun. And now with the new-technology balls available, they're having even more fun. "Scores are definitely up," says Bob Fusco, Jayne's father, who runs a pro shop at the Maspeth Lanes in Maspeth, New York. "But if you're a lousy bowler to begin with, don't expect any miracles with the new balls. The basics are still most important." Too bad. I was hoping one of the new balls (see story on page 60) could turn my 150 average into a 230. . . . **Could the new breed of water bomber aircraft** have saved California last October as thousands of acres in the Laguna Beach and Malibu areas burned free? That's the question that kept going through my mind as I watched a Canadair CL-415 being built at the Bombardier factory in Montreal on a recent visit. This huge plane can dump prodigious amounts of water on a raging fire in almost any location. Yet, there are some California state forestry officials who say the planes couldn't have helped douse last October's fires. To find out why, check our cover story beginning on page 52. . . . **Everybody wants to own a truck**—even if they don't realize it. Unbeknownst to many purchasers, best-sellers such as the Ford Explorer and the Chrysler minivans are considered trucks by the auto industry. Other, more traditional favorites such as the Ford F-Series and the Chevy C/K pickups continue to be the best-selling vehicles in America. If you're interested, and who isn't, our special section begins on page 38. . . . **Are those buds I see on the barren trees** and bushes in my yard? Yes! Time to think about beginning the annual spring cleanup with some new lawn and garden equipment. Like the stuff on page 80. Till next time.


Joe Oldham

Popular Mechanics

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Until recently, there wasn't a medicine that could help the condition known as symptomatic benign prostate enlargement or BPH. But now there is PROSCAR, the first oral prescription medicine that can shrink an enlarged prostate.

However, it is important to know the following: PROSCAR doesn't work for everyone. Even though your prostate may shrink, you may not see an improvement in urinary flow or symptoms. And you may need to take PROSCAR for 6 months or more to see whether it helps you.

How PROSCAR can shrink an enlarged prostate.

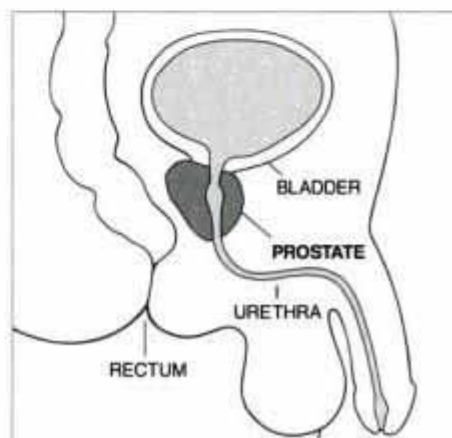
As a man ages, a key hormone can help cause the prostate to grow. PROSCAR actually blocks the production of this hormone, so it helps shrink the prostate to a smaller size in many men. As a result, some men treated with PROSCAR experience an increased urinary flow and an improvement in urinary symptoms.

Why you should see your doctor soon.

Your doctor has several options for the treatment of symptomatic BPH: watchful waiting (monitoring the condition with regular checkups), medication, or surgery. It's important to see your doctor because the problem doesn't usually get better by itself. In many cases, the prostate continues to enlarge and the symptoms may get worse. So if your urinary symptoms are bothering you, have your family doctor or a urologist assess your condition and ask if PROSCAR is an appropriate treatment for you.

It is also important to have regular checkups. *While benign prostate enlargement is not cancer and does not lead to cancer, the two conditions can exist at the same time.*

Remember, only a doctor can evaluate your symptoms and their possible causes. So, if



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.

your urinary symptoms are bothering you, don't wait any longer. You may find that your enlarged prostate can be made into a smaller problem.

For more information about prostate enlargement and PROSCAR, call 1-800-635-4452 today.

TABLETS
PROSCAR[®] 5mg
(FINASTERIDE)



Please see patient information on the following page.

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PATIENT INFORMATION ABOUT PROSCAR® (Prah-s-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.

You should discuss side effects with your doctor before taking PROSCAR and any-time 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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LETTERS

Sub On The Rocks



GENERAL DYNAMICS ELECTRIC BOAT DIVISION PHOTO

On your November cover, an older version of the 688-class of submarines was depicted under the Arctic ice. The earlier Flight 1 and Flight 2 versions of the 688 (*USS Los Angeles*) is not capable of surfacing under ice. Only the 688I (*USS San Juan*, shown above), with its diving planes moved from the sail to the bow, is capable of surfacing under ice. This is because the diving planes on the *Los Angeles*-class could not rotate full-vertical. DUSTIN

(FROM THE PM COMPUTER BULLETIN BOARD)

Popular Iceberg

What is this, POPULAR ICEBERG? Let's cut some of that glitz and get back to basics—like Car Clinic.

JOHN J. LIGHTER
BOWIE, MD

Aiming To Please

I have been a subscriber since 1984 and there have been many articles that I have enjoyed reading and many that I have not. I'm either not interested in the article or I feel that I will not enjoy reading about such a topic. However, I will never threaten to end

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

my subscription just because we don't see eye to eye on a topic. You cannot please all of the people all of the time. I suggest that these outraged readers simply should have an open mind and skip to the next article. If they're willing to end their relationship with our magazine, then let them. They don't deserve to read it.

LUIS DE ANDRADE JR.
BRIDGEWATER, MA

Shades Of Gray

Your story on the new line of Bosch power tools gives the impression that the "blue/gray" Bosch tool line is of lesser quality than "industrial blue" Bosch tools. The industrial line is broader, and does include some tools with more features and specialized applications required by tradesmen. But that essentially is the primary difference. The new blue/gray tools incorporate the same high quality that all Bosch tools provide, yet are targeted to professionals and avid DIYers who shop in hardware stores and home centers.

DALE ELLIOTT
V.P., MARKETING
S-B POWER TOOL CO.
CHICAGO, IL

4-Wheelin'

I have to laugh, or cry, at some of the ignorance that abounds these days. Are your vehicle road testers supposed to be experts or common nitwits? You describe a '93 Cadillac with a 5.7-liter engine towing a 7000-pound boat getting 8.7 mpg as "quite respectable considering the heft of the load." Quite respectable? Pathetic! Especially with an unladen rating of 16/25 mpg. A couple of years ago I owned a '71 International tandem-axle truck with a 392 4-barrel gasoline engine that weighed 18,000 pounds empty. With a 20,000-pound load, it was just 1 mpg shy of your 8.7, dragging along at 55 mph 10 12-ply 10.00-20 tires and two drive axles. I guess modern engineering has become so inept that even the standards are lost.

JAMES LONG
SHARON, WI

I read the Mercury Villager/Nissan Quest Owners Report with much interest. I've had a Villager since August '92 and agree with most of the responses.

Two items not mentioned, though, really bug me. The rear wiper only operates in interval mode. By the time it decides to take another swipe during a snowstorm, the rear view is completely obscured. Item two almost has me paranoid. Set at 56 mph, the speed control will drop to 52 when encountering a grade. It then kicks out the converter lock, increases about 400 rpm, downshifts to Third and speeds up to about 63 over the top of the hill. The dealer couldn't repair it. He checked six more vehicles that all acted the same. I had six Ford Aerostars with basically the same power and gear ratios, and never had a problem. I'm trying the Windstar next.

LEON A. MENSING
LOWDEN, IA

The Oldsmobile Aurora too closely resembles the Lexus LS 400. For example, both cars have a 4.0-liter dohc 32-valve aluminum engine with 250 hp and an electronically controlled 4-speed automatic transmission. Both interiors are

(Please turn to page 14)

Reader Project Of The Month



I had a 1958 Pontiac Bonneville in high school in 1963 and it's been my dream for 30 years to own one again. I found this one last year after nine years of searching, and in March 1993 my dream came true when I finished restoring it. Everything was completely rebuilt. It's all original, including the chrome. And it runs and drives like new. This car has been to 25 shows and has won seven Best Of Show, 13 First Place, two Second Place and one Third Place. It's been a pleasure to drive and show Bonnie Red.

RICHARD BOGGS
BLANCHARD, OK

\$3.00 BACK ON NEW VALVOLINE® DURABLEND™

When you buy 6 quarts of Valvoline® DuraBlend™ Motor Oil or \$.50 rebate per quart (max \$3.00) on Valvoline DuraBlend Motor Oil.

Offer Expires June 30, 1994.

To receive your Valvoline DuraBlend Check good for cash, complete this coupon and send it with your proof-of-purchase to:

DURABLEND \$3.00 CASH-BACK,
P.O. BOX 7299,
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Your original dated sales receipt for Valvoline DuraBlend Motor Oil AND One of the following:
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- UPC code from bottom of one 6-qt. case of Valvoline DuraBlend Motor Oil
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Can use offer twice per quarter (check one):

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Limit of two Valvoline DuraBlend checks each quarter per household, address or organization. Maximum rebate of \$6.00 allowed per quarter. Request in excess of the limit will not be acknowledged or returned. Offer good only in the U.S.A. Offer void where prohibited, taxed or otherwise restricted by law. May not be used in conjunction with any other Valvoline offer. Allow 8 weeks for delivery of your Valvoline DuraBlend Check. Rebate request must be mailed within 30 days of cash register receipt date. Rebate check must be cashed within 90 days of issue.



**PEOPLE WHO KNOW
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LETTERS (Continued from page 13)

close to identical with the steering wheel, gearshift, glovebox and wood trim matching too close for comfort. And the engine-performance statistics are carbon copy!

ERIK VITANDS
WESTFIELD, WI

Hey, that's the point, Vitands. You get about the same car—except for the price. The Oldsmobile Aurora costs about \$35,000, and the Lexus LS 400 about \$50,000. —Ed.

I have been a subscriber to PM for many years and obviously enjoy the magazine. However, the proportion of automobile articles is getting way out of hand and needs to be severely decreased. If management wants to devote a separate magazine strictly to automobiles, that's fine. But need they continue to turn PM into just another automotive magazine?

MYRON E. HINEBAUGH
FORT WORTH, TX

If you check, you'll find that about a third of all our editorial pages are devoted to cars. Always have been. Always will be. —Ed.

Your automotive editors must subscribe to that old homily: "If you don't have something nice to say, don't say anything." The articles and reviews of cars inevitably gush about each model, with almost never a word of criticism. It seems like there is a rule not to offend any potential advertiser. In the future, please try to include some comments that would help a prospective buyer choose between cars of the same class.

STEVE KRAMER
RAMAT-GAN, ISRAEL

I wish our advertisers agreed with you, Kramer, that we never say anything negative about their products. Come to the office sometime. I'll show you the files on companies that have pulled their advertising because they didn't like our articles. —Ed.

Checklist

I'm writing to help encourage your readers to always think safety when using power equipment. I realize that most of the time your editors and writers already do this. As a matter of fact, you featured a pamphlet review on safety tips in the October issue. However, in "Paving The Way," a man is shown using a water-cooled masonry saw and he isn't wearing any eye protection. He does have ear protection and heavy-duty rubber gloves. Common sense would tell you to wear eye protection also.

LUIS DE ANDRADE JR.
BRIDGEWATER, MA

Pistol Or Popgun?

Your article on the new military 92FS Beretta pistol very adequately answered the question: How good is it? My question is: What good is it? Your article states that it has "proven itself in combat in the Gulf War, Somalia, Panama and Grenada." How many enemy combatants were killed, wounded or induced to surrender in these scenarios solely by someone waving a pistol at them? How many infantry officers carried a pistol in 'Nam? How many people actually engaged in combat with an armed enemy, armed with nothing more than a handgun? Will the Navy use this personal popgun to repel borders? Will the rear-echelon weenies of the Army use it to fight off terrorists? The money used to develop the 92FS could have been put to better use. It just sounds like another example of "military intelligence."

J.M. BECK
CULLEOKA, TN

Your glowing report on the U.S. military's newest firearm failed to mention two facts. First, there have been a number of reports of slide cracking with the 92FS Beretta—a potentially dangerous defect. Second, the 9mm projectile has a much smaller frontal area in comparison to the Colt M1911 .45. Military handgun and rifle projectiles are, by international law, round-nose full-metal jacketed. The only way a 9mm projectile could match the .45's stopping power—i.e. halting an adversary intent on killing you—is if it were hollow-pointed. Our military's acceptance of the 9mm as its handgun of choice has put our servicemen's lives in dire jeopardy.

FRED J. HERMON
SANTA ANA, CA

I was an active-duty tanker for four years, and am now in the reserves. I carried the .45-caliber pistol as my sidearm, and still do in my reserve capacity. When the Beretta was introduced, there were mixed feelings from most of us about the selection. The ability to have 15 chances instead of seven to strike a target seemed to be the only advantage. I thought your article was going to just beef up the pistol, and keep the public happy about the latest purchase from the U.S. government. Your well-researched coverage, however, showed me everything that I might want to know about the issue and the weapon. I find that the 92FS Beretta has come full circle and may be one of the best pistols in the world. Congratulations on showing me the facts on a military weapon I used to insult.

TRACY S. COGDILL
AUSTIN, TX

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DURABLEND gives you better engine protection

A REVOLUTIONARY NEW PARTIAL SYNTHETIC MOTOR OIL THAT
CAN ADD YEARS TO A CAR FOR LESS MONEY THAN YOU THINK.

at startup, better deposit control, better fuel economy

DURABLEND'S a remarkable new motor oil
that's a unique combination of technically
advanced synthetic oil and the highest
quality conventional motor oil. With regular
maintenance, Valvoline DURABLEND can
help your car stay on the road for 100, 200,
even 300,000 miles and more.

and a smoother running engine overall than
conventional motor oils.

But (and this is a big but) it costs
substantially less than other synthetic oils.
Sound like the best of both worlds? A better
oil at a lower price? Well you're right. So try
new Valvoline DURABLEND. It's a motor oil
whose time has come.



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TIME MACHINE

90 YEARS AGO: MARCH 1904

Popular Mechanics

America's Wonderful Inexpensive Automobile Boat
The Protector Floats, Cries and D. In Along the Bottom of the
Sea on Wheels as Steam-Submarine Chases
Will be Done

...the Protector...
...the Russian...
...the American...
...the Japanese...
...the submarine...
...the surface...
...the depth...
...the stability...
...the appetites...

Deep Threat

A new predator lurked beneath the waves—the submarine, which was proving its lethal prowess in the Russo-Japanese War. Its American counterpart, the 65-ft. *Protector*, rolled across the seabed on cast-iron wheels and pattered across the surface with a gas engine. Accoutrements included three torpedo tubes and a diver lock-out. Restricted to a depth above 150 ft., the sub nevertheless proved stable enough to whet admirals' appetites.



Ice Queen

Meanwhile, Russia was forever waging war against the frozen seas that locked up supply routes to the Pacific front. Although the mighty *Ermak* was the czar of icebreakers, the Russians were busy copying a pair of unique ice-crushing car ferries that operated in Michigan's Straits of Mack-

inac. Fitted with bow and stern propellers, the ferries transported railway cars between Mackinaw City and St. Ignace. Their wooden hulls sheathed in steel 2 ft. thick, the vessels could plow through ice fields 30 ft. deep. Bigger of the two was the *St. Marie*, whose aft steam engines featured cylinders 4 ft. across.

60 YEARS AGO: MARCH 1934



Car Fans

Fifty miles to the gallon was a Holy Grail for automotive engineers of the '30s, and the quest began in the wind tunnel. At the University of Michigan, researchers harnessed the big fans in search of the perfectly streamlined shape. Others filled full-size cars with boxes mounted on ball bearings to measure wind resistance. Their toughest task: convincing automakers to whittle sedans down to radical teardrop designs.

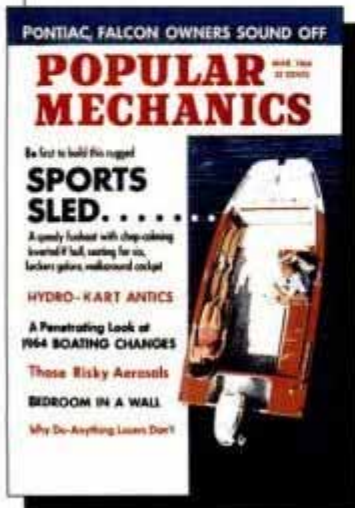


Sand Blaster

Kings, merchants and pilgrims once crossed the Syrian Desert by camel, but now a huge tractor-trailer bus, as big as a Pullman car, roared between Damascus and Baghdad. With a 250-gallon fuel tank, the coach made the 470-mile round trip in two days. Its powerplant: a 385-hp diesel

engine driving three axles with 12 forward speeds and three reverse. Three drivers took turns in the cab, steering across the sands and fording two rivers en route. The 35 passengers enjoyed the comforts of home with a refrigerator, range and buffet. A freight version carried the equivalent of an 80-camel caravan.

30 YEARS AGO: MARCH 1964



Water Rides

Our project boat reflected the heading that watercraft took in the '60s—sculpted multikeel hulls below, wide-open "flight decks" topside. Although the ride was as flat and fast as a '64 Thunderbird, the silhouette wasn't as graceful as past profiles. Meanwhile, hydro-karts were making a splash, taking up where go-karts left off. Little more than plumped-up boogieboards with jetdrives, these buzzbombs still had enough oomph to pull a waterskier.

Answer Me

It's one of life's staples today, but back in the '60s, who had an answering machine? Anyone with a Phonemaster did. A shoebox-size device, Phonemaster performed every task a modern unit does—pick up the phone, deliver a greeting and record the message, using two tape loops. Before touch-tone dialing, Phonemaster came with the Electro-Key, a separate replay-signal box the size



of a cigarette pack. The device was marketed at salesmen who jumped from hotel to hotel.

Light up the night.

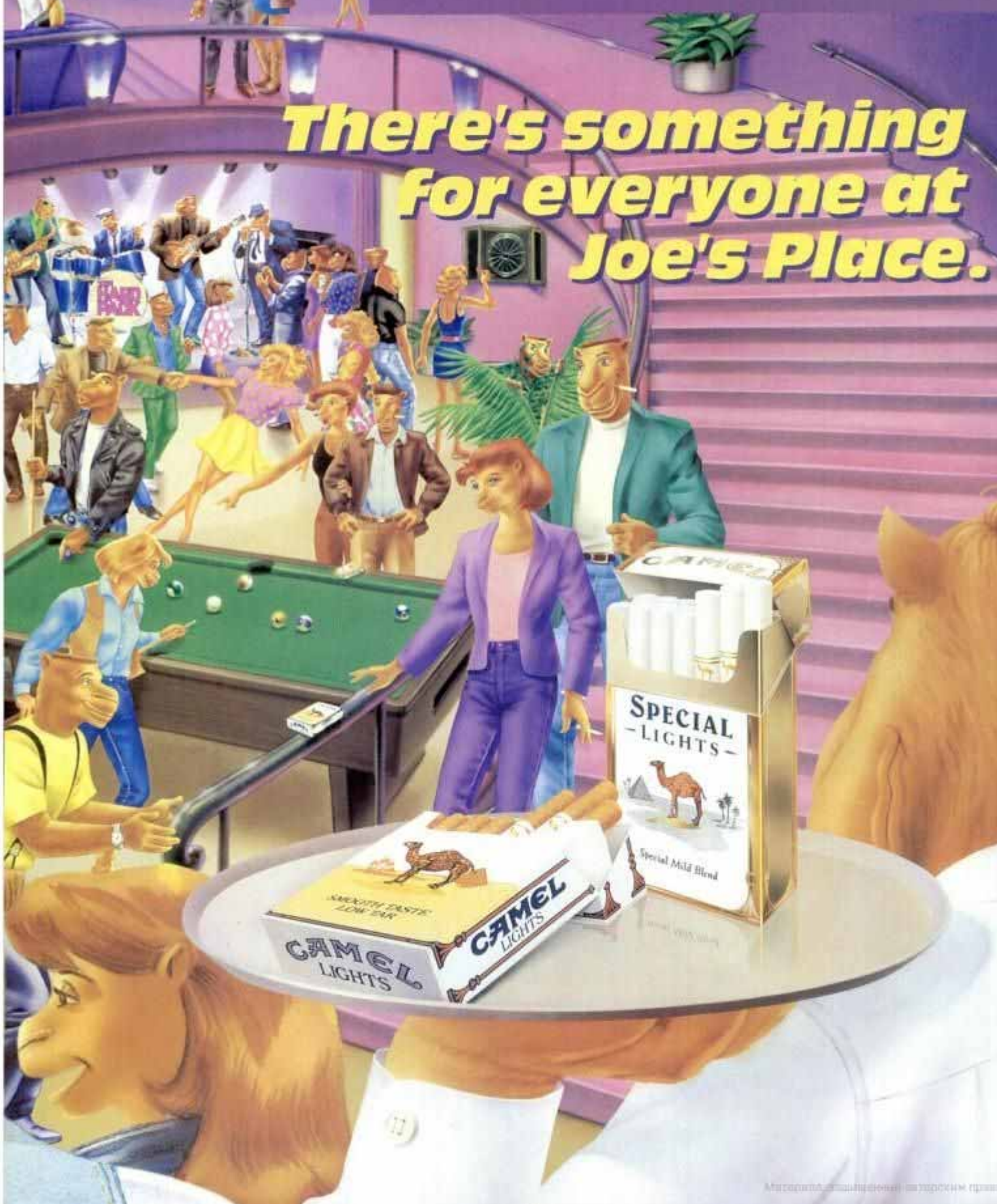




Joe's
PLACE

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

***There's something
for everyone at
Joe's Place.***



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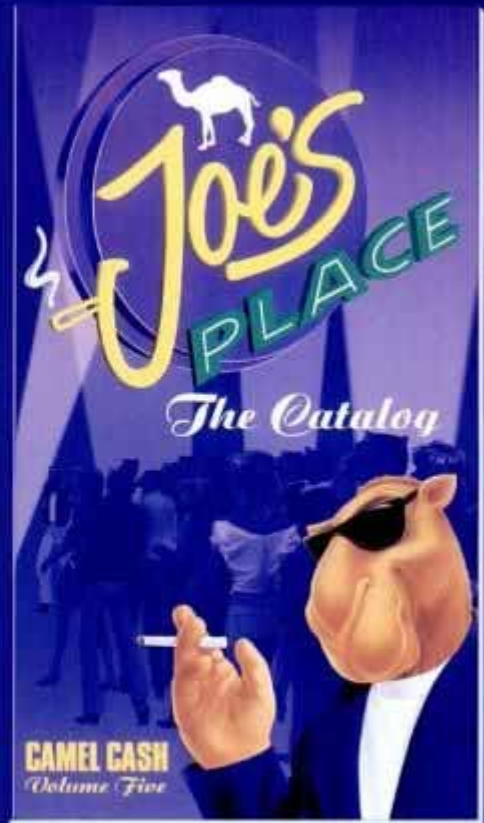
Pick one up wherever Camels are sold.

Or call

1-800-CAMEL CASH*

1-800-226-3522

Ask how to get Joe's V.I.P. Card while you're at it.



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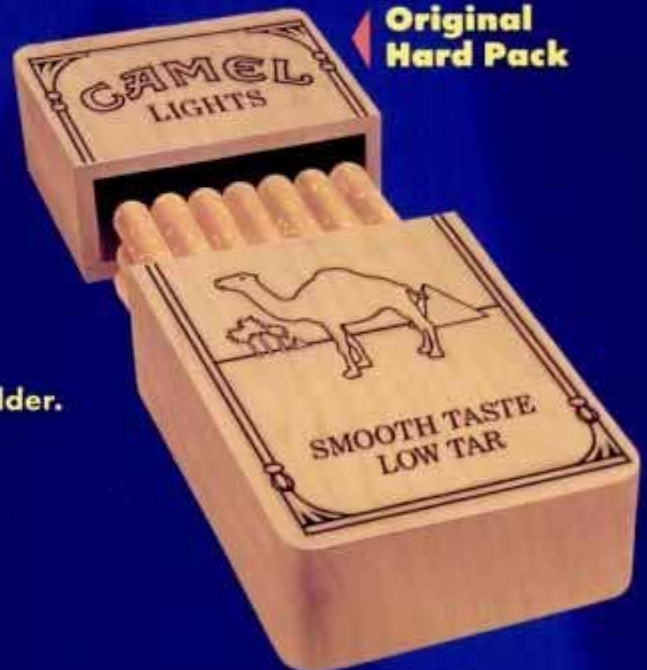


Joe's Place Cap

Special Lights Deco Cigarette Case



8-Ball Smoking Set



Original Hard Pack

* Offer restricted to smokers 21 years of age or older.
11 mg. "tar", 0.8 mg. nicotine av. per cigarette by FTC method.

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

TECH UPDATE

News Of Tomorrow's Technology Today



ILLUSTRATION BY PAUL DIMARE

Who Needs A Launch Pad When We Have The Sea?

FAIRFAX, VA—Satellite launchers are fed up with the long waiting lists at Cape Kennedy and Vandenberg Air Force Base. And who isn't worried about the old Soviet strategic missiles still lying around intact after disarmament treaties?

Some American and Russian entrepreneurs have a solution to both headaches. An outfit called Sea Launch Investors wants to convert Russia's submarine ballistic missiles into cheap, convenient satellite boosters.

The idea of sea-launched rockets isn't new. Back in the 1960s and '70s the Navy aired the concept under a program called Hydra. And lately the Naval Research Laboratory has been studying a Sea Launch and Recovery system featuring reusable hardware (see *Tech Update*, page 17, April '91).

But the Sea Launch Investors approach is different. The rockets themselves, dubbed Surf, would be hybrids. Each would consist of the solid-rocket lower stage of the mighty SS-N-20 crowned with a modified SS-N-23 stripped of its warhead.

With the solid-fuel portion at the bottom, the rocket would float vertically—after it's rolled off the back of a huge amphibious-assault ship. Donated by Russia to the enterprise, the

Hybrid Surf rocket would roll off Russian amphibious-assault craft, right itself, and blast toward the heavens.

500-ft. *Ivan Rogov* would serve as a final assembly and mission-control facility. The vessel could also steam to any location so that launchers could reach specific equatorial or polar orbits without extra transfer boosters.

A Surf could put a 5000-pound payload into low Earth orbit for roughly \$11 million, says the company.

Highlights This Month

- **Beam Shooter**—Lasers promise air defense.
- **Eden For Edisons**—New inventors hall of fame.
- **Sparks Fly**—Electric planes ground hydraulics.
- **Dino Might**—Best prehistoric robot action yet.
- **SEAL Quest**—Search for commando superboats.
- **Backyard Chopper**—Everyman's whirlybird.
- **Sky Moves Earth**—Satellites guide bulldozers.

Editor/Writer: Gregory T. Pope
Reporters: Mike Filion, Samuel M. Katz,
Barry Rosenberg, Bob Scheier, Richard Schrader,
Herb Shuldiner

Light Air Defense



GARDIAN (left) and HELWEPS (above) would slap multiple kilowatts of laser light on incoming missiles.

REDONDO BEACH, CA—Because nothing hits a target faster than a beam of light, engineers have renewed their focus on lasers as last-ditch air defense. TRW, for example, has proposed systems that derive from the company's megawatt MIRACL chemical laser, which shined in the 1980s under Navy and strategic-defense funding.

A seagoing version, called HELWEPS, for High-Energy Laser Weapon System, would sit in for a ship's 5-in. gun. HELWEPS could hammer incoming missiles and beachfront gun batteries with equal efficiency. The land variant—General Area-Defense Integrated Anti-missile, or GARDIAN—would ride a medium tactical truck and fire up to 50 shots per minute.

Their beams fueled by a nitrofluorine-ethylene reaction, the lasers wouldn't drain electrical energy and are a 10th the weight of existing missile-interceptor systems.

Lean, Clean Green Machine

WEST PALM BEACH, FL—The Green Car, a Consulier GTP converted to run on fuel cells, finally broke cover last fall.

Developed by Energy Partners Inc., (see Tech Update, page 12, March '92), the vehicle runs on three 7-kilo-

watt cell stacks. Sixty to a stack, the cells generate electricity by splicing hydrogen—stored at 3000 psi—with air supplied by an on-board compressor.

The Green Car is something of a tortoise, however, despite its jack-rabbit silhouette. It



does 0-30 mph in 10 seconds and won't top 60 mph. Range on a tank of hydrogen is, at best, 70 miles. On the up side, the car emits only water and trace gases.

Fuel cells ride El Camino-style in open trunk, recharging batteries to drive motor.

Inventors' Valhalla



AKRON, OH—Ballplayers have Canton and Cooperstown. Rockers have Cleveland. Now inventors will have Akron.

Destined to open in 1995, Inventure Place—home of the National Inventors Hall Of Fame—will enshrine such luminaries as Edison, Bell and the Wright brothers, along with more than 100 other inductees.

Hallmark of the hall is its arching 75-ft. facade of stainless steel, which doubles as a vast projection screen for the exhibits inside. Meanwhile, underground, visitors can tinker with wind tunnels, lathes, molds and other engines of creation.

Inspired by an airship hangar, Akron's Inventure Place will spread 75-ft. stainless-steel sail.

Eye On Diabetes

NORCROSS, GA—Diagnosing diabetes usually means blood and urine samples, lab processing and a few days wait. But a new technique promises the convenience of an eye examination—because that's exactly what it is.

The SpectRx system focuses a low-intensity, multicolored light on a patient's lens. In an untreated diabetic, certain proteins become concentrated in the lens. The SpectRx light causes the proteins to fluoresce, or give off their own light.

Similar "fluorescence signatures" could ultimately help diagnose cancer and heart disease.

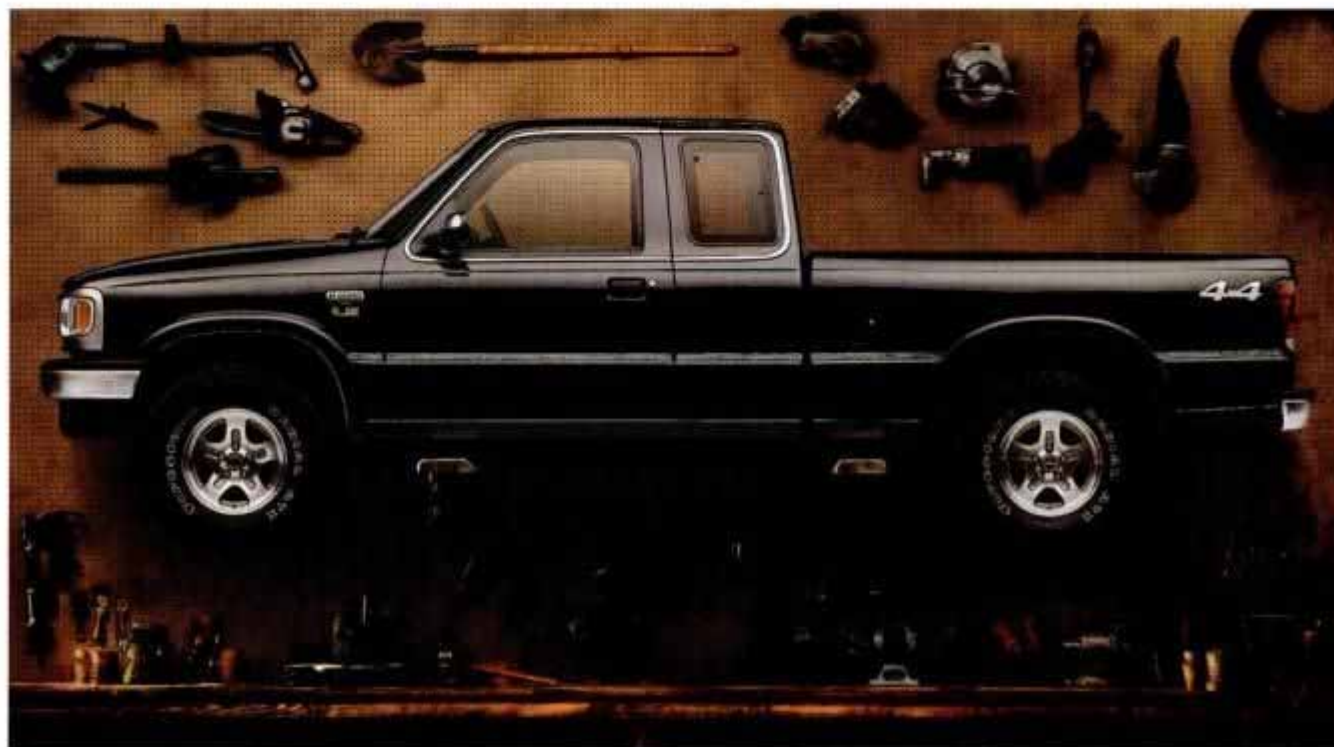


SpectRx illuminates eye, triggering fluorescence.

The New Mazda Truck

When it comes to weekends, Mazda owners are quite industrious. Whether they're putting up drywall, landscaping

gravel. Especially with a bigger available payload than ever. Plus, a 36-month/50,000-mile, bumper-to-bumper warranty,** so you can put



Introducing the best power tool you'll ever buy.

the yard or just running to the hardware store

all your energy into fixing that leaky faucet.

to check out that new line of toggle bolts.

Which is why the all-new Mazda truck is a

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

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

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



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

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

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

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



Triple-Threat Combat Jet

SEATTLE, WA—The Air Force wants to replace the F-16. The Navy wants to replace the A-6. The Marines want to replace the AV-8B. But if wishes were warplanes, beggars would fly: The Pentagon isn't about to spring for three brand-new aircraft after okaying production of the F-22.

Boeing, however, believes it may have a solution: a modular jet-of-all-trades. The multirole tactical airplane would roll off a single assembly line in three different flavors: a runway number for the Air Force, a Navy version built for carrier takeoff and landing, and a short-takeoff vertical-landing variant for the Marines.

Military planners have long sought such a scheme. But advances in composite manufacturing make the concept feasible now, says Boeing. The planes would also share avionics with the F-22.

Air Force version of Boeing's modular jet features conventional propulsion and stealthy internal weapons bays.

The Mighty Worm

OAK RIDGE, TN—Only the Inchworm can wriggle through pipes too twisty for wheels and tracks.

Both head and tail of the new air-driven robot are belted with inner-tube-like air bladders. Three rubber hoses, which act like bellows, connect head and tail.

In motion, the tail bladder inflates to grip the pipe's walls while air pressure through the hoses pushes the head forward. Then the head inflates, the tail deflates and air is drawn from the hoses to pull the tail forward.

Oak Ridge National Laboratories has licensed the technology to Remotec Inc.



For turns, two body hoses are vacuumed while the third is pressurized.

Dante's Revenge

PITTSBURGH, PA—Thwarted in attempt to explore an Antarctic volcano last year (see Tech Update, page 18, Sept. '92), Dante will try again this summer at the other end of the world.

The 8-legged robot will rappel into Mount Spurr, an active volcano in Alaska.

Carnegie Mellon University has refurbished Dante for the effort: Its legs now jut from the corners of two body frames that slide with respect to each other to generate forward motion. This new frame-walking approach is simpler and more resilient, with fewer degrees of freedom.



Dante received extensive rehab after failed assault on volcano in Antarctica.

Electric Hornet

WRIGHT-PATTERSON AFB, OH—On a fly-by-wire aircraft, the control surfaces move in response to signals sent through electrical wires, which have replaced mechanical linkages. But it still takes hydraulics to move the surfaces. So the next step is to chuck the plane's finicky hydraulic system and fly all-electric.

To that end, the Air Force, the Navy and NASA are flying an F/A-18 Hornet modified with electric actuators.

So far, pilots have tested an elec-



Hornet puts electric actuators and controls through torture test.



trically sparked hydraulic aileron actuator. The control electronics aren't in the cooled cockpit computer bay but are stuck on the actuator itself, demonstrating the ruggedness needed to dis-

tribute electronics throughout the plane.

This spring, the jet will begin flight tests with pure electric motors. If the actuators survive the fighter's grueling flight regime, they'll have earned their wings.



ONE DECISION YOU REALLY SHOULD MAKE BY THE SEAT OF YOUR PANTS.

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

Hydrostatic transmission provides smooth speed selection, via a patented, 2-pedal foot control.



And to feel even

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

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



A tight 20-inch turning radius makes for easy maneuvering.



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House-Fighting Tank Buster

CHATILLON, FRANCE—Already a powder keg in Sarajevo and in Mogadishu, the urban battlefield just got nastier with the introduction of a unique missile that can be fired from an enclosed room.

The Eryx can blast through heavy armor and bunkers. Yet it jumps from its shoulder-fired tube at only 45 mph, slow enough to shoot from confined spaces without a dangerous exhaust. Once launched, the Eryx triggers an in-flight booster that can propel the missile 1800 ft. in 3.7 seconds.

Like the TOW missile, the Eryx is guided by a remote-control wire that uncoils from the missile's rear. The infantryman simply keeps his crosshairs on the target.

Aerospatiale Missiles plans to crank out 12,000 of the weapons over the next five years.



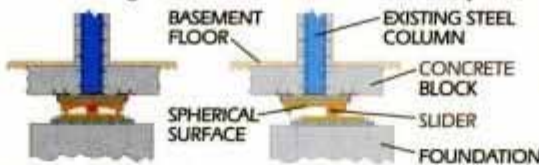
AEROSPATIALE ILLUSTRATION

Fired from enclosed spaces, Eryx can pierce the equivalent of 900mm armor.

Court Won't Court Disaster

SAN FRANCISCO, CA—Engineers are literally pulling a block-long building up by its roots in an effort to isolate it from earthquake damage.

The U.S. Court of Appeals building is getting a friction-pendulum system under each of its 300-ton steel columns. These devices allow the building to swing safely with a quake's shearing forces. If sudden motion displaces the column from the foundation, a slider at its base rolls across a rounded surface—rather like a pendulum—to return the column to its normal position.



UNIVERSITY OF BUFFALO PHOTO

Historic building will be safe from earthquakes thanks to friction-pendulum systems.

Japan's Cretaceous Park

OSAKA, JAPAN—Mechanical dinosaurs recently terrorized this city, operating with speed and fury that would put Godzilla to shame.

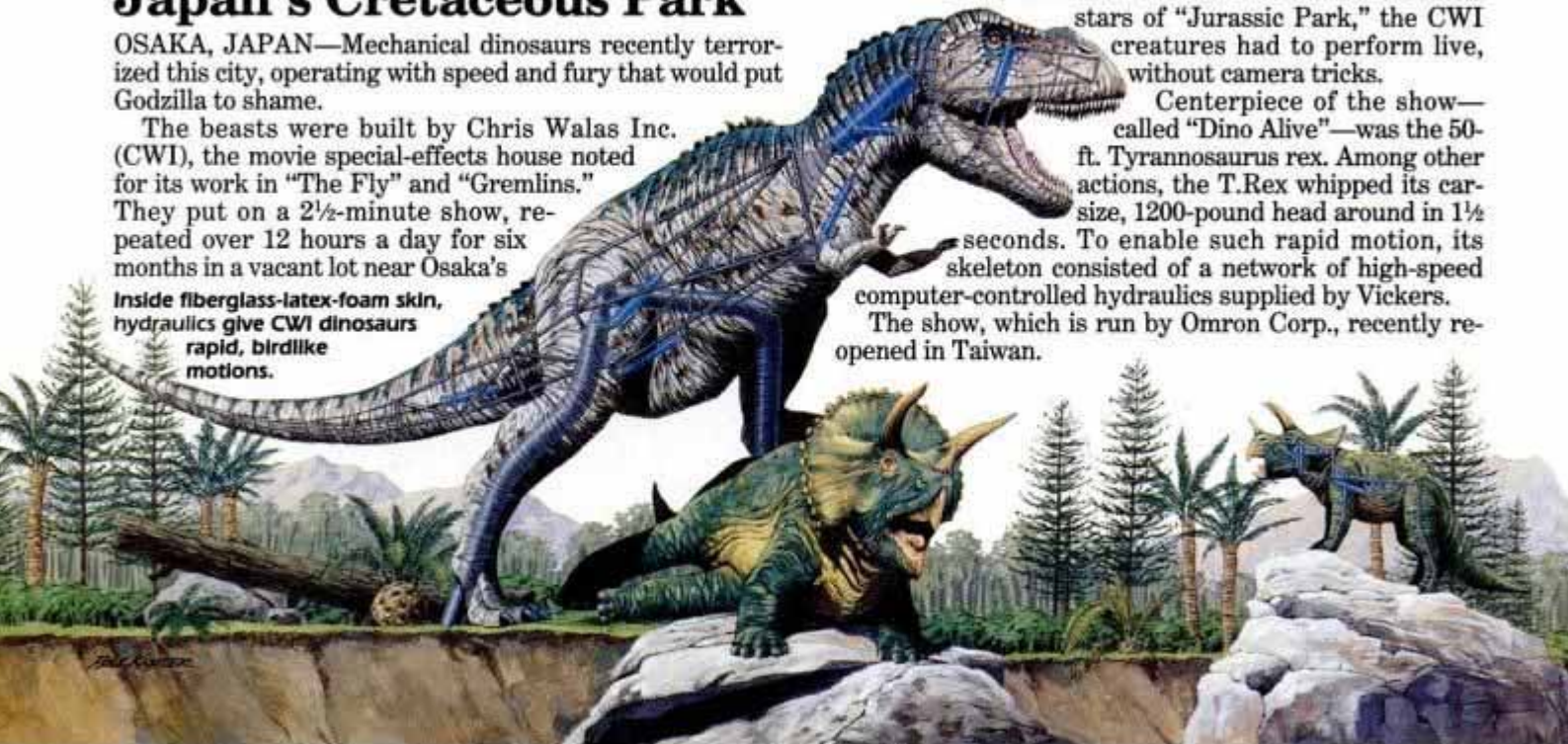
The beasts were built by Chris Walas Inc. (CWI), the movie special-effects house noted for its work in "The Fly" and "Gremlins." They put on a 2½-minute show, repeated over 12 hours a day for six months in a vacant lot near Osaka's

Inside fiberglass-latex-foam skin, hydraulics give CWI dinosaurs rapid, birdlike motions.

main train station. And unlike the mechanical stars of "Jurassic Park," the CWI creatures had to perform live, without camera tricks.

Centerpiece of the show—called "Dino Alive"—was the 50-ft. Tyrannosaurus rex. Among other actions, the T.Rex whipped its car-size, 1200-pound head around in 1½ seconds. To enable such rapid motion, its skeleton consisted of a network of high-speed computer-controlled hydraulics supplied by Vickers.

The show, which is run by Omron Corp., recently reopened in Taiwan.





Good taste still
costs less.

YOUR BASIC® UPDATE

Basic

**SURGEON GENERAL'S WARNING: Quitting Smoking
Now Greatly Reduces Serious Risks to Your Health.**

© Philip Morris Inc. 1994

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

Материал, защищенный авторским правом

SEALs' New Keels: Fast And Furious



SEAL options include craft from Halter Marine (above), Peterson Builders (below) and Israeli Shipyards (left).

NAB CORONADO, CA—The requirements? Deliver a Navy SEAL platoon to its objective quickly and smoothly, without leaving the commandos weaving and heaving. Cover more than 600 miles, topping out above 40 knots. Carry machine guns and fire missiles. Fit into a C-5A.

So runs the wish list for the Special Operations Command Mk. V insertion craft. USSOCOM is looking over three new designs, but an existing Israeli boat may be a dark horse in an emerging, but still shadowy, contest.

Two of the new designs come from Halter Marine—one an aluminum hull and waterjet propulsion, the other a composite hull with surface-piercing propellers. Little else has been released on these boats.

The third option is Peterson Builders' 71-ft. Sea Stalker, an asymmetric catamaran based on the British-built



Cougar Cat 2100. The craft comes with its own transporter for air and road travel.

USSOCOM also has evaluated Israeli Shipyards' Shaldag patrol craft, propelled by waterjet on a stepped deep-V planing hull contoured to keep water off the deck.



BAT Gets Eyes To Go With Ears

LOS ANGELES, CA—The Army's coming deep threat—the anti-armor submunition BAT (see Tech Update, page 24, Nov. '91)—may become even more of a terror behind enemy lines. New BATs may be able to see.

The gliding bomblets will scatter six at a time from missiles lofted by New and improved BATs will drop from Army tactical missiles to home in on armored vehicles.

the Multiple Launch Rocket System. Right now, they are designed to find moving armored vehicles with the help of acoustic detectors and heat-seekers. But BAT-maker Northrop may add millimeter-wave radar or high-resolution infrared seekers.

These added sensors would enable BATs to attack quiet, cold targets, such as Scud launchers or tanks with their engines turned off.

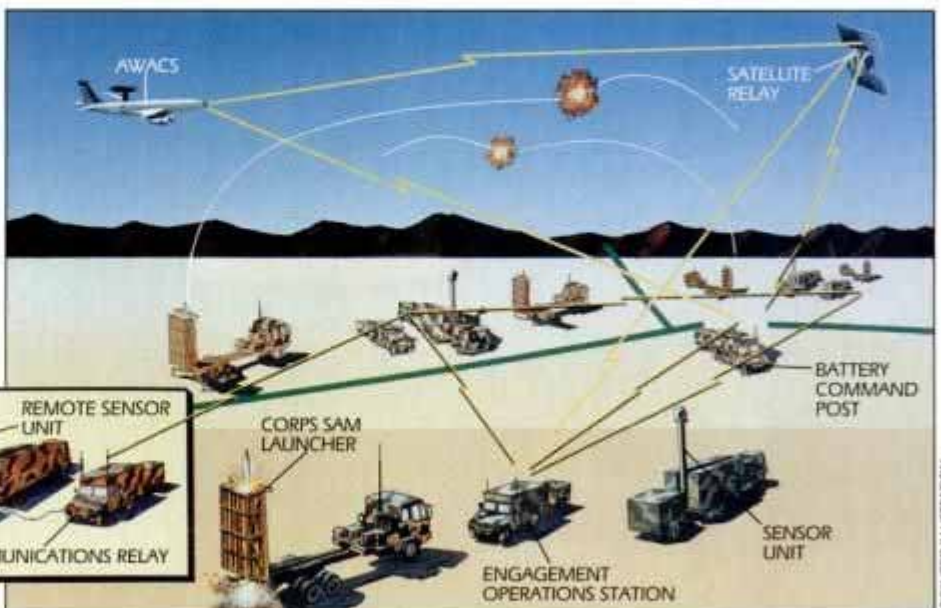
Air Defense For Offense

HUNTSVILLE, AL—While Patriots shield a stationary enclave against tactical missiles, what protects an Army corps as it maneuvers forward? To answer that question, the Army wants to develop a corps-wide defense system known as Corps SAM.

The proposed system is ambitious. The surface-to-air interceptors must be able to home in on either cruise missiles or Scud-type ballistic missiles—two very different threats.

In addition, the launchers will rely on ground radar scattered throughout the corps—even outside the corps. These sensor units will be distributed so that a single antiradiation missile doesn't kyo the whole system.

Aerospace firms are now airing



concepts for the system, which won't be fielded until next century. European allies may help develop it.

Spread across battlefield, Corps SAM equipment will require distributed command-and-control network.

Front and Rear Laser Detection

Another Industry First
from BEL-TRONICS



BEL-TRONICS introduces the latest in Laser Technology—Dual Tracking Laser™. BEL 635i Plus is the only integrated Radar/Laser detector that provides complete front and rear Laser detection.

Dual Tracking Laser™

Because police Laser monitoring devices can clock both approaching and receding vehicles, BEL has developed a new technology called Dual Tracking Laser™. Unlike Radar signals, which are highly reflective, Laser signals have very poor reflective characteristics. These characteristics make traditional Laser technology incapable of detecting Laser signals from the rear. In response, BEL 635i Plus features Dual Tracking Laser™—the only technology to provide front and rear detection of all Laser signals. Dual Tracking Laser™ is based on the same Laser technology used by the military in Operation Desert Storm. This powerful technology offers the best in off-axis detection—the most common form of police monitoring and a Laser detector's biggest challenge.

Super Wideband Ka Radar with FMT®

BEL-TRONICS' dual-patented FMT® maintains full sensitivity over the entire Super Wideband Ka bandwidth—33.4 to 36.0 GHz. Most detectors provide Ka sensitivity that "peaks" at a fixed frequency, then sharply falls off, leaving you without complete Super Wideband Ka coverage.

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Only BEL-TRONICS offers the additional coverage of rear Laser detection. You can have BEL 635i Plus for just \$289.95. To order, or for the name of a dealer near you, call toll-free today:

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Introducing the new BEL 635i Plus

Dual Tracking Laser™

Complete Super
Wideband Ka Radar
Detection with FMT™





First piece of Comanche reveals size and complexity of parts fabricated with new composite manufacturing processes.

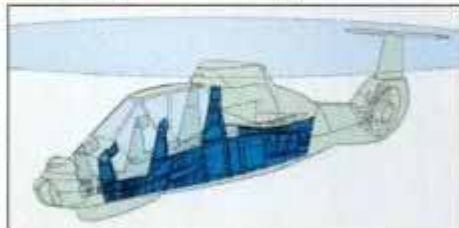
Comanche's Commencement

BRIDGEPORT, CT—Now on its way is the first of the scout/attack helicopters that will combine the eyes of OH-58 Kiowas with the fangs of AH-1 Cobras (see "The Army's Newest Killer Chopper," page 26, July '91). Sikorsky has fashioned a big, complex chunk of an RAH-66 Comanche—its 25-ft. starboard keelbeam.

The graphite-epoxy structure,

when mated with its lefthand counterpart, will shield the chopper's heart from anti-aircraft fire. Over this gawky skeleton will stretch a composite skin. Both will contribute to the Comanche's stealth: Its radar signature is reported to be 1% of that of a current helicopter.

The prototype Comanche will fly in 1995. The chopper will eventually har-



ness the Longbow radar and weapons system under development for the AH-64 Apache. That means beefier engines than originally planned.

Future Robots At A Glance

ROCHESTER, NY—Though you scarcely notice it, your eyes make darting little movements 100,000 times a day. Called saccades, the motions allow you to glean data from your environment as needed, instead of memorizing every detail.



UNIVERSITY OF ROCHESTER PHOTO

Now University of Rochester roboticists hope to endow machines with the same skill. Working with eye-tracking hardware, engineers hope to parlay the effort into new artificial-intelligence architectures that don't rely on vast computer memory to store visual information.

Head-mounted retina-tracker reveals how quick eye movements, rather than memory, aid performance of tasks.

Featherweight Whirlybird



Weighing only 254 pounds, Ultraspout features composite structure and 52-hp Rotax engine.

NEWPORT NEWS, VA—The ultimate in personal flying machines is ready for pick-up. Write a check for \$25,000 and American SportsCopters will hand over the keys to your Ultraspout 254.

No need for a license or flight physical—the Ultraspout is officially an ultralight. The one-seater flies under a teetering-type main rotor with folding blades, along with a ducted tail rotor. Fuselage and blades are composites. Expect a mere \$8 per hour in operating costs, says SportsCopters.

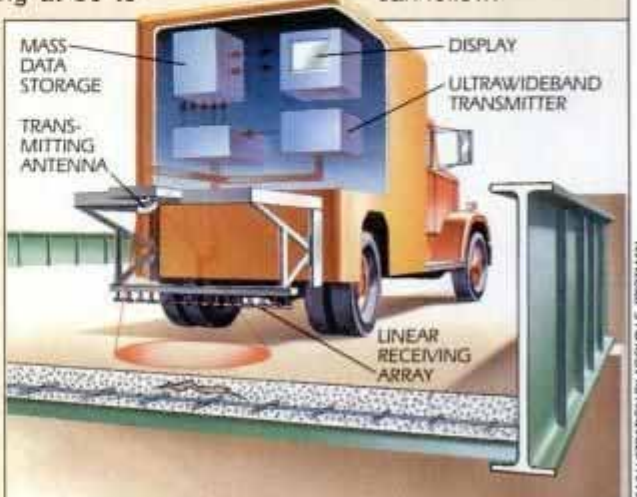
Quick Scans For Sick Spans

LIVERMORE, CA—Aging bridges don't always reveal their aches and pains. And an in-depth examination not only ties up traffic but rarely spots every problem.

But researchers at Lawrence Livermore National Laboratory envision apparatus that, mounted on a truck traveling at 30 to 40 mph, could analyze a wide swath of road.

The ground-penetrating radar at the system's core would be geared to produce high-resolution 3D images. To that end, engineers have de-

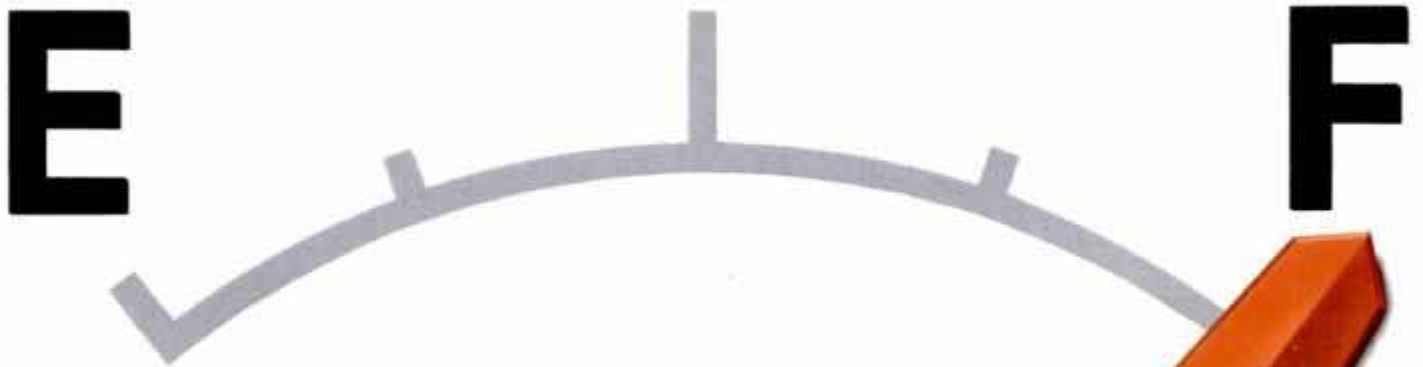
veloped a transistor-based pulse generator that puts out short beeps at 5 kw, strong enough to pass through a road surface. An array of receiving antennas provides fine spatial detail. Image-processing software then renders a subsurface map that repair crews can follow.



Truck-mounted system would spot corrosion before a bridge is too far gone.

AN ILLUSTRATION BY AODUN E. BROTHMAN

Try Using This Gauge When Buying A Truck.



There are a lot of standards you could use when sooner or later, you'll have to stop for Chevy Full-Size Pickup, it will definitely size pickup gets more out of a gallon.

judging a new truck. But gas. If you're driving a new be later. Because no other full- And it does it with the biggest V6

engine you can get. Remember, no matter which truck you're looking at right now, you'll be a lot happier later on if you spend more time looking at a full gas gauge in your brand new Chevy

Truck. Chevrolet. The most dependable, longest-lasting trucks on the road.†



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*Based on EPA estimated MPG 1/2 Ton 2WD, city 17/hwy. 22; 4WD, city 15/hwy. 19. Standard engine transmission. EPA comparisons.
†Dependability based on longevity: 1983-1992 full-line truck company registrations. Excludes other GM divisions. Chevrolet and the Chevrolet Emblem are registered trademarks and Chevy is a trademark of the GM Corp. ©1993 GM Corp. All Rights Reserved. Buckle up, America!

Missile-Warning Woes

WASHINGTON, DC—The Pentagon's plans for future missile-spotting satellites are very much up in the air, with the recent cancellation of the proposed Follow-On Early Warning System (FEWS) and potential scaleback of the Brilliant Eyes constellation.

Right now, officials have five Defense Support Program (DSP) satellites, which sit in geosynchronous orbit watching for missile launches. There are six spares to come. The FEWS spacecraft were supposed to replace the DSPs. TRW and Lockheed, rivals for the FEWS contract, have offered cheaper alternatives.



FEWS (above) is gone, and Brilliant Eyes (right) is facing a slowdown in development.



TRW ILLUSTRATIONS

Meanwhile, Brilliant Eyes—part of

the old Strategic Defense Initiative—would circulate in low Earth orbit. These small satellites would track en-

route missiles and guide interceptors. But budget-cutters are chipping away at this program, too.

Satellites Help Move Earth

PEORIA, IL—The latest trick from the Global Positioning System? Guiding the blades of heavy construction equipment. Caterpillar and Magnavox are developing computer-controlled construction techniques that would rely on signals from the navigation satellites.



Ohio State's Center For Mapping is testing precision control of earthmover blades.

Under a Technology Reinvestment Program grant, the companies will combine kinematic satellite-aided positioning with laser guidance. The idea is to eliminate detailed topographic surveys, while enabling bulldozers to cut paths mapped by computer with accuracies to a fraction of an inch. The technology is also applicable to mining, dredging and farming equipment.

Engineers at Ohio State University have been pursuing similar research.



CATERPILLAR PHOTO

Caterpillar and Magnavox are teaming to pinpoint heavy equipment with GPS signals.

Maps On Wheels

FORT BELVOIR, VA—The Army is exploiting the revolution in digital cartography with a mapmaking truck that will roll with battlefield commanders.

Called the Digital Topographic Support System, the vehicle will house a host of computerized mapmaking tools. Inside, terrain analysts will be able to whip up line-of-sight views, mobility maps and other products in minutes, using Defense Mapping Agency data and other sources.

Two soldiers will crew the DTSS, converting terrain and climate data into maps.

Loral Defense Systems has delivered the first unit.



Elbows For Robots

LANGLEY, VA—For years, NASA has been refining the idea of a variable-geometry truss, a mechanism involving struts that change in length. While such a device could suppress vibration in a spacecraft, there are earthly applications as well.

One under investigation by NASA's Langley Research Center and Pacific Northwest Laboratory is a long-reach robotic arm, to maneuver inside subterranean waste-storage tanks at the old Hanford nuclear-weapons complex. In a prism-like configuration known as a double octahedron, the truss could serve as an elbow for such an apparatus. A waste-retrieval hose would snake through the open framework.

Variable-geometry truss could provide maneuverability for manipulator arm inside underground storage tank.



PN ILLUSTRATION BY ED VAUGHN

John's losing his hair. His mission: get it back.

ASAP!

But how?

Weaving? No.

Transplant?

Not for him.

A hairpiece?

Never, never.

What John really

wants is his
own hair back.

And now he's learned,
for male pattern

baldness, only

Rogaine[®] has been

proven to regrow hair.

Rogaine[®] Topical Solution (minoxidil 2%) works in part by prolonging the growth of hair, which grows in cycles. With more hairs growing longer and thicker at the same time, you may see improved scalp coverage.

After one year, over three fourths of men reported some hair regrowth.

Dermatologists conducted 12-month clinical tests. After 4 months, 26% of patients using *Rogaine* reported moderate to dense hair regrowth, compared with 11% of those using a placebo (a similar solution without minoxidil — the active ingredient in *Rogaine*). After 1 year, 48% of the men who continued using *Rogaine* in the study rated their regrowth as moderate to dense. Thirty-six percent reported minimal regrowth. The rest (16%) had no regrowth.

Side effects were minimal: 7% of those who used *Rogaine* had itching of the scalp.

Rogaine should only be applied to a normal, healthy scalp (not sunburned or irritated).

Make it part of your normal routine.

Studies indicate that *at least 4 months of twice-daily treatment with Rogaine* are usually necessary before there is evidence of regrowth. So why not make it part of your normal routine when you wake up and go to bed, like brushing your teeth.

As you'd expect, if you are older, have been balding for a longer period, or have a larger area of baldness, you may do less well.

Rogaine is a treatment, not a cure. So further progress is only possible by using it continuously. Some anecdotal reports indicate that if you stop using it, you will probably shed the newly regrown hair within a few months.

Get your free Information Kit today.

You may even be eligible for a free, private hair-loss consultation with a doctor.*

Why wait? Find out whether *Rogaine* is for you. Call 1-800-229-9332 for a free Information Kit about the product and how to use it. **And because *Rogaine* requires a prescription**, we'll include a list of nearby *dermatologists or other doctors experienced in treating hair loss who may be able to offer you a free, private hair-loss consultation.**

Call

1 800 229-9332

for your free *Rogaine* Information Kit.

We'll also tell you how to find out if you're eligible for a free, private hair-loss consultation with a doctor.*

Rogaine[®]
TOPICAL SOLUTION minoxidil 2%

See next page for important additional information.

*Not available in all areas.
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Rogaine[®]
TOPICAL SOLUTION
minoxidil 2%

The only product ever proven to regrow hair.

What is ROGAINE?

ROGAINE Topical Solution is a prescription medicine for use on the scalp that is used to treat a type of hair loss in men and women known as androgenetic alopecia: hair loss of the scalp vertex (top or crown of the head) in men and diffuse hair loss or thinning of the front and top of the scalp in women. ROGAINE is a topical form of minoxidil, for use on the scalp.

How effective is ROGAINE?

In men: Clinical studies with ROGAINE of over 2,300 men with male pattern baldness involving the top (vertex) of the head were conducted by physicians in 27 US medical centers. Based on patient evaluations of regrowth at the end of 4 months, 26% of the patients using ROGAINE had moderate to dense hair regrowth compared with 11% who used a placebo treatment (no active ingredient). No regrowth was reported by 41% of those using ROGAINE and 58% of those using a placebo. By the end of 1 year, 48% of those who continued to use ROGAINE rated their hair growth as moderate or better.

In women: Clinical studies with ROGAINE were conducted by physicians in 11 US and 10 European medical centers involving over 600 women with hair loss. Based on patient evaluations of regrowth after 32 weeks (8 months), 23% of the women using ROGAINE had at least moderate regrowth compared with 9% of those using a placebo. No regrowth was reported by 43% of the group using ROGAINE and 60% of the group using placebo.

How soon can I expect results from using ROGAINE?

Studies show that the response time to ROGAINE may differ greatly from one person to another. Some people using ROGAINE may see results faster than others; others may respond with a slower rate of hair regrowth. You should not expect visible regrowth in less than 4 months.

How long do I need to use ROGAINE?

ROGAINE is a hair-loss treatment, not a cure. If you have new hair growth, you will need to continue using ROGAINE to keep or increase hair regrowth. If you do not begin to show new hair growth with ROGAINE after a reasonable period of time (at least 4 months), your doctor may advise you to discontinue using ROGAINE.

What happens if I stop using ROGAINE? Will I keep the new hair?

Probably not. People have reported that new hair growth was shed after they stopped using ROGAINE.

How much ROGAINE should I use?

You should apply a 1-mL dose of ROGAINE twice a day to your clean dry scalp, once in the morning and once at night before bedtime. Wash your hands after use if your fingers are used to apply ROGAINE. ROGAINE must remain on the scalp for at least 4 hours to ensure penetration into the scalp. Do not wash your hair for at least 4 hours after applying it. If you wash your hair before applying ROGAINE, be sure your scalp and hair are dry when you apply it. Please refer to the Instructions for Use in the package.

What if I miss a dose or forget to use ROGAINE?

Do not try to make up for missed applications of ROGAINE. You should restart your twice-daily doses and return to your usual schedule.

What are the most common side effects reported in clinical studies with ROGAINE?

Itching and other skin irritations of the treated scalp area were the most common side effects directly linked to ROGAINE in clinical studies. About 7 of every 100 people who used ROGAINE (7%) had these complaints.

Other side effects, including light-headedness, dizziness, and headaches, were reported both by people using ROGAINE and by those using the placebo solution with no minoxidil. You should ask your doctor to discuss side effects of ROGAINE with you.

People who are extra sensitive or allergic to minoxidil, propylene glycol, or ethanol should not use ROGAINE.

ROGAINE Topical Solution contains alcohol, which could cause burning or irritation of the eyes or sensitive skin areas. If ROGAINE accidentally gets into these areas, rinse the area with large amounts of cool tap water. Contact your doctor if the irritation does not go away.

What are some of the side effects people have reported?

ROGAINE was used by 3,857 patients (347 females) in placebo-controlled clinical trials. Except for dermatologic events (involving the skin), no individual reaction or reactions grouped by body systems appeared to be more common in the minoxidil-treated patients than in placebo-treated patients.

Dermatologic: irritant or allergic contact dermatitis—7.36%; **Respiratory:** bronchitis, upper respiratory infection, sinusitis—7.16%; **Gastrointestinal:** diarrhea, nausea, vomiting—4.33%; **Neurologic:** headache, dizziness, faintness, light-headedness—3.42%; **Musculoskeletal:** fractures, back pain, lumbago, aches and pains—2.59%; **Cardiovascular:** edema, chest pain, blood pressure increases/decreases, palpitations, pulse rate increases/decreases—1.53%; **Allergic:** nonspecific allergic reactions, hives, allergic rhinitis, facial swelling, and sensitivity—1.27%; **Metabolic-Nutritional:** edema, weight gain—1.24%; **Special Senses:** conjunctivitis, ear infections, vertigo—1.17%; **Genital Tract:** prostatitis, epididymitis, vaginitis, vulvitis, vaginal discharge/itching—0.91%; **Urinary Tract:** urinary tract infections, renal calculi, urethritis—0.93%; **Endocrine:** menstrual changes, breast symptoms—0.47%; **Psychiatric:** anxiety, depression, fatigue—0.36%; **Hematologic:** lymphadenopathy, thrombocytopenia, anemia—0.31%.

ROGAINE use has been monitored for up to 5 years, and there has been no change in incidence or severity of reported adverse reactions. Additional adverse events have been reported since marketing ROGAINE and include eczema; hypertrichosis (excessive hair growth); local erythema (redness); pruritus (itching); dry skin/scalp flaking; sexual dysfunction; visual disturbances, including decreased visual acuity (clarity); increase in hair loss; and alopecia (hair loss).

What are the possible side effects that could affect the heart and circulation when using ROGAINE?

Serious side effects have not been linked to ROGAINE in clinical studies. However, it is possible that they could occur if more than the recommended dose of ROGAINE were applied, because the active ingredient in ROGAINE is the same as that in minoxidil tablets. These effects appear to be dose related; that is, more effects are seen with higher doses.

Because very small amounts of minoxidil reach the blood when the recommended dose of ROGAINE is applied to the scalp, you should know about certain effects that may occur when the tablet form of minoxidil is used to treat high blood pressure. Minoxidil tablets lower blood pressure by relaxing the arteries, an effect called vasodilation. Vasodilation leads to fluid retention and faster heart rate. The following effects have occurred in some patients taking minoxidil tablets for high blood pressure:

Increased heart rate: some patients have reported that their resting heart rate increased by more than 20 beats per minute.
Salt and water retention: weight gain of more than 5 pounds in a short period of time or swelling of the face, hands, ankles, or stomach area.
Problems breathing: especially when lying down; a result of a buildup of body fluids or fluid around the heart.
Worsening or new attack of angina pectoris: brief, sudden chest pain.

When you apply ROGAINE to normal skin, very little minoxidil is absorbed. You probably will not have the possible effects caused by minoxidil tablets when you use ROGAINE. If, however, you experience any of the possible side effects listed above, stop using ROGAINE and consult your doctor. Any such effects would be most likely if ROGAINE was used on damaged or inflamed skin or in greater than recommended amounts.

In animal studies, minoxidil, in much larger amounts than would be absorbed from topical use (on skin) in people, has caused important heart-structure damage. This kind of damage has not been seen in humans given minoxidil tablets for high blood pressure at effective doses.

What factors may increase the risk of serious side effects with ROGAINE?

People with a known or suspected heart condition or a tendency for heart failure would be at particular risk if increased heart rate or fluid retention were to occur. People with these kinds of heart problems should discuss the possible risks of treatment with their doctor if they choose to use ROGAINE.

ROGAINE should be used only on the balding scalp. Using ROGAINE on other parts of the body may increase minoxidil absorption, which may increase the chances of having side effects. You should not use ROGAINE if your scalp is irritated or sunburned, and you should not use it if you are using other skin treatments on your scalp.

Can people with high blood pressure use ROGAINE?

Most people with high blood pressure, including those taking high blood pressure medicine, can use ROGAINE but should be monitored closely by their doctor. Patients taking a blood pressure medicine called guanethidine should not use ROGAINE.

Should any precautions be followed?

People who use ROGAINE should see their doctor 1 month after starting ROGAINE and at least every 6 months thereafter. Stop using ROGAINE if any of the following occur: salt and water retention, problems breathing, faster heart rate, or chest pains.

Do not use ROGAINE if you are using other drugs applied to the scalp such as corticosteroids, retinoids, petrolatum, or agents that might increase absorption through the skin. ROGAINE is for use on the scalp only. Each 1 mL of solution contains 20 mg minoxidil, and accidental ingestion could cause unwanted effects.

Are there special precautions for women?

Pregnant women and nursing mothers should not use ROGAINE. Also, its effects on women during labor and delivery are not known. Efficacy in postmenopausal women has not been studied. Studies show the use of ROGAINE will not affect menstrual cycle length, amount of flow, or duration of the menstrual period. Discontinue using ROGAINE and consult your doctor as soon as possible if your menstrual period does not occur at the expected time.

Can ROGAINE be used by children?

No, the safety and effectiveness of ROGAINE has not been tested in people under age 18.

Caution: Federal law prohibits dispensing without a prescription. You must see a doctor to receive a prescription.

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DIVISION

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PM HOTLINES

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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 on line, 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.

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BEYOND JURASSIC PARK

The next special effect for films will be computer-generated movie stars. Get ready for the return of Marilyn.

BY KIRBY CARMICHAEL

• Marilyn Monroe moves smoothly under a red kimono, and the audience gasps with delight. The scene cuts to Marilyn seated in a swinging trapeze far above the ground. Her face is animated and happy, platinum hair flying in the breeze and her short skirt flipping up over her sleek, attractive thighs.

As in her previous life, nobody really knows this Marilyn. This Marilyn is a computer construct—a proof-of-concept synthetic human actor used to advance the science and art of realistic 3D digital animation.

The screen goes dark. Nadia Magnenat-Thalmann, one of the filmmakers, whispers up at the screen: "There went the last two years of work." This Marilyn Monroe "Fashion Show" was created at MIRALab—University of Geneva and the Swiss Federal Institute of Technology under the direction of Professor Nadia Magnenat-Thalmann and Professor Daniel Thalmann.

"I want to one day be able to exactly model humanity," says Magnenat-Thalmann, her eyes shining. "Movement, clothes, hair—all of it."

Last summer's release of "Jurassic Park" was an eye-opener to many people unaware that computer animation had advanced so far. "Jurassic Park" used a combination of computer-generated dinosaur actors mixed with live-action mechanical models and puppets. The slow-moving

BEYOND JURASSIC PARK



dinosaur closeups were generally created with mechanical models. If it was running, however, chances are it was a computer-generated image (CGI).

Viewing "Jurassic Park" might make you think that the major problems facing the computer animation of synthetic actors have been solved. In fact, many have—but only since the production phase of the movie ended. The beasts in "Jurassic Park" seemed so real and alive that it can be difficult to imagine how much more realistic a CGI animal could look.

But think back. There were two raptors in the movie. Which one was dominant? Did they have individual personalities? How many times did they actually look each other in the eye? Did any of the CGI dinosaurs show significant facial animation beyond growls? How many emotional nuances beyond predation were displayed by the T.Rex? Did any dinosaur reach out and grasp an object? And did you notice whether the T.Rex's quality of motion changed as its body grew tired from chasing the jeep?

The "Jurassic Park" dinosaurs strike us as real because we've had no previous experience with dinosaurs. Yet we interact with other humans a good part of every day. The level of realism in "Jurassic Park's" CGI dinosaurs, as good as it is, is far below the level that will be necessary to maintain convincingly animate synthetic human actors.

Until "Jurassic Park," computer animators were limited to hierarchical animation. A 3D leg rotated forward at the hip, for example, would carry the knee and foot with it. After rotating the leg, the lower leg would have to be rotated to get the proper angle at the knee and then the foot would be similarly rotated to place it flat on the



A computer image of Marilyn Monroe demonstrates movement (top left). Clothes and body move independently in both a short dress (top right) and in a kimono.

ground. Only during the production phase of "Jurassic Park" did SoftImage, the French company that created the animation program used in the movie, add inverse kinematics to its program. Inverse kinematics allows the animator to grab the foot and place it appropriately. All other parts of the leg and connecting joints rotate properly in response. This automatic routine eased the burden on the animators tremendously and in fact made the use of CGI dinosaurs economically feasible. Other automatic routines were already available in SoftImage, such as the physics of gravity, collision detection and wind.

Contrary to what you may think, facial animation is not the largest problem in creating realistic synthetic

human actors. In fact, the facial animation problem has essentially been solved. Work by Demetri Terzopoulos and his team at the University of Toronto uses a 3-layer approach to facial animation—elastic facial tissue covering muscle tissue overlying the nondeformable 3D bone structure. Terzopoulos' work utilizes a deformable springs-and-nodes wireframe mesh with facial color and texture data scanned from a human being via a Cyberware laser scanner. The data is mapped onto the mesh that is applied to the 3D model of a head. Facial muscles are controlled by means of "snakes"—26 portions of the wireframe mesh designated as facial muscles—and the resulting facial animations can be so realistic as to be unnerving.

Terzopoulos' approach promises variable spring depth and tension, with the spring mesh automatically responding to the movements of the synthetic actor. For instance, the creation of a potbelly on a synthetic human actor might merely require a set of longer springs with lower tension so that the stomach would shake like a bowl of jelly.

Talking heads

Spoken language is still a problem, however. Animating a CGI face to articulate phonemes so that lip movements can be lip-synced with a human actor is well along, but problems have been encountered in necessary rotation of the lip muscles for plosive phonemes (like the "p" sound). The problems should be solved in time.

Human expression, however, is not so much a concern of high-level computer scientists, but rather a matter for individual animators. There are currently very few 3D animators trained or experienced in the task of

facial expression in 3D. Since Terzopoulos' work (and that of the Thalmanns and Norman Badler of the University of Pennsylvania) is state of the art, no commercial tools exist upon which 3D animators can be trained in the art of 3D human expression. The problem will solve itself as software developers utilize this basic work of the researchers to extend the functions of their 3D animation programs.

Will the techniques of the Thalmanns and other researchers lead to the end of the acting profession? Many in the film industry are afraid of just that. There is a popular fear that recreating characters from the past in film-realistic form could lead to a dearth of new character introductions in movies. Why experiment when you can revive bankable characters from the past? Humphrey Bogart films will always draw a strong audience, and a good new Marilyn Monroe film might outdraw reptile movies. Human actors might be reduced to an insignificant role—one that might be termed Data Acquisition Models (DAMs).

Automatic response

Automatic routines resulting in autonomous or semiautonomous synthetic actors promise serious reductions in animator workload, and may set the scene for a film's director to be a one-person production company. A semiautonomous actor would have the capacity for a certain amount of self-directed movement and response independent of input by an animator. An autonomous actor would be able to independently respond to his environmental situation by, for example, blushing at embarrassing moments or wiping sweat from his brow during periods of heavy physical exertion. The animator would not so much determine which moments were embarrassing to a character, as he would establish an embarrassment threshold while designing the character. This threshold would determine the extent to which a character determined a given situation to be embarrassing. Would it be embarrassing for your pants to accidentally drop while singing the national anthem at a baseball game? A "no" answer means the character has a high threshold.

What if the animator could give spoken instructions to a semiautonomous actor in his language of choice? Norman Badler heads research into a project called JACK, which has already seen practical commercial use by the John Deere Co. in bulldozer design and by the U.S. Army in weapons research.

Essentially, JACK is a set of computer routines that allows the anima-



The collage at top shows a digitized scan of a person's face and the computer model, later manipulated to show various emotions. Remove the texture mapping (bottom left) and you see the 3D triangulated surface mesh. A closeup (bottom right) reveals the amount of detail in the computer construct.

tor to type English language commands to a digital actor. The routines analyze the commands and set a list of priorities for the synthetic Jack to carry out. Jack obeys the laws of physics. He has a center of gravity, and if you push him he'll try to recover but is likely to fall over. Most important, though, Jack has a set of eyes through which he evaluates his environment. Jack will automatically avoid objects that could trip him. He can look directly into the face of another actor. He can see what a human would see from the operator's seat of a bulldozer so that a design may be changed for operator safety. Jack can "go fetch" objects without an animator's input, and he can also make decisions as to where those

objects are most likely to be.

How long will it be before we're seeing synthetic human actors on the screen that are so realistic we don't know they're synthetic? Mark Sylvester, a vice president and founder of Santa Barbara, California's Wavefront—producers of one of the most powerful 3D animation systems—was quite direct and representative of the range of opinions.

"We're seeing synthetic actors that are realistic now. Haven't you seen 'Jurassic Park'? Synthetic human actors, though?" He paused a moment to consider. "We'll see them in two to five years. We'll need another magnitude of computer speed, but that's inevitable—it's just a matter of when we get it."

FM

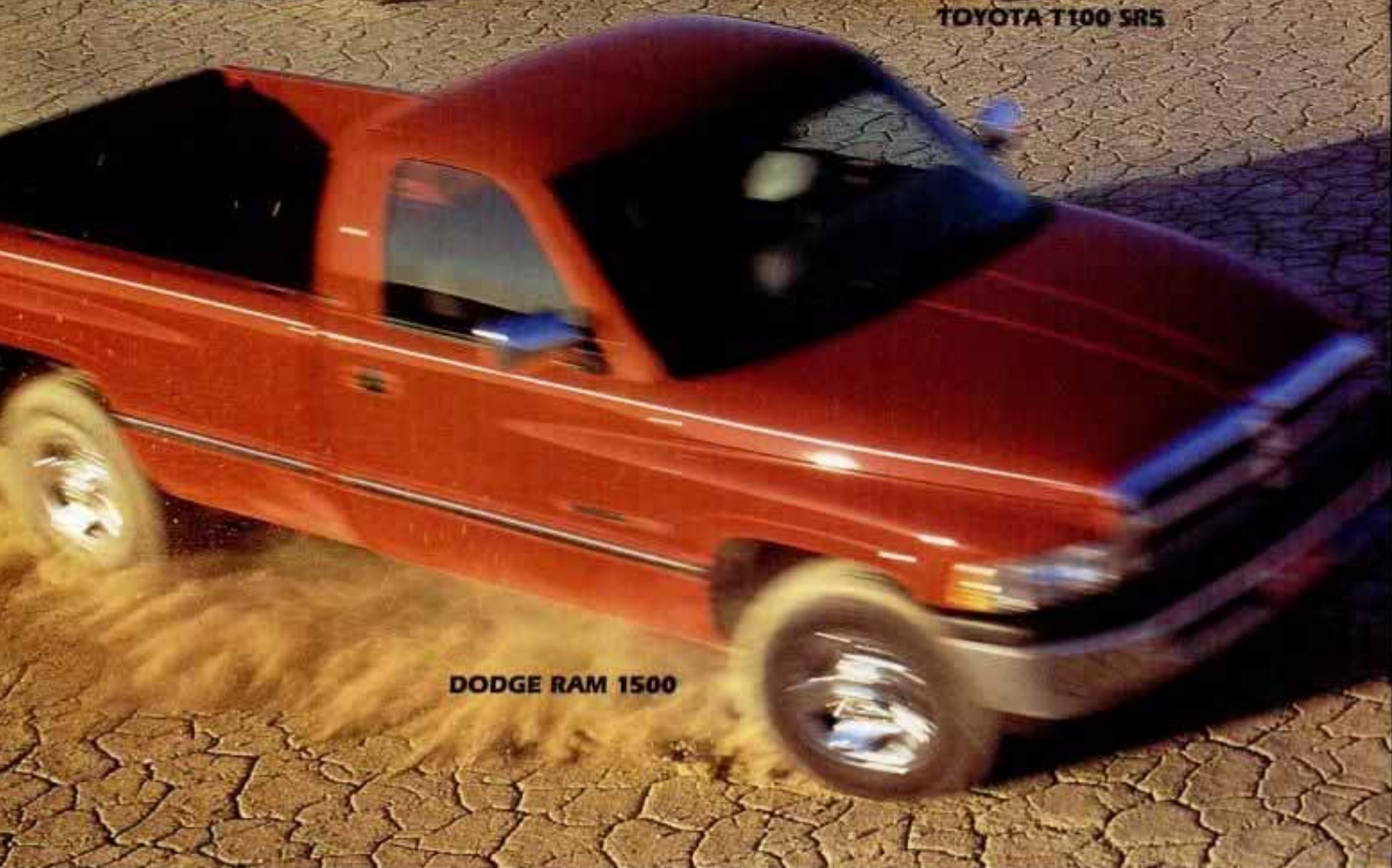
TRUCKS



MAZDA B4000



TOYOTA T100 SR5



DODGE RAM 1500

● Beverly Miller buckles her son, Howard, into the child safety seat in her Plymouth Voyager minivan. Miller loves driving her minivan, but she would never dream of driving a truck.

Phil Stroh jams the shift lever on his Jeep Grand Cherokee into 4WD Low Range to make it up an ice-slicked hill. Stroh also has no desire to own or drive a truck.

But both Beverly Miller and Phil Stroh are in for a surprise, because according to automotive industry classifications, they both own trucks.

Once considered commercial workhorse haulers, trucks have gained not only social respectability, but status. A \$30,000 Jeep Grand Cherokee Limited is just

as at home at the country club as it is clawing up a muddy rock-strewn path to a mountain vacation retreat. Light trucks, including all their variants—pickups, minivans and sport/utility vehicles—are the

hottest segment of the new-vehicle market. In 1992, for example, new-car sales rose a modest 0.4%. Light trucks in the same period rose 12.4% and accounted for 36.3% of the total market.

The truck boom is even louder in 1993. Figures through August show the overall

new-car market up 7.9%, but trucks are thundering along with a 17.6% increase over '92.

So why does it seem that almost everyone wants a truck? One big reason is that manufacturers are mak-



CHEVROLET C 1500



GMC SONOMA



FORD RANGER SPLASH

TRUCKS HIT HIGH GEAR

Everybody wants a truck. Here's what's fueling their new wave of popularity.

BY CLIFF GROMER, Contributing Editor
PM Photos by Rich Cox



OLDSMOBILE BRAVADA

ing their light trucks, well, less trucklike. Or put another way, these trucks are more carlike. The result is that they are more conducive

for dual use—personal transportation along with cargo carrying. Light trucks now boast the same advanced safety features as cars—airbags, antilock brakes and door side-impact beams. And you won't find a shortage of creature comforts in the new breed of haulers, either. Long-standard equipment and option lists offer such goodies as cruise control, tilt steering wheel, CD sound systems that will knock your socks off and even electronic vehicle information displays that do everything but take dictation. Let's not forget premium leather seating, plush carpeting and super sound insulation.

What about performance? How about V8 power that will put some so-called hot-performance cars to shame. Or potent V6s that will fry the tires if you're

in that kind of culinary mood. Or a new V10 engine, the likes of which you won't find anywhere but in the new Dodge Ram

pickup—or the ultra-sport Dodge Viper.

But the biggest improvement—and drawing card—in the light truck's strong hand is its ride comfort. The once-familiar buckboard bounce is ancient history. Suspension engineers have continually redesigned and refined components and systems to the point of today's highly touted "soft-ride" suspensions that don't give up anything in terms of load capacity.

Buyers are taking note of all this as well as new styling treatments that feature more-rounded exteriors, sharp-styled wheels and eye-catching colors. Add to this the increased interior room of minivans and sport/utilities, compared to typical sedans, and buyers also see the practical side of light trucks. In fact, many industry observers see trucks as the station wagons of the '90s.

TRUCKS HIT HIGH GEAR



FORD BRONCO



TOYOTA 4RUNNER



MERCURY VILLAGER



NISSAN PATHFINDER

Without a doubt, the biggest truck news for 1994 has to be the totally redesigned full-size Dodge Ram series. And the news is big, as the Ram sports the biggest, roomiest standard cab in its class and the biggest engine of any light pickup in the world. The powerhouse V10 delivers 300 horsepower and an almost board-flat torque curve that peaks at a barn-raising 450 ft.-lb. of torque. Of course, if you don't need all those cylinders, you can choose from two V8s, a V6 and an inline 6-cylinder Cummins diesel. A full herd of Rams, including extended-cab versions, will soon complement the standard-cab offerings available in 2- and 4-wheel drive, in ½-ton, ¾-ton and 1-ton series. Safety highlights include a driver's airbag and the first 4-wheel antilock brake system to be installed in a pickup truck.

Chevrolet's compact S-Series pickups—along with their cousins, GMC's compact Sonomas—are re-engineered from the ground up, starting with a stiffer frame, to have more carlike amenities. Features such as an easy-riding suspension, a new interior, a high comfort level and an instrument panel with more carlike cues make this one of the prime dual-purpose pickups. S-Series engine choices range from a 110-hp Four to a 195-hp V6—the most power you can get in a compact pickup. Body styles include regular and extended-cab versions, with bed-length options available with the regular cab. All come in two levels of trim and choice of 2-wheel or 4-wheel drive.

Two special models set the S-Series apart: the Super Sport and the ZR2. The 2wd Super Sport package combines the 195-hp V6, 4-speed automatic transmission, sport suspension and 3.42:1 ratio locking differential with a leather-wrapped wheel, exterior cues, P215/65R15 tires on alloy wheels and SS graphics. The 4wd ZR2



GEO TRACKER

off-road performance package starts with a beefed-up frame, a wider-track (front and rear), special heavy-duty suspension components, 3.73:1 ratio rear, 31x10/R15 on/off-road tires and a choice of a 165-hp or 195-hp V6 mated to either a 5-speed manual or 4-speed electronically controlled automatic transmission.

Ford hopes to make some waves with its Splash model—an option in its Ranger series that offers Flareside (traditional external rear fenders/narrow box) styling that's unique to the compact truck field. Special Splash graphics are an added touch. Mechanicals are standard Ranger fare, with the choice of a 98-hp 4-cylinder or one of two V6s that produce 140 and 160 horsepower respectively. Splash

comes in standard and new-for-'94 SuperCab trim and either 2-wheel or 4-wheel-drive versions.

Toyota's long-awaited full-size T100 pickup measures in a little shorter than its U.S. counterparts, and slightly larger than the Dodge Dakota midsize pickup. For '94, Toyota has moved last year's base V6 up a notch to slide a price-leading base 4-cylinder 2-wheel-drive model in at the bottom of the lineup. The 2.7-liter dohc balance-shaft Four dishes out a respectable 150 hp and 177 ft.-lb. of torque—the same horsepower rating and only 3 ft.-lb. less than the 3.0-liter sohc V6.

Mazda's '94 B-series compact pickups debut in a completely redesigned package—their first revamp in 10 years. Everything about the trucks is new—from bigger engines to longer wheelbases to updated exteriors and interiors. Mazda shares the same basic platform with the popular Ford Ranger. Three engine choices range from a 98-hp 4-cylinder to the 160-hp V6, the most powerful engine in an import nameplate pickup. The V6-engined B4000 is the only model that offers 4-wheel drive. There are a total of 11 models consisting of two cab configurations, two bed lengths and three trim levels.

For a more comprehensive buyers guide, one that covers all the models of light trucks, vans and sport/utilities in full- and compact-size trim, see the following story. If you've been thinking about buying a new truck, this may be the year.

PM



GMC SONOMA

1994 BUYERS GUIDE

All the new full-size and compact pickups, vans and sport/utilities.

BY CLIFF GROMER, Contributing Editor

● If you're interested in buying a new truck, in any variety of the breed—pickup, van or sport/utility—the critical factor in making the right decision is relevant information, which is the obvious reason for this buyers guide. Here you'll find an overview of every 1994 truck on the market. Information on the hottest of the new pickups—Dodge Ram, Ford Ranger Splash, Chevrolet S-Series/GMC Sonoma, Mazda B-series and Toyota T100—is in the previous article, "Trucks Hit High Gear," starting on page 38. There are also additional photos of new models there.

For even more in-depth coverage of all the new models, check out our special publication, *POPULAR MECHANICS New Car And Truck Buyers Guide 1994*. You can find it on newsstands, or through the

POPULAR MECHANICS Reader Service Bureau, 224 W. 57th St., New York, NY 10019; (212) 649-3127. The price of the Guide is \$3.95, plus \$1 for postage and handling.

AM General

Hummer full-size sport/utility: new less-expensive Recruit Series, 2- and 4-door. Engine: 6.2L GM diesel V8/3-speed auto.

Chevrolet

S-Series compact pickup: (see page 42). **C/K** full-size pickups: new grilles, side-impact beams, new 6.5L turbodiesel V8, two trim levels, regular/extended cabs, short/long/wide/narrow beds. Engines: 4.3L 165-hp V6 to 7.4L 230-hp V8. **Blazer** and **Suburban** full-size sport/utilities:



CHEVROLET LUMINA

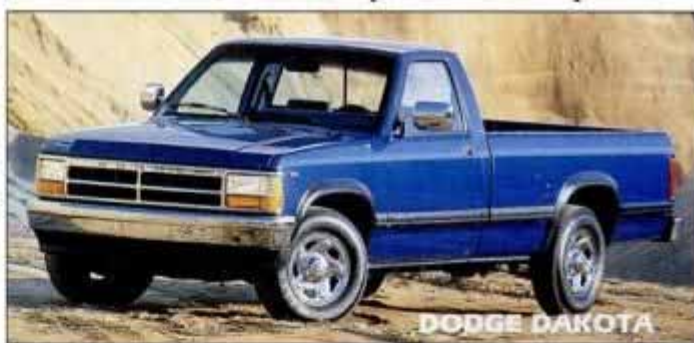


CHEVROLET C/K PICKUP

beams, integrated child safety seat, four trim levels. Engines: 2.5L 100-hp I4 to 3.8L 162-hp V6. **Ram Wagon/Van** (full-size): new front-end appearance, side-impact beams, 4-wheel ABS, firmer ride, three models, two wheelbases, two lengths, four trim levels. Engines: 3.9L 175-hp V6 to 5.9L 230-hp V8. **Dakota** midsize pickup: driver's airbag, three wheelbases, two cabs, 2wd/4wd. Engines: 2.5L 99-hp I4 to 5.2L 220-hp V8.

new grilles, new 6.5L turbodiesel V8/4-speed auto, 2wd/4wd. Engines: 5.7L 210-hp V8, 7.4L 230-hp V8. **S-Blazer** compact sport/utility: formerly S10 Blazer, carryover model, 2- and 4-door, 2wd/4wd, three trim levels. Engines: two 4.3L V6s—165 and 200 hp. **Astro** minivan: driver's airbag, side-impact beams, improved chassis and corrosion protection, rear Dutch door, regular and extended body, three trim levels. Engines: two 4.3L V6s—165 and 200 hp. **Lumina** minivan: APV designation dropped, shortened nose, driver's airbag, optional power sliding door, 2- to 7-seat models. Engines: 3.1L 120-hp V6, 3.8L 170-hp V6.

Chrysler **Town & Country** minivan: fwd/awd, luxury model on extended wheelbase, new instrument panel, dual airbags/ABS (on awd) standard. Engine: 3.8L 162-hp V6.



DODGE DAKOTA

Dodge **Caravan** minivan: best-selling minivan, along with Plymouth Voyager, standard/extended sizes, new bumper fascias, dual airbags, side-impact

Eagle **Summit Wagon** minivan: 5-passenger, three trim levels, 2wd/awd. Engines: 1.8L 113-hp I4, 2.4L 136-hp I4.



FORD WINDSTAR

Ford **Windstar** minivan: slated for midyear introduction, fwd, based on Taurus sedan platform. Engine: 3.8L 155-hp V6. **F-Series** full-size pickups: driver's airbag, side-impact beams, three cabs, five load series, two lengths, wide/narrow beds, three trim levels. Engines: 4.9L 145-hp I6 to 7.5L 245-hp V8 and 7.3L 190-hp turbodiesel



FORD RANGER SPLASH

V8. **Bronco** full-size sport/utility: 2-door/4wd, driver's airbag, side-impact beams. Engines: 5.0L 205-hp V8, 5.8L 200-hp V8. **Explorer** compact sport/utility: 2- and 4-door, 2wd/4wd, longest wheelbase in class, five trim levels.

hp V8 and 6.5L 180-hp turbodiesel V8. **Yukon** full-size sport/utility: 2-door/4wd only, new grille, two trim levels. Engines: 5.7L 210-hp V8, 6.5L 180-hp turbodiesel V8. **Suburban** full-size sport/utility: 2wd/4wd, two payload

two wheelbases, two payload series. **Vandura**: three wheelbases, three payload series. Engines: 4.3L 155-hp V6 to 7.4L 230-hp V8 and 6.5L 160-hp diesel V8.

Honda

Passport compact sport/utility: essentially a rebadged Isuzu Rodeo.

Isuzu

Amigo compact sport/utility: entry-level 2-door model, 2wd/4wd, two trim levels. Engine: 2.6L 120-hp I4/5-speed manual. **Rodeo** compact sport/utility: midlevel 4-door model, 2wd/4wd, two trim levels. Engines: 2.6L 120-hp I4, 3.2L 175-hp V6. **Trooper** compact sport/utility: flagship model in 2- and 4-door, 2wd/4wd, 4-wheel ABS, heated 4-way power seats. Engines: two 3.2L V6s—175 and 190 hp. **Pickup** compact: 2wd/4wd, two cabs, short/long beds, two trim levels. Engines: 2.3L 96-hp I4 to 3.1L 120-hp V6.

Jeep

Wrangler compact sport/utility: 2-door/4wd, four trim levels, new lockable carpeted storage area. Engines: 2.5L 123-hp I4, 4.0L 180-hp I6. **Cherokee** compact sport/utility: 2- and 4-door, 4wd (full-time/part-time) three trim levels, new side-impact beams. Engines:



FORD F-150

Engine: 4.0L 160-hp V6. **Club Wagon/Econoline** full-size vans: 4-wheel ABS, side-impact beams, three payload series and three trim levels. Engines: 4.9L 150-hp I6 to 7.5L 245-hp V8 and 7.3L 185-hp diesel V8. **Aerostar** minivan: due for phaseout as Windstar production ramps up. **Ranger** compact pickup: 2wd/4wd, two cabs, three wheelbases, two bed lengths, five trim levels. Engines: 2.3L 98-hp I4 to 4.0L 160-hp V6.

series, two trim levels. Engines: 5.7L 210-hp V8, 7.4L 230-hp V8, 6.5L 180-hp turbodiesel V8/4-speed auto. **Jimmy** compact sport/utility: 2- and



FORD EXPLORER

4-door, 2wd/4wd, new 60/40 split front bench seat, four trim levels. Engines: two 4.3L V6s—165 and 200 hp. **Safari** minivan: driver's airbag, side-impact beams, improved lengths, rear Dutch (combo liftgate and cargo) doors. Engines: two 4.3L V6s—165 and 200 hp. **Rally/Vandura** full-size vans: driver's airbag, side-impact beams. **Rally**: two body lengths,

4-door, 2wd/4wd, new 60/40 split front bench seat, four trim levels. Engines: two 4.3L V6s—165 and 200 hp. **Safari** minivan: driver's airbag, side-impact beams, improved lengths, rear Dutch (combo liftgate and cargo) doors. Engines: two 4.3L V6s—165 and 200 hp. **Rally/Vandura** full-size vans: driver's airbag, side-impact beams. **Rally**: two body lengths,

Geo

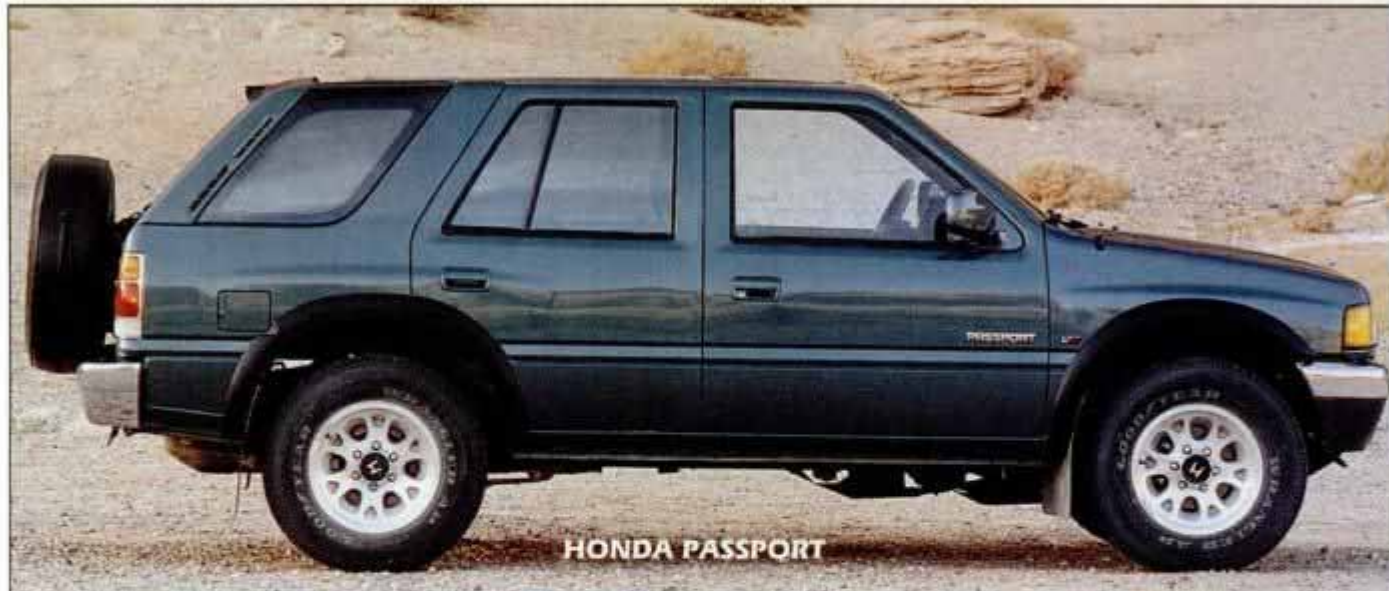
Tracker compact sport/utility: entry-level model, 2wd/4wd, three wheelbases, two bed lengths, five trim levels. Engines: two 1.6L I4s—80 and 95 hp.

GMC

Sonoma compact pickup: all-new (see page 39). Special Highlander 4x4 model has beefed-up frame, regular cab/short box. Engines: 2.2L 110-hp I4 to 4.3L 195-hp V6. **Sierra** full-size pickup: 2wd/4wd, two cabs, long/short/wide/narrow beds, three payload series. Engines: 4.3L 165-hp V6 to 7.4L 230-



GMC SUBURBAN



HONDA PASSPORT

2.5L 130-hp I4, 4.0L 190-hp I6. **Grand Cherokee** compact sport/utility: luxury end of market, 4wd (part-time/full-time) and awd, driver's airbag,

Mazda

Navajo compact sport/utility: 2-door, based on Ford Explorer, 2wd/4wd, two trim levels, rear ABS standard. Engine: 4.0L 155-hp V6. **MPV** minivan: rwd/4wd, large hinged right-side door. Engines:

2.6L 121-hp I4, 3.0L 155-hp V6.



ISUZU RODEO

4-wheel ABS, optional 4-wheel disc brakes. Engines: 4.0L 190-hp I6, 5.2L 220-hp V8.

Land Rover

Defender 90 compact sport/utility: all-new model, 2-door/5-speed manual trans, one trim level, only V8-powered softtop in its class, tops and carpeting optional. Engine: 3.9L 182-hp V8. **Range Rover** compact sport/utility: 4-door/4-speed auto trans, County and LWB (Long Wheelbase) models, standard height-adjustable electronic air suspension, full-time 4wd, traction control. Engines: 3.9L 182-hp V8, 4.2L 200-hp V8.



JEEP GRAND CHEROKEE

Mercury

Villager minivan: fwd wagon and cargo van, seating for seven, pro-

duced jointly with Nissan (as the Quest), driver's airbag, larger radiator, two trim levels, ABS standard. Engine: 3.0L 151-hp V6.

Mitsubishi

Expo minivan: fwd/awd, seating for seven, driver's airbag, three trim levels. Engine: 2.4L 136-hp I4. **Expo LRV** minivan: fwd/awd, seating for five. Engines: 1.8L 113-hp I4, 2.4L 136-hp I4. **Montero** compact sport/utility: 4-door/4wd, new larger engine, driver's airbag, optional seating for seven, two trim levels. Engines: 3.0L 151-hp V6, 3.5L 215-hp V6. **Mighty Max** compact pickup: entry-level truck, 2wd/4wd (standard cab) and rwd

(extended Macrocab). Engines: 2.4L 116-hp I4, 3.0L 151-hp V6/5-speed manual.

Nissan

Pickup compact: two cabs, standard bed (2wd/4wd)/long bed (2wd). Engines: 2.4L 134-hp I4, 3.0L 153-hp V6. **Pathfinder** compact sport/utility: 4-door, 2wd/4wd, new LE luxury trim includes heated leather seats, 4-wheel disc brakes, limited-slip, automatic; 2wd in one trim level/4wd in three trim levels. Engine: 3.0L 153-hp V6. **Quest** minivan: fwd, joint effort with Ford, driver's airbag, ABS, two trim levels. Engine: 3.0L 151-hp V6/4-speed auto.



MITSUBISHI MONTERO

Oldsmobile

Silhouette minivan: fwd, high end of market, driver's airbag, reduced engine noise, one well-equipped trim level with ABS and a/c. Engines: 3.1L 120-hp V6, 3.8L 170-hp V6. **Bravada** compact sport/utility: high end of market, similar to Chevy S-Blazer and GMC Jimmy; unique-to-Bravada full-time awd, standard equipment a/c, premium sound system, leather and CD optional. Engine: 4.3L 200-hp V6/4-speed auto.

Plymouth

Colt Vista minivan: fwd/awd, lower end of market, seating for five, driver's airbag, power steering, optional 4-wheel disc brakes/ABS. Engines: 1.8L 113-hp I4, 2.4L 136-hp I4. **Voyager** minivan: best-selling along with Dodge Caravan, standard/extended sizes, three trim levels, dual airbags, integrated child safety



PLYMOUTH VOYAGER

Suzuki

Samurai compact sport/utility: 2-door/2-seat/4wd, lowest price in field, new 15-in. wheels. Engine: 1.3L 66-hp I4/5-speed manual. **Sidekick** compact sport/utility: 2-door softtop/4-door hardtop, 2wd/4wd, lower end of market, three trim levels. Engine: two 1.6L I4s—80 and 95 hp.

116-hp I4, 3.0L 150-hp V6. **Land Cruiser** full-size sport/utility: 4-door/full-time 4wd, upper end of market. Engine: 4.5L 212-hp V6/4-speed auto. **Pickup** compact: 2wd/4wd, standard/extended beds, three trim levels. Engines: 2.4L 116-hp I4, 3.0L 150-hp V6. **T100** midsize pickup: see page 40.



NISSAN PICKUP

seat, side-impact beams. Engines: 2.5L 100-hp I4 to 3.8L 162-hp V6.

Pontiac

Trans Sport minivan: new shorter nose, new instrument panel, optional integral child safety seat, power sliding door, electronic leveling, traction control, one trim level with five option packages. Engines: 3.1L 120-hp V6, 3.8L 170-hp V6.

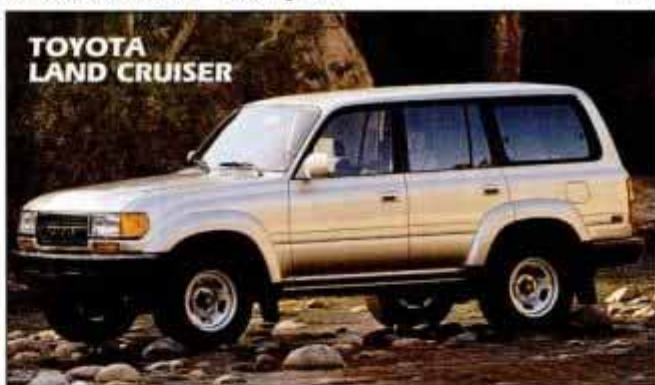
bags and side-impact beams. Engine: 2.4L 138-hp I4/4-speed auto. **4Runner** compact sport/utility: 2wd/4wd, two trim levels, new side-impact beams, oak/leather interior and ABS (V6 models). Engines: 2.4L

Toyota

Previa minivan: rwd/awd, high end of market, dual air-

Volkswagen

Eurovan minivan: '93 carryover, high end of market, three trim levels, large interior volume. Engine: 2.5L 109-hp I5. **PM**



TOYOTA LAND CRUISER



TOYOTA T100



SOUND SHAPERS

New loudspeakers use electronics to deliver richer, more natural sound.

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

• Next time you're out to catch some tunes, check out the band member who isn't on stage, doesn't get paid and never takes breaks. This extra performer isn't obvious to the eye but definitely affects what you hear. It's the listening room itself, which, for better or worse, shapes the sound created by musicians and vocalists. If you're listening at home through the loudspeakers of an audio system, you've got additional phantoms in the opera. The speakers alter the original sound of the recorded performance even before the surfaces and furnishings of your room take a whack at them.

This double whammy of speaker peculiarities interacting with room acoustics remains the final frontier for audio engineers to tame—and the most difficult.

Most of the problems of high-fidelity sound reproduction have already been licked. For example, today's amplifiers deliver heaps of power with negligible distortion. The computer accuracy of the digital compact disc has replaced the analog record and electromechanical turntable. Loudspeakers, too, are electromechanical devices. Now, to improve this last link in the sound chain before your ears, audio designers have begun to apply digital signal processing (DSP) similar to that used for high-speed communications and radar-evading stealth aviation techniques.

Most people don't lose any sleep over inaccuracies in sound reproduction. Those who do jeopardize their sanity, much like the guy who gets too engrossed in the Hall of Mirrors at the Fun House—which is actually what your



Electronic circuitry can now anticipate the reproduction errors of loudspeakers and correct them before the sound is heard.

listening room would look like if you could see the sound-waves reflecting all around.

The fun-house mirrors are a good metaphor for what happens when recorded sound enters a room through loudspeakers. The silly fun-house mirrors stretch, bend, squash or otherwise alter an image. To a greater or lesser degree, this is what loudspeakers do, owing to their inherent mechanical limitations. You get a reasonable facsimile of the recording, but not an exact replica.

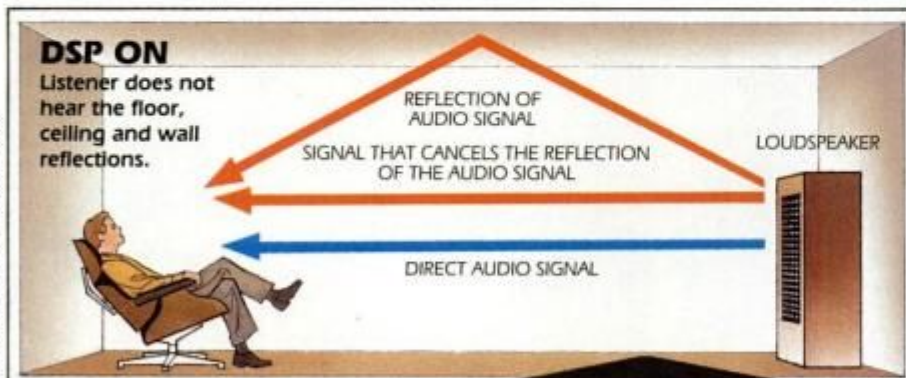
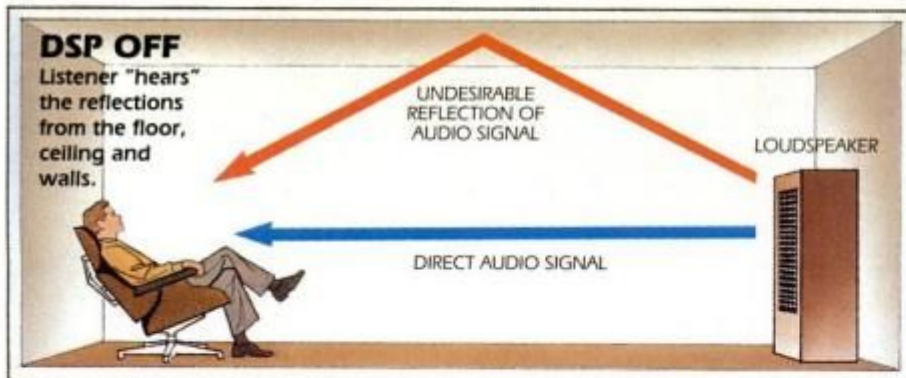
Now, project these distorted reflections onto other mirrors, at various angles and placement and of different size and texture, and the freak show multiplies. That's what the sonic reflections off the walls, floor and ceiling of your room do, with further embellishments added by furnish-

ings. Fact is, though, even if the first mirror—the speaker—was picture-perfect, the subsequent reflections would still create a madhouse effect.

It's that first reproduction that loudspeaker makers such as Celestion, DGX and Philips have begun to correct. Meanwhile, at Snell Acoustics there's also work in progress on taming the room.

For some time now, sophisticated measurement techniques have enabled manufacturers to identify and analyze the shortcomings of their loudspeakers. Over the same time period, the storage format of recorded music has switched from analog waveforms to the 1s and 0s of digital code. This computer language, as found on compact discs, can be manipulated to compensate for the known charac-

SOUND SHAPERS



FM ILLUSTRATIONS BY ADOLPH E. BROTHMAN

integrated amp, which houses the custom microprocessor for the pair of DDL-1 speakers that make up the rest of the system. The DDA-1 provides two channels of power amplification at 100 watts each, and has inputs and outputs for a variety of music sources— analog tuners and tape decks as well as digital components. Built-in digital-to-analog and analog-to-digital converters let you feed the DDA-1 signal from any compact-disc player.

Philips, too, wraps its DSP in a bundle, but all you see is the DSS930 loudspeaker (\$1200 each). Each cabinet contains the DSP chip and two amplifiers matched to the speaker— 80 watts for bass, 20 watts for treble. The signal to the speakers remains digital all the way from the digital output of an audio component. Signal correction, digital-to-analog conversion and power amplification occur within the speaker.

Speaking of rooms, neither the Celestion, DGX nor Philips DSP systems purport to do anything about the interaction between loudspeakers and listening rooms. To date, only Snell Acoustics has addressed this box-within-a-box conundrum. Like a jazz virtuoso playing a club for the first time, most loudspeaker designers concede they're working in the dark as far as how speakers will sound in your home. Even given perfect reproduction from the speaker, the rooms vary and the ground rules change from sound field to sound field.

The Snell approach is called CyberAcoustics. The idea is to anticipate how a room behaves under varying musical signals and counteract these conditions dynamically—as they occur.

In the case of Snell's forthcoming System Five, anticipating really means preemptive evasion.

If System Five sounds slightly militaristic, it's fitting, because Snell's DSP operates similarly to the way so-called stealth planes evade detection. The plane senses an incoming ping and, before it can pong, emits a signal that cancels out the reflection. A customized DSP chip alters the speaker's output in such a way as to neutralize the room's reaction so, in effect, the reaction never occurs. Snell expects its forthcoming System Five to cost about \$10,000.

Of course, the best solution would be a smart speaker that could adapt to any room. As cheap as computing power has become, the self-analyzing speaker is still in its visionary stages. In the meantime, DSP technology is as close to a perfect score as we have.

FM

teristics of a given loudspeaker. For example, if the speaker maker knows that bass performance drops just so many decibels between frequencies X and Y, the digital code of the signal sent to the speaker can be rewritten to boost the bass an exact amount over a specific range. Similarly, the timing of output signals can be re-scheduled so that the express trains connect with the locals.

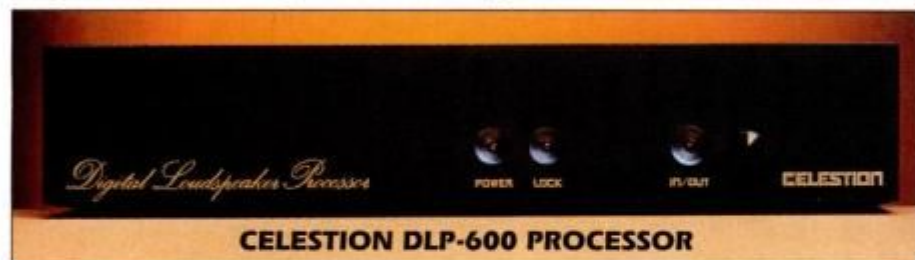
In one way or another, the smart loudspeakers available from Celestion, DGX and Philips anticipate the errors the speakers will create, and apply a corrective signal before amplification and transmission to the speaker. They perform their DSP sleight of hand directly on the data



SNELL SYSTEM FIVE PROCESSOR

each speaker maker has to analyze its speaker and write the corrective computer program. And it has to build a very good speaker to begin with, to keep the already complex and costly corrections to a minimum. DSP can make a good-sounding speaker better, but can't make a poor one sound good.

Although they pursue the same goal, the Celestion, DGX and Philips systems take different forms.



CELESTION DLP-600 PROCESSOR

that flies off a digital recording—before the disc or tape player's circuits convert the digital signal to analog waveforms that the amp can handle.

All of this sounds easier than it is. For example, DGX Audio states that the microprocessor in its system, called DDAS, performs 18 million mathematical calculations per second. That's a lot faster than you can say Digital Deconvolution Audio System, which is what the process is called. But even before any company's DSP chip can strut its stuff,

Celestion, for example, specifies its top-shelf SL-600SI speakers (\$1995 a pair) to work with a black box called the DLP-600 (\$800). All the DSP magic occurs in the box, which connects between the digital outputs of a CD player then loops back into the player's digital-to-analog converter inputs or those of an outboard D/A converter. From there, it's on to the amp and speakers in the usual hookup.

DGX offers DSP as a speaker/amplifier package. The business end of the DDAS (\$1995) is the DDA-1



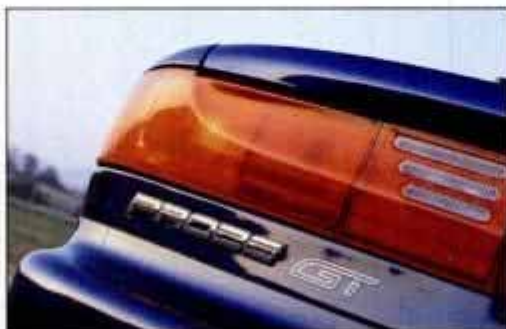
FORD PROBE

Once again, the eyes have it.

BY MICHAEL LAMM, Contributing Editor; PM Photos by Rich Cox

● Ford launched the first-generation Probe on May 12, 1988. Enthusiastic buyers, smitten with the coupe's good looks, stormed dealerships in mobs. Initial demand was so great that the Mazda/Ford plant that builds the Probe in Flat Rock, Michigan, had to go into overtime. Some dealers had 6-week waiting lists.

Initial sales of the second-generation Probe have been almost as hot, but in a much cooler economic climate and with many more rivals. The Probe 2+2 sport coupe currently stands out in a crowd that includes the Nissan 240 SX, Toyota Celica GT-S, Mazda MX-6, Honda Prelude, Volkswagen Corrado and the Diamond-Star triplets—the Mitsubishi Eclipse, Plymouth



Laser and Eagle Talon. This remains an extremely competitive market segment that places tremendous emphasis on that most subjective of traits—styling.

Americans fell in love with the first Probe's swoopy lines, and the same happened again with the current model. The original coupe's styling, however, drew more raves than the new one. In our 1989

Owners Report, 91.4% of those responding chose the Probe mainly on the basis of styling. This time around, styling accounted for only 78% of the purchase decisions.

Second-generation Probes again share the Mazda MX-6 platform and powertrain, just as they did in the original version. This time, though, Ford had a chance to help plan

FORD PROBE



New instrument panel rated high marks.

Owners liked front seats, criticized rears.

Some V6 owners had knock problems.

and engineer the package from the outset. The first time around, Mazda sailed through the engineering exercise mostly alone. Ford barely had time to send in its design team to work out the sheetmetal and to add some suspension tweaks.

This time, Ford and Mazda worked

together. The result: a Probe with a track that measures 2.0 in. wider, a body that hunkers down 2.7 in. lower at the cowl, a wheelbase that stretches 4.0 in. longer and a windshield that starts 3.0 in. farther forward. Also noteworthy is the 50 to 80 pounds that have been trimmed from

the package (depending on model and accessories).

There are only two Probe models this year—base and GT. The sportier GT boasts a firmer all-independent suspension system, 4-wheel disc brakes and fat P225/50VR16 tires on alloy wheels. The GT's supportive

SUMMARY OF FORD PROBE OWNERS REPORTS*

Total miles driven	1,592,951	Good	36.8	Comfort opinion, front seats:		Cruise control	6.1
Average miles driven	5835	Average	5.7	Excellent	65.1%	Power windows	6.1
Purchase price:		Poor	0.6	Good	29.8	Wipers and washer	6.1
Average	\$16,800	Handling:		Average	3.3	Repair it yourself?	
Range	\$12,800-\$21,000	Excellent	82.2%	Poor	1.8	No	94.0%
Why did you choose the Ford Probe?		Good	17.2	Comfort opinion, rear seats:		Yes	6.0
Styling	78.0%	Average	0.6	Excellent	9.4%	Dealer repairs satisfactory?	
Handling	19.2	Poor	0.0	Good	25.2	Yes	52.5%
Price/value	15.7	Braking:		Average	35.0	No	47.5
Previous ownership	12.9	Excellent	66.7%	Poor	30.5	Dealer service opinion:	
Performance	11.4	Good	32.2	Specific likes:		Excellent	39.3%
Power	6.7	Average	0.6	Styling	82.2%	Good	41.8
Reputation	6.3	Poor	0.6	Handling	54.7	Average	12.9
Avg. mpg, city/hwy:		Overall performance:		Engine power	23.3	Poor	6.0
4-cylinder	26.1/30.8	Excellent	73.4%	Performance	22.9	Dealer sales policy opinion:	
V6	21.4/26.4	Good	26.6	Comfort	19.0	Excellent	54.1%
5-speed manual	23.5/28.4	Average	0.0	Ride quality	15.0	Good	35.3
4-speed automatic	23.6/28.7	Poor	0.0	Fuel economy	14.7	Average	6.4
Model choices:		Control layout:		Specific dislikes:		Poor	4.1
Probe GT	50.4%	Excellent	71.3%	No complaints	14.3%	Number of vehicles owned:	
Standard Probe	49.6	Good	25.3	Uncomfortable rear seats	10.8	This vehicle only	31.4%
Engine choices:		Average	2.3	Not enough legroom	10.4	Two vehicles	27.8
2.5-liter V6	54.3%	Poor	1.1	Wind noise	9.5	Three vehicles	23.5
2.0-liter Four	45.7	Instrumentation:		Fit of window moldings	8.7	Four or more	17.4
Transmission choices:		Excellent	74.1%	General comfort	7.4	Principal driver:	
5-speed manual	53.6%	Good	24.7	Suggested changes:		Female	57.3%
4-speed automatic	46.4	Average	0.6	Improve front-seat comfort	10.3%	Male	40.5
Options/Accessories:		Poor	0.6	Larger rear-seat area	8.8	Equal	2.2
Air conditioning	99.6%	Driver sightlines:		More rear legroom	8.8	Age distribution of owners:	
Preferred Equipment packages	87.9	Excellent	62.6%	Better window molding fit	7.2	Under 29	35.4%
Cruise control	86.4	Good	34.5	Add coin and cup holders	6.7	30-49	43.1
Keyless entry	66.4	Average	1.7	More power	5.7	50-plus	21.5
Antilock brakes	66.4	Poor	1.1	Mechanical trouble?		Based on your experiences, would you buy a Ford Probe if you had it to do over again?	
Sunroof	31.4	Workmanship opinion:		No	81.7%	Yes	65.0%
Engine power:		Excellent	62.8%	Yes	18.3	Maybe	29.6
Excellent	56.9%	Good	32.8	What type of trouble?		No	5.4
		Average	4.0	Electrical system	20.4%		
		Poor	0.4	Engine noise (V6)	16.3		

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

bucket seats have electric lumbar supports and power-adjustable side bolsters. All Probes can be ordered with antilock brakes, 4-speed automatic transmission, keyless entry and a sliding electric sunroof. Both series come with a driver's airbag and 50/50 fold-down rear seats.

Probes also benefit from two new Mazda engines: a 2.0-liter dohc 16-valve alloy Four and a 2.5-liter V6 in the GT. The V6 is adapted from the narrow-V 1.8-liter dohc 16-valve V6 that powers the Mazda MX-3 coupe. It delivers 164 hp at 6000 rpm and hustles the GT from 0 to 60 mph in just over 7 seconds. The Four makes 115 hp at 5500 rpm and can't be accused of loitering either. The old Probe's turbocharged engine is gone, but the combination of reduced weight and a broader V6 powerband adds up to generally improved performance in the new GT.

In the minus column, more than half of our owners stated that early 1993 Probes suffered from poor window sealing, citing gaps between the glass and the rubber molding. This caused wind noise and water leaks. According to Ford, the early Probe's soft rubber seals weren't installed correctly at the plant. Ford issued a technical service bulletin (93-3-2) that tells technicians how to reinstall the molding. The repair is covered by Ford's 3/36 warranty. Later Probes don't have this problem.

As long as we're mentioning problems, we must point out that very, very few owners reported any mechanical problems at all with their Probes. In fact, nearly 82% of our owners had none. Of the remaining 18% who did cite one malady or another, the most common complaints seemed to be about odd noises coming from the V6 engine in the GT and assorted electrical ills.

Interestingly, a small number of the respondents found the suspension and the seats in the Probe GT to be too firm. These folks are clearly in the minority, since the most outstanding feature of the car as cited by more than 82% of the owners is the Probe's excellent handling. Also singled out for praise are the engine's response, fuel economy and the superb layout and quality of the driver's controls.

Given the price of the Ford Probe—owners paid on average \$16,800 for the privilege of driving a shiny new Probe away from the dealership—many of the respondents gave the car's price/value relationship very high marks.

All in all, the Probe itself received a shower of praise and plaudits from its legion of discerning, trendy and enthusiastic owners. **PM**



Whether it's coming, going or just standing still, the new Probe's sleek styling converted more shoppers into buyers than all other purchase motivators combined.

EDITORS REPORT

Truth In Packaging

● Every time we begin thinking that Ford's design minions might be slowing down, they turn out another winner—like the car shown here. For all its many sport-coupe virtues—a lengthy list indeed—sheetmetal is what seems to propel most owners into new Probes.

We're inclined to dismiss the even higher percentage of style-driven purchases in our 1990 Ford Probe Owners Report as a statistical aberration, mainly because we think this Probe—particularly the Probe GT—is far more seductive. If the original looked hot, then this edition was conceived to melt your sneakers. Low, squat, lean, mean, with lots of rubber on the ground—just the thing to appeal to the boy racer in all of us.

And hot it is. Although the GT's 2.5-liter V6 doesn't deliver quite as much straightahead go-power as the previous GT's 2.2-liter turbo Four, it's far smoother and far easier to live with. We've seen no sign of the start-up knock mentioned by owners.

Clutch engagement is as sweet as money from home, and the powerband is broader. More important, there's no turbo-lag and no hint of the pronounced torque steer that went with full boost in the old car.

Mazda has also improved the shift feel of the 5-speed manual transaxle that's standard in all Probes. All in all, there are few powertrains more cooperative than this one.

The improvements in the chassis are at least as impressive as the powertrain, if not more so. In particu-

lar, the joint Mazda/Ford development task force zeroed in on chassis stiffening, which in turn pays benefits in the handling department. Although some owners found the new Probe GT to be a trifle firm in the shock/spring department, we think its suspension tuning is right on the money. We also think it's far more responsive and agile—far less inclined to wallow—than its predecessor.

The big caster revision that accompanied the rear-canted front struts (laid back to accommodate the sloping hoodline) lends a particularly decisive feel to steering inputs. Braking is also much improved and measures up well versus the competition, something that couldn't be said for the original Probe GT.

Inside, the Probe's totally redesigned instrument panel and seating is almost as arresting as the all-new exterior. The sporty cockpit theme is particularly well executed here, clearly conceived to stimulate your Walter Mitty glands.

While we agree with our owner group concerning the limited dimensions of the rear-seat area—yes, it's cramped—it's hard to be sympathetic to these complaints. This is a sport coupe, a classic 2+2, a sports car with emergency rear seats, and in this respect it's very much like its contemporaries. If you need real rear-seat legroom, buy a sedan. But if that's not a consideration, the Probe should be on your shopping list. It does everything well, and looks good doing it. —Tony Swan

COVER STORY





FIRE BOMBERS

As wildfires rage ever closer to home, a fleet of new aerial firefighters pours on the relief.

BY MICHAEL PATRICK; PM Illustration by Jeff Mangiat

The locals can't remember the last time it rained. Everything is as dry as a corn chip. Then the huge cumulo monsters come marching across the boiling bright sky, and the thunder rumble begins. Despite the sound and fury of the storm, not a drop of water reaches the parched ground. But lightning does. Out West they call this phenomenon dry lightning. Sometimes they call it something worse, because those bolts are the fingers of the devil himself, touching off thousands of wildfires each year.

A network of lightning-strike detectors and weather stations sends data to the National Interagency Fire Center in Boise, Idaho. If conditions suggest trouble—dry brush and timber, harsh winds and temperatures—a local patrol goes out to investigate. If they find a fire, they try to extinguish it. Failing that, they call in reinforcements.

And if the fire is burning out of hand, they call in an air strike.

The mission goes to the fire bombers, aircraft fitted with huge internal tanks and customized dispersal systems. Their job is to snuff conflagrations whether they threaten backyard

Manitoba or backyard Malibu. More commonly known as tankers, these planes make a motley armada. Although California has its own fleet, and National Guard aircraft fly in when needed, more than 100 tankers in the United States are scattered among special outfits such as Aero Union in Chico, California, and Hawkins & Powers in Greybull, Wyoming. The aircraft range from single-engine cropdusters with 600-gallon hoppers to Martin Mars flying boats, WWII-vintage leviathans that can dump 6000 gallons of water—that's 24 tons—in a single pass.

Last October's inferno in Southern California put these flying extinguishers in the spotlight, especially when widespread blazes spread the state's tanker fleet thin. In the aftermath, homeowners scorched state officials for having stuck with slow veteran planes instead of forking out for new aircraft built for fast response. But as that controversy burns, so does a disturbing new threat: the wildfire that rips through populated areas. The potential for catastrophe sharpens the focus on the methods and machines of aerial firefighting.

Canadair CL-415 unleashes 1600 gallons.



Grumman S2F becomes Turbo Firecat with PT6A turbines and 4-compartment retardant drop system (inset).

CONRIF PHOTOS

In the line of fire

Firefighters agree that the best time to attack a fire is as soon as it is discovered. You can halt the fire's advance by having a tanker lay lines of retardant around its perimeter, or you can simply extinguish the blaze by dousing it with foamy water.

Either way, an assault on a large fire typically begins with the arrival of an air-attack plane—anything from a Cessna 172 to a surplus OV-10 Bronco—over the site. Inside, the air-attack officer assesses the blaze, determining its direction and speed, noting any natural firebreaks and identifying any structures or people in its path. That done, he draws up a plan of attack.

Ideally, the next aircraft on the scene is a government-owned lead plane, usually a Beech Baron. Once

the bombing line is determined, it's this plane's job to guide the tankers through. As the bombers approach, they report in to the lead. If there's no



T&G Aviation's Pat Laroux flies a converted former Delta Airlines DC-7.

MICHAEL O'LEARY PHOTO

lead, they take orders from the air-attack plane circling 1000 ft. above.

Those orders will include start and stop points as well as the desired level

of retardant coverage. To assure fire blockage, the retardant must drench everything right down to the dirt, creating a barrier 25 to 75 ft. in width. These days, the retardant is a slurry of water, fertilizer, thickener and anti-corrosion agents. This red-dyed "mud" sticks to everything it touches and remains effective for several days. After the fire is out, the retardant's fertilizer promotes new growth.

Once cleared, the tanker pilot descends to between 150 and 200 ft. of the treetops and begins his run at about 130 knots. The altitude is just high enough to assure that all forward motion has ceased by the time the stuff hits the ground in a thick mist. After all, the impact of 13 tons of moving goo can rip trees in half and kill any breathing thing in its path.



AERO UNION PHOTO



MICHAEL O'LEARY PHOTO



MICHAEL O'LEARY PHOTO



CONRIF PHOTO

Big fires call for big bombers. Clockwise from top left, Lockheed C-130 Hercules swamps blazes with modular tank system, Consolidated PB4Y Privateer sprays mud or water, Douglas DC-6 delivers retardant and Martin Mars flying boat scoops up 24 tons of water.

Firebirds reborn

When such aerial attacks began 40 years ago, there were no airplanes built for the task, so operators had to improvise. They fitted tanks into war-surplus Avengers, B-26s, PB4Ys, even Stearmans, and went to war all over again. For some, the hostilities have never ended.

For example, the fleet Hawkins & Powers fields today includes five PB4Ys—the Navy version of the B-24. Pampered mechanically, these V-J Day-vintage birds remain in demand, dispensing 2000 gallons of mud on fires from Florida to Alaska. Also still on duty are tank-equipped P2Vs, KC-97s and others, all con-

ceived when Dwight Eisenhower was still in uniform.

But although these old radial-engined horses still account for themselves admirably, the passage of time has brought inevitable maintenance problems. The solution, of course, is to use newer-generation airplanes and turbines for power. And that is exactly what's happening.

The workhorse at British Columbia-based Conair, the world's largest aerial firefighting company, is a modified Grumman S2F Tracker. This former submarine chaser now flies on a pair of PT6A turboprops. Not only do the engines boost reliability, they bump cruise speed almost 50 knots to 220 so that the tanker can respond faster and more frequently to a fire.

The biggest turbo tankers at work today are Aero Union's 4-engined P-3 Orions and the C-130 Hercules operated by Hawkins & Powers, among others. These airplanes have been outfitted with permanent tanks and belly doors programmable for retardant release. In a pinch, however,

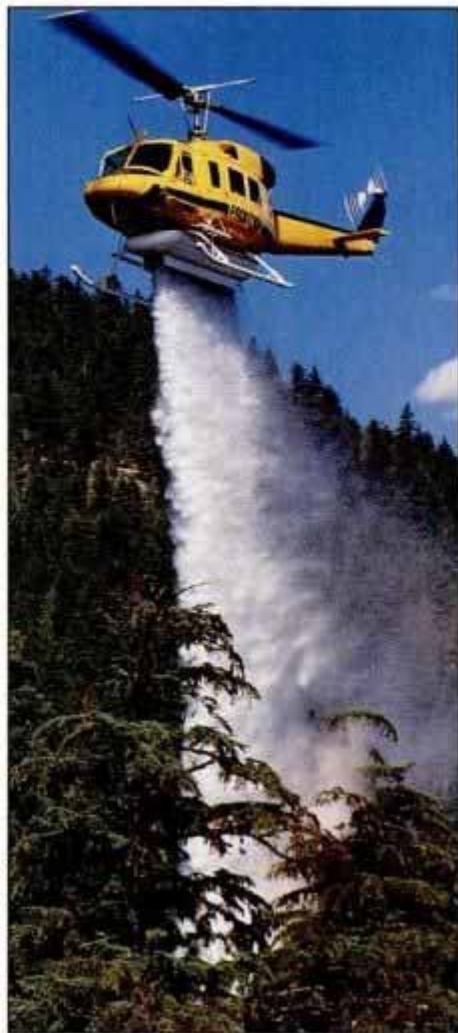


Versatile Bell 212 can deploy probe to draw water out of source as shallow as a foot deep or dump 360 gallons of foam.

a standard C-130 can become a temporary fire bomber with a tank/dispersal system slipped into the Herky-bird's cargo hold. Manufactured by Aero Union, this 3000-gallon, twin-nozzle contraption is known as a Modular Airborne Fire Fighting System.

Puddle pumpers

The only aircraft designed and built specifically for the job is Canadair's CL-215 and its turboprop successor, the CL-415. Each plane is actually a



COVER PHOTO



CANADAIR PHOTO

Canadair CL-215 flits from lake to flames to deliver water like an aerial bucket brigade.

flying boat fitted with retractable probes in its belly. The pilot descends to a lake, river or ocean and deploys the probes. Twelve seconds later, the plane flies off with 1600 gallons of water in its tanks. This water is then mixed with a detergent that triples its effectiveness by reducing its contact adhesion, thus allowing each water molecule to penetrate more completely.

Despite the airplane's formidable record and firefighting capability, however, Canadair has delivered just 124 CL-215s worldwide during its 21 years of production. The CL-415 was launched with an initial 20 orders placed by France and Quebec, Canadair's home province, but these have yet to be followed by any others. One possible reason: The CL-415 is price-tagged at \$20 million (Canadian), a number that leaves a lot of potential customers—such as the state of California—gasping for air.

No matter how modern the aircraft, however, killing wildfires will always remain a difficult business. The airplanes and men who do it are toughened to the task. That they do it well is demonstrated by the fact that more fires are snuffed faster every year. And as civilization creeps into tinderbox regions, all of us, not just the trees, benefit from that record. **PM**

**TO
REMEMBER
A TRIP
ACROSS
AMERICA
THERE'S
NOTHING
LIKE
PICTURES**



IndyCar Champion Ford-Cosworth Indy Car



The Winningest Team In NASCAR History



IMSA-GTS Ford Mustang



Off-Road Champion Ford Rough Riders



Memories of things passed. And on the racetrack in 1993,

Ford passed just about everything. The Ford-Cosworth Indy Car tallied



six wins and a Driver's Championship. The NASCAR Thunderbirds' ten season wins capped off another

AND SOUVENIRS



great year for Ford, the winningest company in NASCAR

history. The IMSA-GTS Mustang delivered Ford its tenth straight

Rolex 24 at Daytona.



And Ford off-road trucks took six class trophies, plus the big and small truck championships.

All in all, we're glad we brought the camera.

And, of course, that extra suitcase.



**HAVE YOU DRIVEN
A FORD LATELY?**

TELECOMMUNICATIONS

Cable Television Without The Wires

A 5-in. antenna receives the microwave signal.

BY STEPHEN A. BOOTH, Contributing Editor
PM Photo by J.R. Rost



● Like most of Brooklyn, there are lots of trees and lots of churches in the Brighton Beach section of the New York City borough. But you don't see a lot of coaxial TV cables along the residential streets that begin—or end—at the Atlantic Ocean.

Brighton isn't exactly the land that time forgot. It's got a Sizzler fast-food joint, high-tech hi-fi dealerships, and the subway has been running through to nearby Coney Island since about the time Teddy Roosevelt moved from Manhattan to the White House. On the other hand, wiring this seashore community hasn't exactly been a priority for the cable companies.

Nobody in the neighborhood seems to have come unwired about it, though. Fact is, Brighton Beach is going wireless.

This corner of New York is the first area in the United States to get subscription TV in a manner that's closer to cellular telephone communications than it is to conventional cable.

You won't see any wok-shaped satellite dishes on the homes or apartments, either. CellularVision, as the technology is called, delivers its signals to a waffle-size antenna—and for almost half the monthly cost of cable, to boot.

Like the cellular radio telephone system that makes voice communications wireless and mobile, CellularVision uses high-frequency radio waves to transmit its signals. Also like cellular phoning, the new TV system distributes signals to a network of local relay points, or cells, which redistribute the programs to home antennas within range.

Specifically, CellularVision (CV) employs microwave frequencies in the 27.5- to 29.5-gigahertz (GHz, or billions of cycles per second) range. The millimeter-size waves in this portion of the radio spectrum had once been reserved for point-to-point commercial communications. By late 1992, however, nobody was doing any talking on these airwaves so the Federal Communications Commission reassigned the band.

The multipoint signal distribution system developed by New York-based CellularVision Technologies and Telecommunications (CT&T) was just the sort of innovation the FCC wanted to fill dead air and create alternative routes for a futuristic-looking national information highway.

After the usual dog's age of testing, the FCC assigned the 28-GHz band to the applications pioneered by CT&T, and even awarded the patent-holder exclusive franchises in the Los Angeles and New York metropolitan areas. The rest of the nation goes up for grabs in competitive bidding this year.

The setup now delivering "wireless cable" in Brighton Beach illustrates how the system would work elsewhere.

A central cell in each region has dish antennas to re-

ceive the downlink from the same satellites that distribute cable and network TV programs. This central head-end relays the signals, by microwave, to local cell sites in the region. Each cell has a range of 3 miles in all directions.

According to CV inventor Bernard Bossard, only 1 GHz of bandwidth is used in each region. This is split into 49 channels, each carrying a 20-megahertz (MHz, or millions of cycles per second) FM signal. The system can handle an equal number of channels going in reverse, for the 2-way communications that would be needed for interactive television or other services. This intriguing option is possible because two signals can share a single frequency if they are transmitted at opposite polarities to one another. CV cleverly exploits this and other peculiarities of the millimeter wave.

For example, these gigahertz frequencies went unused in the past because their tiny waves require a clear line of sight between transmitter and receiver. CV, though, takes advantage of the fact that these waves bounce off obstructions without losing signal quality. Accordingly, the transmitters in CV cells emit signals in all directions. Therefore, if a home antenna doesn't get a direct hit, it's sure to pick up a ricochet.

Having multiple cells ensures adequate signal saturation through the region. However, no TV ghosts or other forms of interference materialize on-screen should signals from one cell stray into adjoining ones.

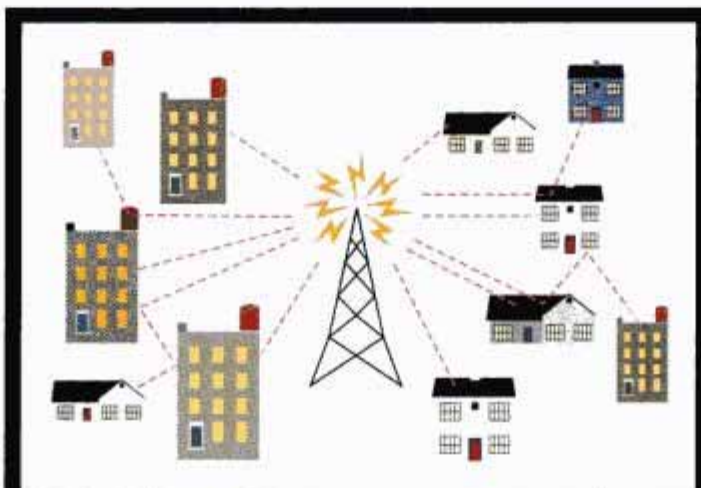
This is because the CV system alternates the polarity of the signals among adjacent cells. The principle is similar to the shuttered screens used to create 3D effects. The shutters are angled in patterns so that one eye doesn't see what was meant for the other.

From what we could see on our visit to Brooklyn, the CV system was worth the trip. The 4.5-in. square antenna, mounted inside a window facing the distant cell transmitter, delivered crystal-clear pictures and sound. Quality remained rock-steady even after the antenna was placed inside the room and metal blinds were drawn across the window. Usually, solid metal would prevent the waves from penetrating, but these blinds were your typical household design, so the signal had no trouble squiggling through available spaces.

Similarly, service wasn't affected when the antenna was turned away from the transmitter and aimed through another window—one facing the brick wall of a nearby building. There was no visible or audible difference in the reflected signal. About the only thing that stopped the show was when Shant Hovnanian, CV's prosperous-looking chief executive officer, placed his person directly in front of the antenna.

Hovnanian explained that even a 190-pound-weak-

(Please turn to page 111)



A local relay point distributes the CellularVision TV signal to small antennas. The microwave signal can ricochet off other buildings and still be received clearly by viewers.

STRIKE

A new-design bowling ball makes throwing a strike almost a sure thing.

BY JOHN G. FALCIONI; PM Illustrations by Paul Kratter

● In sports like professional football, where 110-pound linebackers are nonexistent, success comes as a direct result of size, strength and speed. Shoulder pads and helmets provide safeguards against injury, but in terms of physical attributes, equipment cannot improve what Mother Nature has bestowed. In bowling, where strength is not as essential to good performance, but nevertheless plays an important role, a series of sophisticated equipment developments have leveled the playing field for keglers of all sizes.

Today, the combination of a resin ball and the proper

arm swing can make a 110-pound bowler rattle the pins as hard as a 200-pounder. Moreover, the revolutionary developments behind bowling's new wave of balls promise to free the sport from the shackles of a reputation created by the likes of Ralph Kramden and Archie Bunker. The sport has become so sophisticated that knowledge of engineering and physics is likely to prove more helpful in throwing strikes than doing curls with a dumbbell.



Resin-Ball Weight-Block Designs



BRUNSWICK TEAL RHINO PRO

Brunswick Corp., one of the world's leading producers of bowling equipment and supplies, is recognized as having taken the first serious foray into the core of the ball to predict reaction and consistency, the hallmark of good bowling performance. With its Phantom family of urethane balls, introduced in late 1991, Brunswick showed how the size, shape and location of the core in a ball chiefly determine its rotation and reaction as it travels through and across the oil pattern on a lane.

Knowing how a ball is supposed to react, if released correctly, is important because, like different greens on a golf course, bowling lanes vary greatly. In fact, the oil pattern of even a single lane will change several times throughout a game, causing the ball to react one way during the early frames and differently by the end of the game.

The reason for this is the shifting of the oil used to condition the lanes. A mineral oil is applied to all lanes once a day to protect the wood from the pounding of the balls. Typically, the first 25 to 40 ft. of a lane are oiled, with a heavy concentration applied to the middle of the lane and a medium concentration on the outside edges.

The number of balls rolled on a lane will change the lane condition and so will the temperature inside and outside the bowling center. Therefore, a



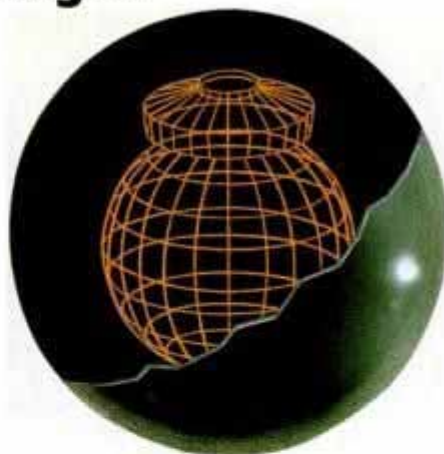
COLUMBIA POWER TORO

lane condition will change even if no one is bowling on it because of the evaporation of the oil. That's why predicting how a ball will react is essential to consistency.

"The shape of the core is significant in predicting reaction because it provides the dynamic stability to maintain the preferred axis of rotation after drilling the grip holes," says Ray Edwards, an engineer and former professional bowler who is now a research and development specialist at Brunswick.

Bowling balls are produced in two or three pieces depending on the desired effect. Traditional 3-piece balls provide a controlled and "true" roll. These balls feature a weight block of 2 to 4 ounces added to the core during manufacture. The block compensates for the weight that is removed by drilling the grip holes. Two-piece balls consist of a single-piece core and the cover stock. These balls generally begin to roll earlier on the lane than the 3-piece balls. St. Louis, Missouri-based ball manufacturer Faball Inc. is credited with developing the 2-piece ball, now the favored construction method.

The cores themselves are made of a resin system and high- and low-density fillers. Track Inc. has recently unveiled a new triple-density ball called Critical Mass, which features a distinctive heavy ceramic circular core



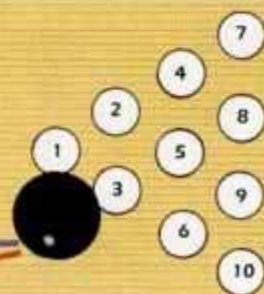
TRACK INC. NUKE

inside its regular lightbulb-shaped core. The ball is topped off with the same Versathane cover stock used in the company's Nuke ball.

"This ball is capable of generating the lowest radius of gyration possible to achieve maximum revolutions with less hand action," says Phil Cardinale, president of Track. The hard ceramic core of the ball is designed to begin rolling on the oily part of the lane, as a urethane ball does, and then, because of its resin shell, react sharply in the back end of the lane. By not skidding through the oil, this ball is designed to provide the advantage of a urethane roll with the power of a resin ball.

Critical Mass is innovative because it is the first to use a heavy ceramic core. But Track isn't the only manufacturer with a new ball. Most major bowling-ball makers have unveiled new products this year. Brunswick has even started a new company, called Quantum BTV (Brunswick Technology Venture), and introduced three new balls. These Quantum balls, says Brunswick's Bill Wasserberger, an engineer in the R&D department, preserve the rotational dynamics of 15- and 16-pound balls in lighter weights (10, 12 and 14 pounds). Each ball, regardless of weight, is designed to have the same maximum and minimum radius of gyration for a standard

(Please turn to page 112)





Valvoline
MOLSON

BELL
HELMETS

Valvoline

AL UNSER, JR.

Valvoline

Callie
SINCE 180

FORCE

But in a sport big on tradition, where equipment upgrades such as the use of polyester in addition to rubber in ball making took decades, the sudden introductions of intricate core configurations for bowling balls and new reactive materials for their outer shells have been met with some criticism and a lot of confusion.

Many standout bowlers are critical of these balls (which are often called "cheaters"), arguing that players of lesser ability and striking power are now ranking among the top of the Professional Bowlers Association (PBA) prize-money list. This may be an overstatement of the facts, but it is true that even among amateurs the new balls have had staggering effects. The American Bowling Congress (ABC) in Greendale, Wisconsin, reports that the number of per-

fect games—occurring when a player rolls 12 strikes in a row for a 300 score—soared to a national high of 17,654 during the 1992-93 winter bowling season, the first full winter season following introduction of resin balls, versus 14,889 the previous season.

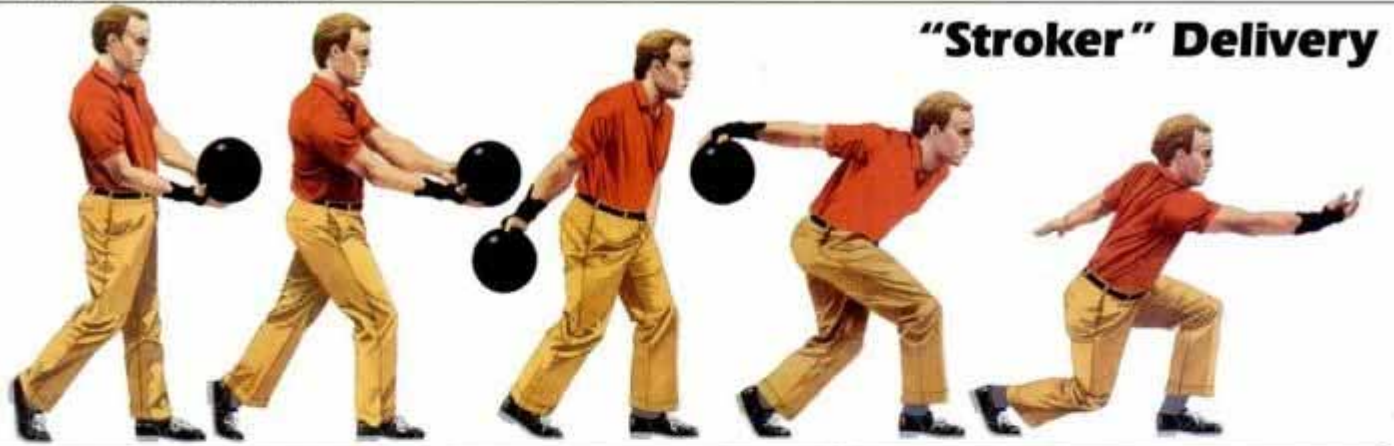
Introduction of the resin balls has even forced the ABC, which regulates the sport, to issue new guidelines that stymie manufacturers from illegally manipulating specifications such as a ball's coefficient of friction, coefficient of restitution, moment of inertia and radius of gyration.

Essentially, resin bowling balls provide the two most important factors that increase the probability of striking: greater angle of entry into the pocket and greater energy transfer. Polished, these balls

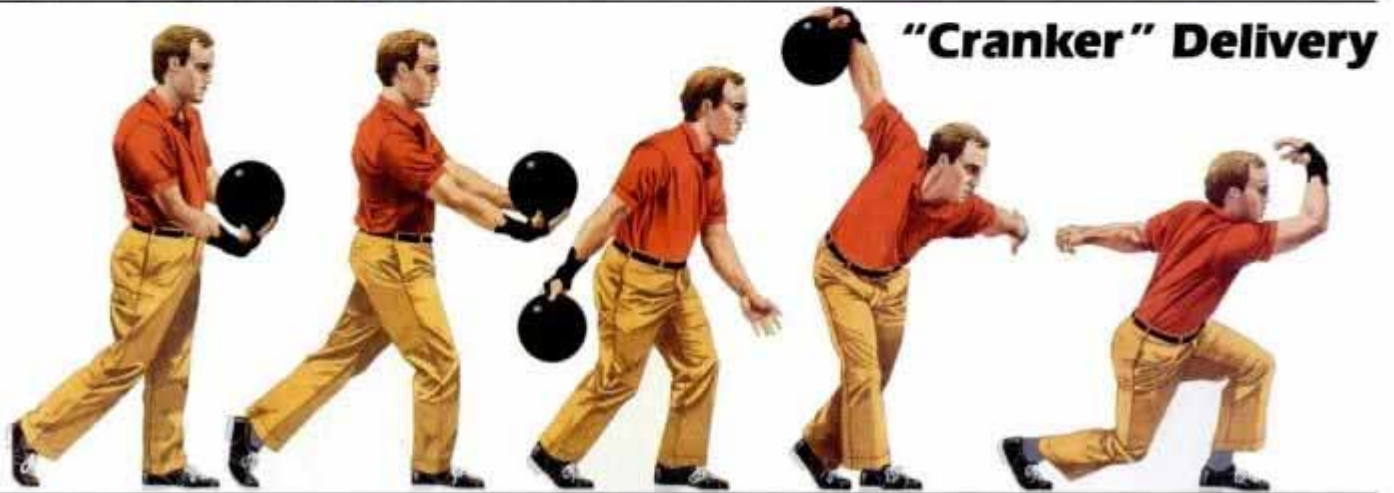


AMF NINJA

STRIKE FORCE



"Stroker" Delivery



"Cranker" Delivery

The rendering shows a comparison between a righthanded "stroker" and a "cranker," each using a 5-step approach. From left to right, the stroker (top) pushes the ball out in front of him in the second step, has a level backswing by the fourth step and releases the ball smoothly during the sliding fifth step. To gain added leverage and power, a cranker (above) will open his right shoulder during the third step, as if to throw a roundhouse punch. By the fourth step, the ball will be above his shoulder and ready for a quick swing. At the point of release, the arm will snap up abruptly toward the head. The cranker's wrist will be cocked throughout the arm swing.

skid straight through the "heads," the oily first 45 ft. of the lane, and then snap strongly in the "back end," the last 15 ft.

Resin balls produce significantly lower friction than traditional high-friction urethane balls, especially on the oily part of a lane, says Daniel Speranza, a mechanical engineer and manager of the equipment-specifications department at the ABC. But on the drier end, near the pins, resin balls appear to have higher friction than regular urethane balls. This results in a greater angle of impact into what's known as the "pocket"—for righthanders, the area on a lane between the headpin and the No. 3 pin,

or between the headpin and the No. 2 pin for lefthanders.

For a righthander, the pocket width for a 0° entry angle, for example, is only 1 in., located 2 to 3 in. to the right of the headpin. But a 6° entry angle has a 2-in.-wide strike pocket, between 2 and 4 in. to the right of the headpin.

What makes these balls react so drastically on dry lanes is a heavily guarded proprietary chemical recipe. Manufacturers say that resin balls are created the same way existing urethane balls are made, except that the resin additive is mixed in. Bowling-ball makers have aligned themselves with chemical suppliers who concoct

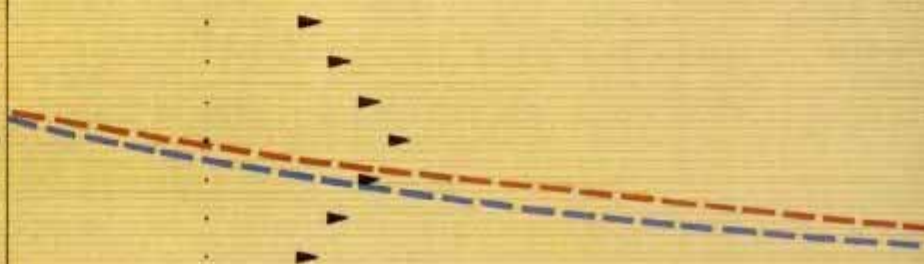
distinct resin formulations for different companies. For example, chemical supplier BASF Corp., in Parsippany, New Jersey, developed a product with the trade name Versathane for a ball called Nuke, designed by San Antonio, Texas-based Track Inc.

With so many balls now on the market, at prices ranging from \$120 to \$160 for resins, \$60 to \$140 for urethanes and \$25 to \$80 for polyesters, most bowlers don't know the difference between a Ninja and a Power Torq, or a Teal Rhino and a Purple Rhino, or a Nuke and a Crush.

What differentiates balls of similar cover stock is the shape of the inner core. Muskegon, Michigan-based

Resin-Ball Track

Because a resin ball (red line) will skid through the "heads" of the lane and hook sharply into the pocket, the ball is released farther inside on the lane. Thus, when the ball begins hooking to the "pocket," the angle of impact will be greater than that of a non-resin ball (blue line).



SAFETY AT SPEED

Aerodynamics are as important as safety in radical new crash helmets.

BY CHARLES PLUEDDEMAN

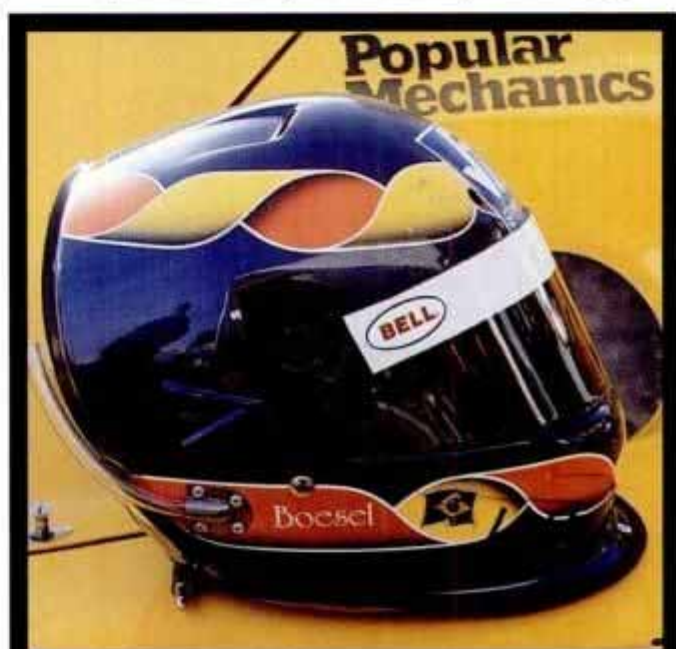
● Formula One champion Nigel Mansell, a rookie on the IndyCar circuit in 1993, pushes his Lola racer past its limit on the 1-mile oval at Phoenix. In a burst of flame and carbon fiber, the car slams into the retaining wall at 183 mph. The crash destroys the car and punches a hole in the concrete wall, but Mansell not only survives with minor injuries, he goes on to win the 1993 IndyCar championship.

In a duel for the lead at Talladega, one of the top superspeedways on the NASCAR circuit, the Pontiac driven by Rusty Wallace is bumped from the rear. The car goes airborne and cartwheels into the infield. It comes to rest in a heap of steam and twisted metal, but amazingly, Wallace suffers only a minor injury.

That drivers like Wallace and Mansell walked away from these crashes is a testament to new technology employed in motorsports. Even as speed increases, new car and track designs are playing a major part in making racing safer. And just as it has been for years, a critical element in protecting drivers is the helmet, a high-tech safety component that has undergone an evolution recently as manufacturers work to keep up with the increasing demands of professional drivers. While helmet manufacturers are constantly striving to improve impact protection, driver comfort and aerodynamics have increasingly become key elements.

In the world of IndyCar auto racing, speeds routinely exceed 200 mph. At that velocity, the flow of air over a helmet creates lift that tugs at the driver's chin strap. The helmet is also exposed to turbulent air that passes over the car's body or peels off passing cars. Turbulence became especially severe for drivers of the 1990 Lola IndyCar, with helmets jostling so much that drivers had trouble maintaining clear vision.

Bell stepped in with a solution, the addition of molded trip strips at the top of the helmet and V-shaped vortex generators at the sides of the shell. The trip strips break up airflow over the top of the helmet to reduce lift, while the vortex generators reattach airflow to the helmet sides to reduce buffeting. These features were incorporated a couple of years ago in models that



Bell Feuling SS For IndyCars



Al Unser Jr. (far left) and Raul Boesel (top), driver of the PM-sponsored Dick Simon IndyCar entry, wear the Bell Feuling SS (above), which has a squared back to clean up turbulence affecting the downward force of the car's rear wing.

SAFETY AT SPEED

also feature a ventilation system to flow cool air through the helmet and an adaptation of the Reebok Pump air-bladder system that offers a snug, adjustable fit in the lower liner.

At the 1993 Indianapolis 500, Bell debuted what may be the future of open-cockpit helmet technology, the Bell Feuling SS. Designed around a patented aerodynamic element invented by Jim Feuling and worn by top IndyCar drivers such as Raul Boesel, driver of the POPULAR MECHANICS-sponsored Dick Simon entry, this helmet has a tapered trailing edge that appears squared off at the back and a spoiler device under the chin bar. The shape not only offers extraordinary stability at high speed, but also improves the performance of the car.

Wind-tunnel testing shows that turbulence caused by a standard helmet creates a small dead spot in the center of an IndyCar's rear wing. By cleaning up this turbulence, the Bell Feuling increases the downforce potential of the rear wing. Currently, helmet manufacturers work with IndyCar teams during winter testing of new cars to make changes to the helmet to suit the car. In the future, the car and the helmet may be designed together as one integral unit.

Turbulence rarely buffets helmets worn by drivers of enclosed NASCAR sedans, but these racers have to endure tremendous heat and breathe an atmosphere rich in carbon monoxide. To solve these problems,



FM PHOTOS BY DON HUNTER

same power-to-weight ratio as a Formula One auto, but lays that power down through a tire-contact patch a little larger than a postage stamp. With riders wrestling bikes into turns and struggling with the forces of sharp acceleration and deceleration, controlling these 200-mph screamers is one of the most demanding jobs in motorsports.

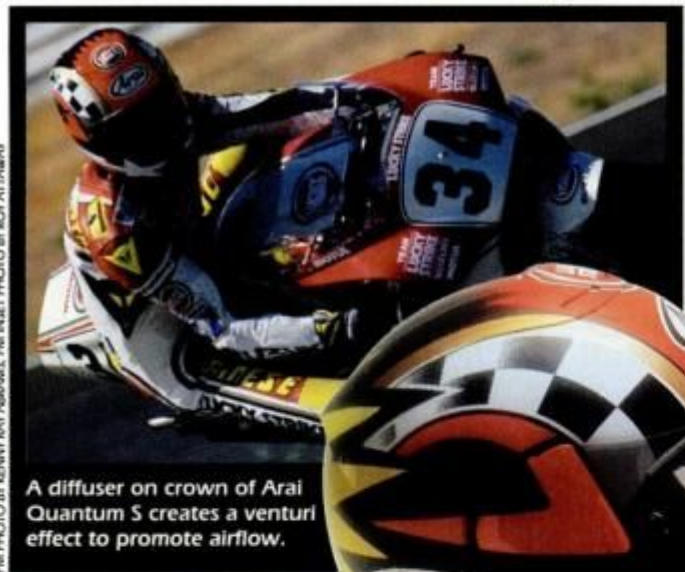
The motorcycle's fairing and the driver's crouched position limit buffeting, but keeping cool is a definite problem. Arai tackled this problem for 1993 Grand Prix and Superbike racers by adding a plastic diffuser device to the crown of the Quantum S helmet. The diffuser is located over seven small holes in the helmet shell and creates a venturi effect that produces suction to draw air around the liner and out the holes. At speeds of more than 125 mph, the effect is so efficient that riders feel their hair lift, and often return to the pits with lines of sweat trailing out the diffuser.

Because high speed is required to make the diffuser work, it has little application for street riding, but Arai speculates that the design might lead to active vent systems for future nonracing helmets.

Helmets used in these and most forms of motorsports must meet safety performance standards established by the Snell Memorial Foundation of St. James, New York, an organization founded after the preventable racing death of William "Pete" Snell in 1957. For helmets to gain Snell certification they must be submitted for testing and evaluation, and those that pass may carry the Snell certification sticker. To make sure that submitted helmets match production units, Snell monitors helmet integrity by periodically testing off-the-shelf products.

Lighter, more comfortable and more aerodynamic helmets are emerging in professional racing, and this technology will lead to better helmets for amateur racers and enthusiasts, too. But a helmet won't work if it's not on your head. All bikers, snowmobilers and other motorsports enthusiasts should always wear a properly fitted, Snell-certified helmet, and if these helmets don't come cheaply, just ask yourself, "Do I have a cheap head?" You know the answer.

FM

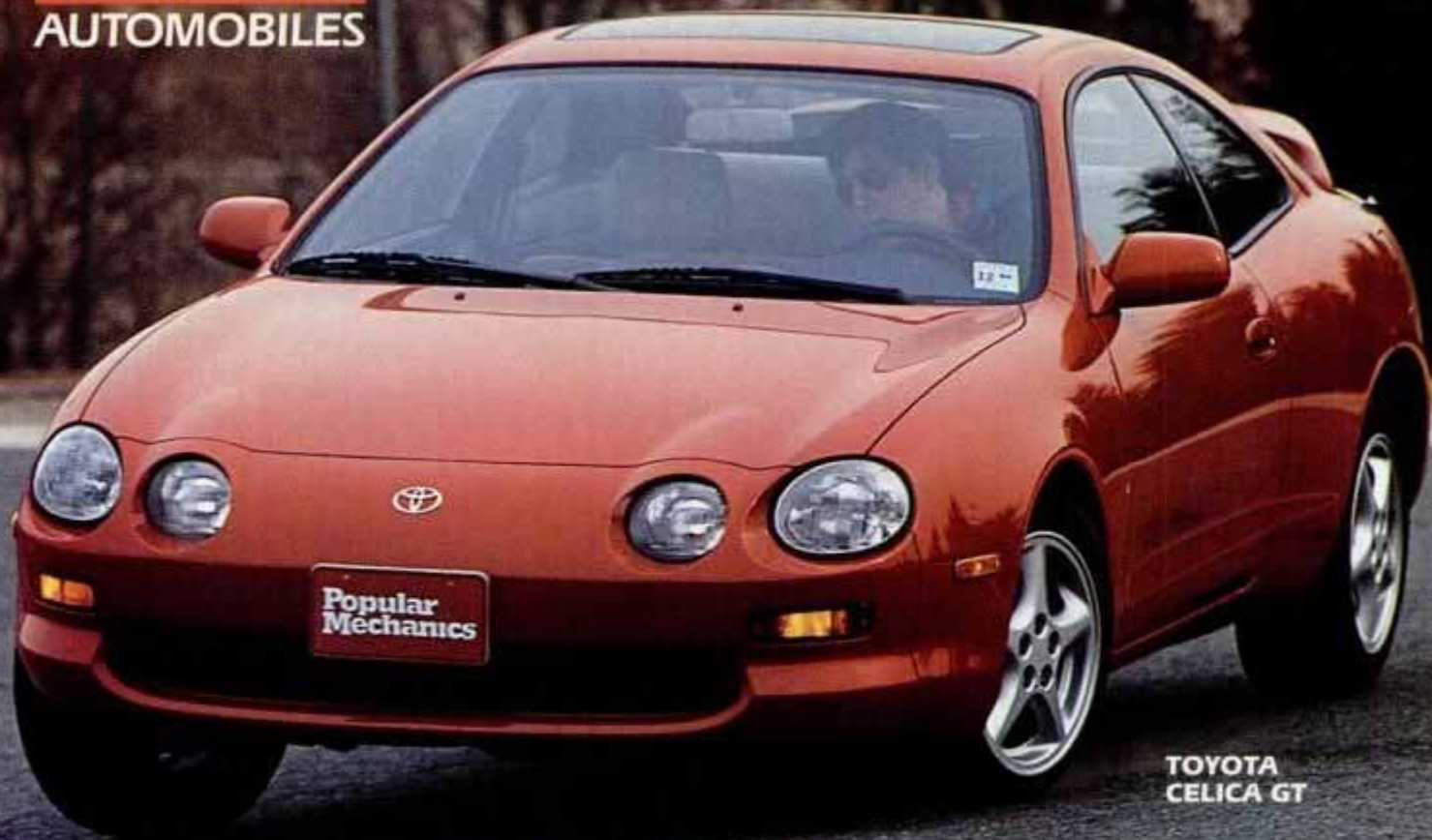


FM PHOTO BY KENNY BAY ASSAMS; FM INSET PHOTO BY ROY ATTAWAY

stock-car drivers are turning to forced-air systems that pump cool, clean air into the helmet. These systems pull air from outside, filter it and blow it through a heat exchanger located in an ice-filled cooler. The cooled air enters the helmet through a hose connected to a duct on the chin bar and exits through a port in the helmet's crown. This air is not only cool, but has a much lower carbon-monoxide content than air trapped in the car.

In the Simpson Sidewinder model, the majority of fresh air is directed at the face shield to reduce fogging, with the rest aimed at the driver's face. The result is a cooler, more alert driver, who's able to concentrate in the critical late stages of a race.

A 500cc Grand Prix motorcycle has roughly the



TOYOTA
CELICA GT

LONG-TERM TEST CARS

Three new imports join our fleet.

● As our test fleet rolls over and we begin testing new-for-'94 models, a weird thing has happened. Because of late introductions of several domestic models, we find ourselves overloaded with cars bearing import nameplates. In our next report, this will even out. Meanwhile, we add a Toyota, Honda and Isuzu to our fleet, and bid *adieu* to our Mercury Villager. We're also taking a crash course in Japanese.

Toyota Celica GT

Wow! Is that the new Celica or the new Supra? The sixth generation of one of Toyota's most popular models, the Celica, sure looks like a baby Supra for 1994 and that's what intrigued us most about this sporty 2+2 coupe. Since we'd already given a '94 Design & Engineering Award to the new—and much more expensive—Supra, we wanted to see if its sister car, the Celica, could live up to the sporty aspirations hinted at by its all-new

design. We asked Toyota to lend us a new Celica GT liftback and it now resides in our long-term test fleet.

Although we've just taken delivery of the bright red tester, we can tell you that Toyota watchers immediately pick up on the similar styling cues shared by both cars. The front-end styling, in particular, with its distinctive grilleless treatment and integrated bumper, is especially striking. At the back end, a new spoiler adds a lean, tucked-in look that emphasizes the big, fat wheels and tires.

Our test car has the GT option. That means a larger, more powerful 2.2-liter 4-cylinder engine rated at 135 hp at 5400 rpm and 145 ft.-lb. of torque at 4400 rpm. Standard-issue Celica STs have a 1.8-liter Four rated at 110 hp. GTs also get different gearing, different suspension calibrations, bigger brakes, wider wheels and tires, and several interior differences. All of these differences make a GT acceler-



DODGE INTREPID ES

LONG-TERM TEST CARS



FM PHOTO BY CLIFF GROMER

ate more quickly, handle more responsively, and have a higher top speed than an ST, according to Toyota. We'll run our own tests and let you know in the next installment.

But first, we'll put on some break-in miles, run our regular battery of performance tests, then put the Celica GT into daily commuter service—the most severe test of all. We'll update you soon.
—Joe Oldham

Dodge Intrepid ES

With almost 8500 miles on the clock, the Intrepid continues to improve its fuel mileage, nibbling away at the 20 mpg mark in New York City grudge-match commuting. When we do have an opportunity to hit the interstate, the overhead trip computer camps somewhere between 27 and 28 mpg, depending on how far we screw down the radar detector.

Chrysler has been very solicitous as to the health of this vehicle—perhaps more so than it would be about a car purchased by a customer than one lent to a magazine with 9 million readers per month. How often has your car company sent an engineer from Detroit to your house for a day to

test-drive your car—especially when you've reported nothing wrong?

Since that test drive, we have managed to find something to complain about. There's a minor rattle in the right rear door. It's minor enough that we haven't really been concerned, but we'll look into it the next time the car goes to the dealer for scheduled service. Also, the relatively weak light generated by the high beams continues to be a source of annoyance. In fact, we've been told that the light output of all Chrysler LH sedans has been upped for the '94 model year. Other than those little irritants, we can't praise the Dodge Intrepid enough. It's the car everyone wants to take home for the weekend, and we're no exception.
—Mike Allen

Isuzu Amigo XS

To understand the Isuzu Amigo, you have to go to the nearest college campus and watch the kids react to it. They love this thing.

You, as an adult over the age of 35, may have a problem comprehending that. We did too. Who wants to drive around in a vehicle that has a marked resemblance to a 1960 Jeep CJ? Who

wants to put up with the bouncy ride? Who wants to hassle with a cloth top, roll-up windows and a stick shift?

Your college-age son or daughter, that's who.

It turns out that the Isuzu Amigo is one of the most popular vehicles with college-age kids. It has become almost a cult car for young adults between 16 and 25 years of age. If they can't have a muscle car like a Camaro, Firebird or Mustang, there's a very good chance they'll want something at the complete opposite end of the performance scale—like an Isuzu Amigo. It's a gutsy (or cute, depending on whether you're asking a college-age male or female), fun-to-drive vehicle, sturdy but slow and accepted by young people.

Because of its new-found popularity, and because your son or daughter may be hocking you to buy an Amigo for them, we decided to add one to our long-term test fleet.

Our Electric Blue tester is powered by the standard 2.6-liter 4-cylinder engine rated 120 hp at 4600 rpm and 150 ft.-lb. of torque at 2600 rpm. Also standard is a 5-speed manual transmission and a 4.55 final-drive ratio.

There are no powertrain options. Our test vehicle does have the XS option, meaning that it has power side mirrors, rear defogger and larger 7.55x16 aluminum wheels and P245/70R16 tires. Our test Amigo is also a 4wd. This gets you a standard 2-speed transfer case, manual locking hubs and underbody skid plates.

We have just taken delivery of our Amigo and have racked up about 800 miles thus far. Already, we wish it had more power. Zero-to-



FM PHOTO BY ROY ATTAWAY



60 mph takes almost 19 seconds. And though the 4-wheel drive gives you a real sense of security on any kind of road surface, the bouncy ride is fatiguing after awhile. The wind noise through the fabric top is loud at highway speeds. But remember, we don't understand this vehicle. We're too old.

We gave a ride to a couple of teenagers who live in the neighborhood and they thought it was very cool.

Our plan is to put several thousand break-in miles on the Amigo, then hand it over to a typical college student who will do some "environmental" testing for us. That is, park the Amigo in the right environment, like the student-center parking lot; drive it in the right environment, like around the quad; and generally "test" it for opposite-sex appeal.

We'll let you know how the test is going in about three months. —J.O.

Mazda 626 ES

Few experiences tell you more about a car's all-around livability than a really hard cross-country run. Up until the Christmas holidays, that element of our year with this midsize Mazda was missing. So we saddled up one misty morning and pointed the 626 toward Detroit.

Some 5500 miles and about a week later, our esteem for this understated sport sedan stood even higher. Though they're bolstered to keep driver and passenger firmly in place during back-road thrashing, the leather-clad bucket seats deliver all-day comfort. The 2.5-liter V6 produces excellent fifth-gear passing power, as well as very good open-road fuel economy—we averaged almost 27.5 mpg for the whole trip. Finally, the ride quality struck a surprisingly good balance between sporty firm and freeway supple. The 626 always reminds you that it's ready for any moves that may be

needed, without rattling your teeth over freeway expansion joints.

As you'd expect, a couple of previously unmentioned idiosyncrasies were recorded during this period. First, the cruise control is a little imprecise by contemporary standards, particularly when you're making small adjustments



SUBARU IMPREZA L

using the Accel/Decel feature. Second, the logbook had a couple mentions of wind and road noise at freeway speeds. It's not excessive, but it's not perfect either. Then again, the 626 doesn't pretend to be a perfect, vanilla-flavored car. This one's got soul. —Tony Swan

Honda Accord EX

You have to pay attention to any new Honda Accord. All the world's car companies do. Automotive journalists do. And anyone in the

market for a new car does. And why not? Until last year, the Accord was the best-selling car in America for three years in a row. The previous-generation Accord set standards for cars in its class that are still the envy of many carmakers. And now, there is a totally new generation of Honda Accords on the road.

Honda introduced its '94 Accord several months ago and we immediately requested one for a long-term test.

Since everyone else is probably going to test an Accord 4-door sedan, which is Honda's bread-and-butter car, we decided to go for an Accord coupe. Nowhere near as popular as the wildly successful 4-door sedan, the coupe has its own appeal.

Our new Accord's 145-hp 2.2-liter 16-valve 4-cylinder VTEC engine uses technology found in the Acura NSX sports car. The VTEC system uses a computer-controlled hydraulic system to change the camshaft profile—changing both lift and timing—at high rpm and wide throttle settings. The result is a tractable engine off-idle and through the midrange. But the engine's character changes at 5200 rpm when the

(Please turn to page 113)

MERCURY VILLAGER LS



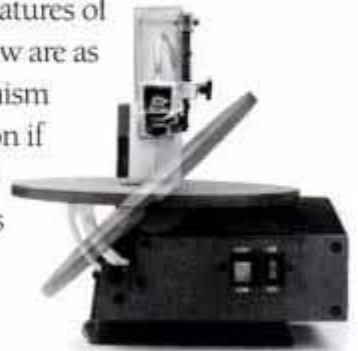
What it takes to cut it as a Consumers Digest Best Buy.

You don't get named a *Consumers Digest* Best Buy without working at it. You have to be an *outstanding* value. That's the Dremel 1671 Scroll Saw.

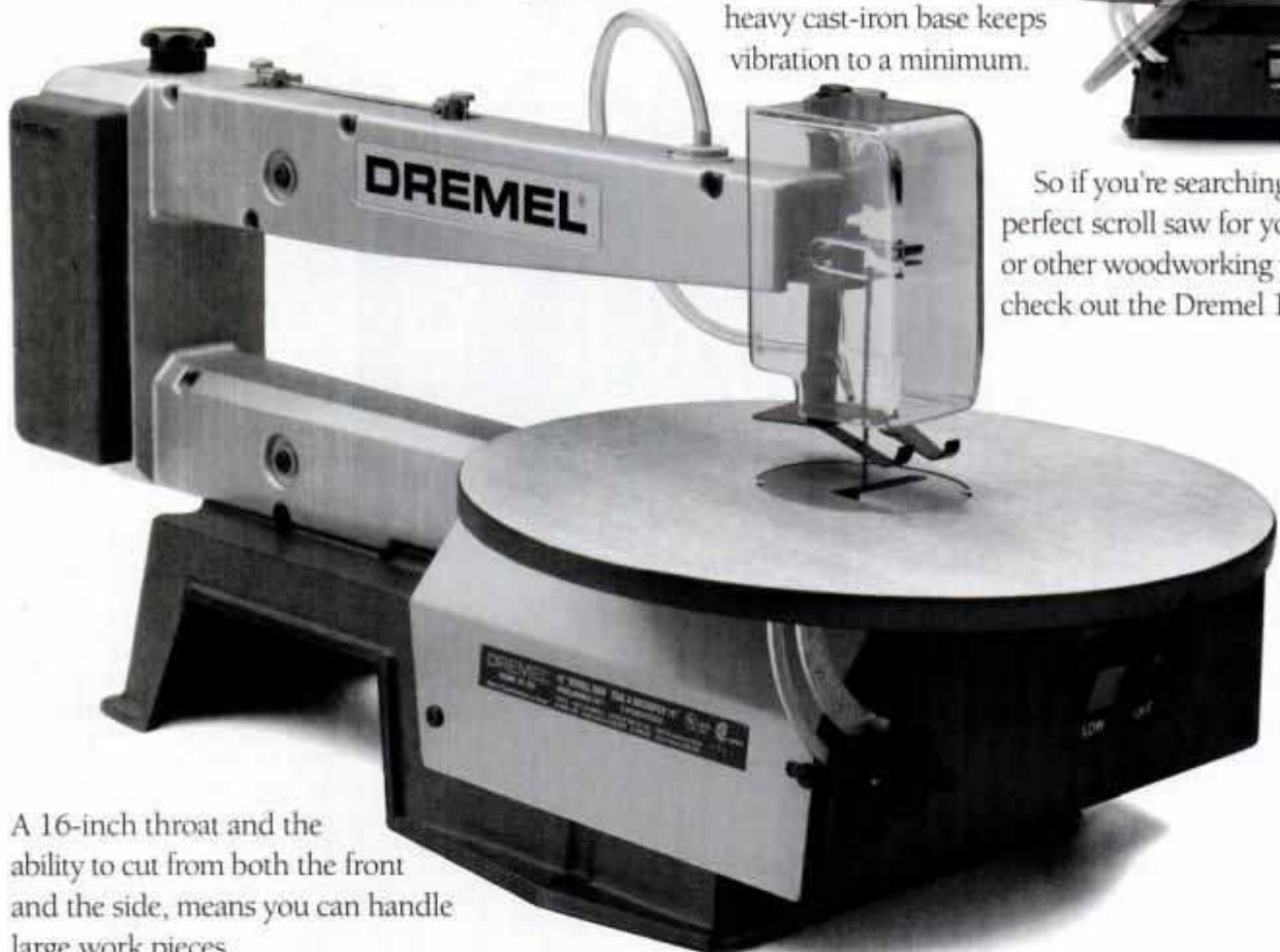
The Dremel 1671 has a lot of features that make it a pleasure to use. It has two cutting speeds and a powerful motor that lets you buzz through wood up to two inches thick, as well as sheet metals and plastics.

The sturdy, 12-inch cast aluminum table is adjustable from 0° to 45° for accurate bevel cuts up to 1-inch thick.

Of course, not all the features of the Dremel 1671 Scroll Saw are as obvious. A special mechanism quickly stops cutting action if the blade breaks. And the heavy cast-iron base keeps vibration to a minimum.

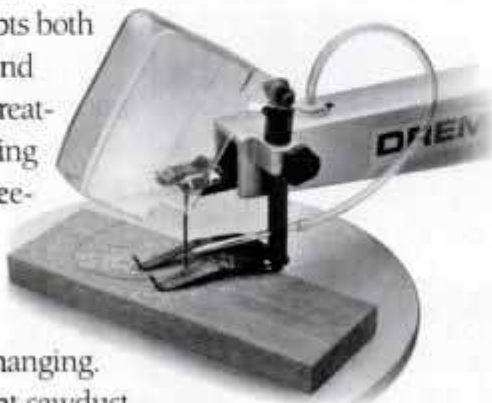


So if you're searching for the perfect scroll saw for your craft or other woodworking projects, check out the Dremel 1671.



A 16-inch throat and the ability to cut from both the front and the side, means you can handle large work pieces.

The saw accepts both plain- and pin-end blades, for the greatest possible cutting versatility. The see-through blade guard pivots out of the way for easy blade changing. And a convenient sawdust blower keeps your cutting line clear for accurate cuts.



And see why *Consumers Digest* placed it a cut above the rest.

For a free copy of the *Dremel Scroll Saw Blade Application Guide* write to: Dremel, Dept. S-PM, P.O. Box 1468, Racine, WI 53406-1468.

DREMEL®





PHOTO: THE PAGE BY JOHN GREEN

SHOP PROJECT

Hired Hand

You'll roll through the toughest jobs with this garden cart.

TEXT AND PHOTOS BY NEAL BARRETT

● Any gardener knows what a chore it can be to haul materials around the yard. Whether you're moving plants, bags of fertilizer and seed, or tools, it is a relief to have a convenient way to move all this stuff, namely a sturdy garden cart.

In designing our cart, we combined utility with good looks. We built it out of mahogany marine plywood fin-

ished with a tough exterior polyurethane so it will resist moisture. And we fastened the plywood panels using aluminum channel, so it would be reasonably lightweight. The cart rides on 20-in.-dia. wheels and a 3/4-in.-dia. solid-steel axle. In other words, it's built to take it. To make the cart convenient to use, the front panel slides in and out of its aluminum channel.

The cart's woodworking is not difficult. The wooden parts are cut to size and then fastened with aluminum angle stock. The metalwork is also straightforward. Since you probably don't own the die and die stock to thread the axle, you might be able to rent one or ask a student in an industrial-arts class to cut the threads. Also, a machine shop should be able to do the work inexpensively.

Building The Cart Body

Although we built the cart body from mahogany marine plywood, you can use marine fir plywood or pressure-treated plywood. If you can't find a marine plywood supplier near you, you can order it from: M.L. Condon Co., 246 Ferris Ave., White Plains, NY 10603.

Begin construction by laying out the cart pieces on the plywood sheet. Support the plywood on a sawhorse, and clamp a straightedge to the panel to guide the saw when cutting the panels to size (Photo 1).

Next, smooth the ends of the plywood panels using a belt sander or a hand-sanding block and 120- and 220-grit sandpaper.

Apply the finish to the plywood panels before the cart is assembled. By doing so, even the areas covered by the aluminum channel and angle stock will be protected by the finish. Drive finish nails into the panel ends and suspend the panels between sawhorses (Photo 2). Apply the finish.

Next, cut the $1\frac{1}{2} \times 1\frac{1}{2}$ -in. angle stock. Since it's hard to see a layout mark on the aluminum surface, put a piece of masking tape over the angle stock, and mark your cutlines on the tape with a pen. Clamp the angle firmly in a vise, and make the cut (Photo 3). Cut just to the waste side of the line, and then remove burrs and square the cut if necessary using a file. Cut the notches in the front piece of the angle stock.

Put another piece of tape along the angle stock, and mark for the pilot holes along the length of the workpiece. Bolt a fence to the drill-press table, and then clamp the angle stock to the fence to support it while drilling the holes (Photo 4).

Cut the $\frac{1}{2}$ -in. channel stock to length for the top and edge of the side panels. Next, cut the miters on the pieces by laying them in a miterbox supported on a piece of $\frac{1}{2}$ -in.-thick scrap (Photo 5). File off any burrs after the miters are cut.

Drill the pilot holes in the $\frac{1}{2}$ -in. channel stock in the same manner as with the angle stock.

Next, install the channel stock on the top and back edges of the side panels. Bore $\frac{3}{16}$ -in.-dia. holes into the panel before driving the screws (Photo 6). Fasten the channel to the panel using $\frac{3}{4}$ -in. No. 6 round head self-tapping screws (Photo 7). Remove the sharp corner where the channel is mitered using a file (Photo 8). If you lack a fine file, use a sanding block and fine abrasive paper.



1 Cut the plywood panels to size using a circular saw. Clamp a guide to the panel and run the saw along it.



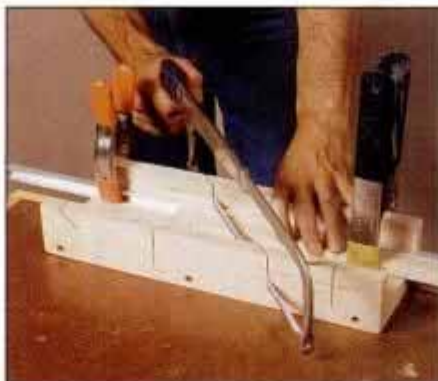
2 Suspend the panels from between sawhorses. Apply the exterior polyurethane finish on the panels' faces and edges.



3 Apply tape to the angle stock, and mark the cutline on the tape. Clamp the angle stock firmly while cutting it.



4 Clamp a fence to the drill-press table. Clamp the angle stock to the fence to support the stock while drilling.



5 Cut miters on the ends of the channel stock in a miterbox. Support the channel walls with a scrap block.



6 Place the channels on the panel edges. Bore the pilot holes for the screws that hold the channels in place.



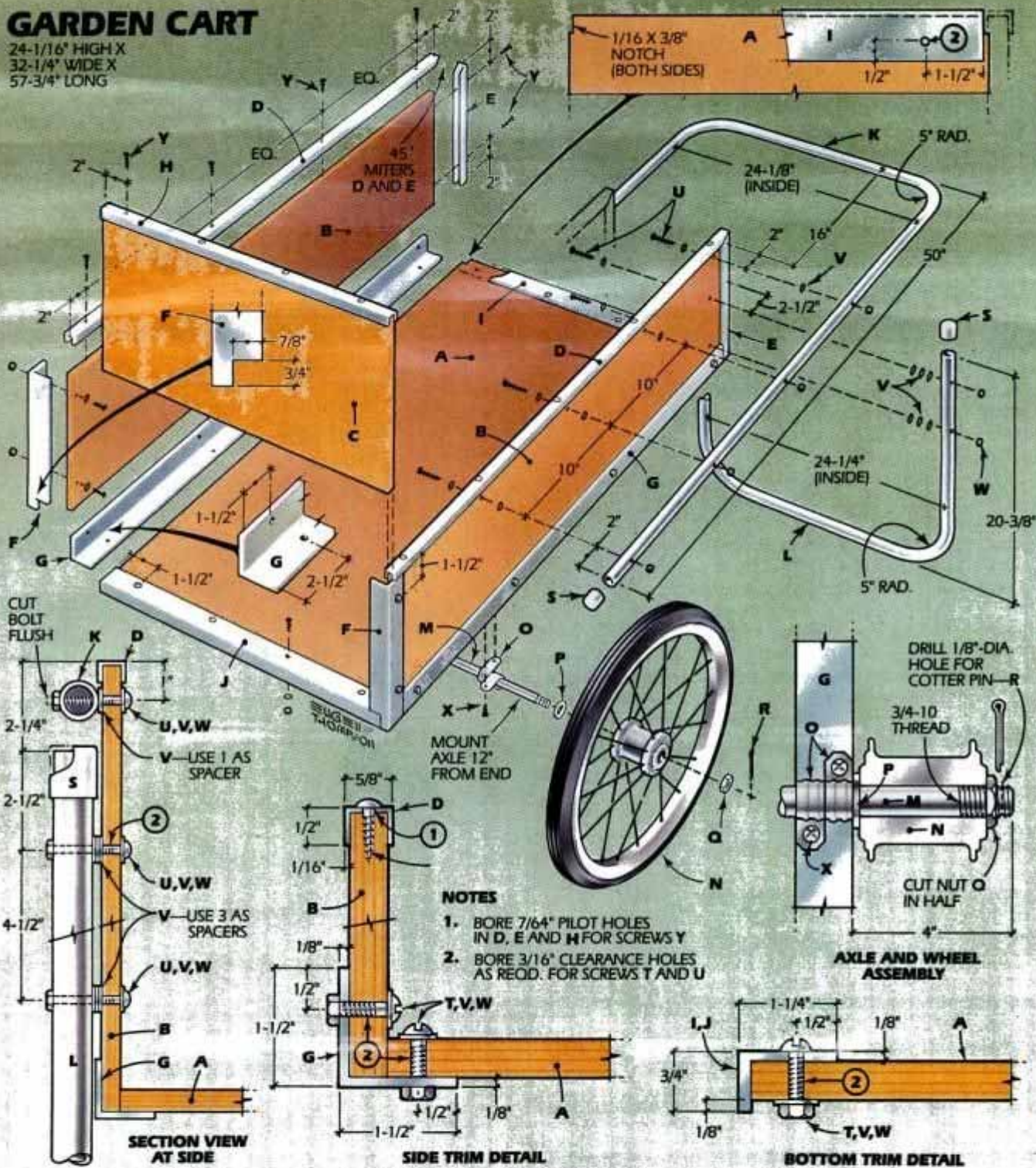
7 Screw the channels in place using self-tapping round head screws. These screws hold firmly in marine plywood.



8 File a small bevel on the miter corners where channels meet. If you lack a fine file, use a sanding block.

GARDEN CART

24-1/16" HIGH X
32-1/4" WIDE X
57-3/4" LONG



NOTES

1. BORE 7/64" PILOT HOLES IN D, E AND H FOR SCREWS Y
2. BORE 3/16" CLEARANCE HOLES AS RECD. FOR SCREWS T AND U

MATERIALS LIST—GARDEN CART

Key No.	Size and Description (use)
A	1 1/2 x 23 x 41 1/2" mahogany plywood (bottom)
B	2 1/2 x 12 x 41 1/2" mahogany plywood (side)
C	1 1/2 x 13 1/2 x 23 1/2" mahogany plywood (end)
D	2 1/2 x 41 1/4" aluminum channel (side top trim)
E	2 1/2 x 12 3/4" aluminum channel (side end trim)
F	2 1 1/2 x 1 1/2 x 11 1/4" aluminum angle (corner trim)

G	2 1 1/2 x 1 1/2 x 39 3/4" aluminum angle (side bottom trim)
H	1 1/2 x 23 3/4" aluminum channel (end trim)
I	1 1/4 x 1 1/4 x 22 1/4" aluminum angle (bottom trim)
J	1 1/2 x 1 1/2 x 23" aluminum angle (bottom trim)
K	1 3/4-in.-dia. x 10-ft. electro metallic tubing (handle)
L	1 1/2-in.-dia. x 10-ft. electro metallic tubing (leg)
M	1 3/4-in.-dia. x 32 1/4" cold-rolled

N	2 steel bar stock (axle)
O	4 1 1/4-in.-dia. (wheel)
P	2 1-in.-dia. conduit strap
Q	2 1/2-in.-inside-dia. washer
R	2 3/4"-10 hexnut
S	2 1/2 x 1 1/4" cotter pin
T	28 1-in.-inside-dia. plastic cap
U	12 28 3/4 x 10-32 rh machine screws
V	60 2" x 10-32 rh machine screws
W	60 No. 10 washers
X	40 No. 10-32 hexnuts
Y	4 1/2" No. 8 self-tapping screw
Z	16 3/4" No. 6 self-tapping screw

Place a bottom angle in position on a side panel, and clamp it in place with a scrap block behind it. Use the angle as a template to bore pilot holes in the panel (Photo 9). Fasten the angle stock to the panel using machine screws, so the screwheads are on the panel's inside (Photo 10).

Cut a piece of $\frac{3}{4} \times 1\frac{1}{4}$ -in. angle stock to length for the front end of the cart bottom. Drill the pilot holes through both the angle and bottom panel, and install it with the screwheads on the inside of the panel and the washers and nuts on the bottom.

Lay the bottom panel upside down on the workbench, and place one of the sides in position (Photo 11). Bore pilot holes through the bottom. Again, use a backer block to prevent splitting out the veneer where the bit exits the hole. Screw the bottom and side together.

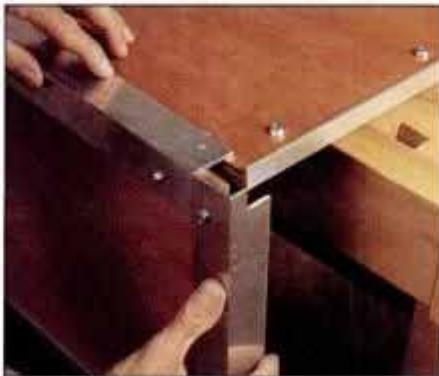
Cut the remaining piece of $\frac{3}{4} \times 1\frac{1}{4}$ -in. angle stock to length for the open side of the cart. Drill the pilot holes through it, and fasten it in place. Test fit the sliding panel (Photo 12). If the panel binds slightly, apply a bit of wax or Teflon spray to both panel ends and the angle stock that forms the track. Cut and apply the $\frac{1}{2}$ -in. channel stock along the top edge of the sliding panel.



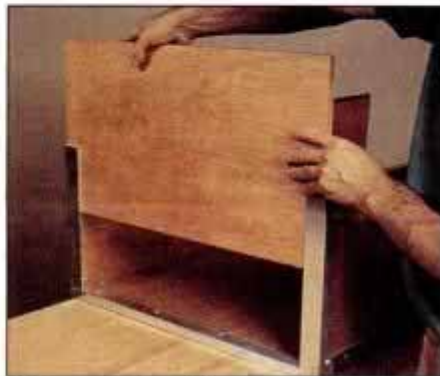
9 Clamp a scrap block and an angle to a side panel. Bore pilot holes through the panel, the angle stock and the channel.



10 Attach the angle stock to both sides and the bottom with machine screws. The screwheads go inside the cart.



11 Lay the bottom panel upside down on the bench. Position the side panels, and bore the pilot holes.



12 Test fit the sliding panel. If it sticks a little, apply lubricant to the panel edges and to the channels.

Wheels, Axle, Handle And Stand

The axle is made from a piece of $\frac{3}{4}$ -in.-dia. cold-rolled bar steel. You can cut it to length with a hacksaw, but it's easier to specify the length and have the material supplier cut it.

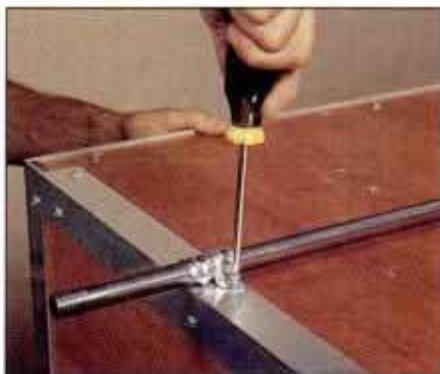
Cut the threads on the axle using a $\frac{3}{4}$ -in.-10 die ($\frac{3}{4}$ in. dia., 10 threads per inch) held in a die stock. Clamp the axle upright in a vise and position the die over the end of the axle. Apply some cutting oil to the bar, and slowly advance the die about one-eighth of a turn. Then, reverse direction to clear the chips from the die's cutting edges. Proceed until you have threaded 1 in. of the axle (Photo 13). Repeat the procedure on the other end.

Position the axle on the cart bottom, and fasten it in place using two conduit straps at each end of the axle. Drill pilot holes through the angle stock, and attach the straps using $\frac{1}{2}$ -in. No. 8 screws (Photo 14).

We used heavy-duty spoked wheels manufactured by Martin Wheel Co. Inc., 342 West Ave., P.O. Box 157, Tallmadge, OH 44278. This company will not sell directly to you, but you can contact it for the name of a distributor in your area (such as an industrial supply house). The wheels



13 Cut the threads on the axle. Take small turns, back off and then cut some more. Use plenty of cutting oil.



14 Attach the axle to the cart bottom using electrical conduit straps and screws. Use two straps at each axle end.



15 Slide a washer onto the axle. The washer acts as a bearing surface between the wheel hub and cart.



16 Clamp the nut in a vise and then saw it in half. Clean up the saw marks with a fine file or a sanding block.

are stock No. SP-20HD-34BB, and a pair costs about \$116.

Slide a $\frac{3}{4}$ -in. washer over each end of the axle (Photo 15), and slide the wheel against the washer. The wheels are held in place by a $\frac{3}{4}$ -in. nut, but since the nut is too thick for this application, you must cut it in half.

Clamp the nut in a vise, and cut it in half with a hacksaw (Photo 16). Use a file to clean up the cut surface and remove any rough edges. Tighten the nut until the wheel is held in place without any side-to-side play.

Next, install a cotter pin through the axle to hold the nut in place. To mark the pin hole, dimple the axle with a centerpunch (Photo 17).

Remove the nuts, wheels and axle. Place the axle on a support block. This block is just a piece of scrap with a shallow $\frac{3}{4}$ -in.-wide channel cut into it. Clamp the block and the axle to the drill-press table. Set the drill press to its slowest speed, apply plenty of machine oil to the bar stock and drill the hole (Photo 18).

The drill bit will probably leave a burr where it exits the bar stock. Do not use a file to remove this burr as it will damage the axle threads. Instead, clamp the axle in a vise and use the die, with plenty of cutting oil, to remove the burrs.

Reinstall the axle on the cart. Install the cotter pins through the axle. Bend the legs of the cotter pin to the side with a pair of pliers (Photo 19).

Make the leg and handle from $\frac{3}{4}$ -in. electrical conduit. This material is quite a bit easier to bend without kinks than aluminum tubing. The conduit is bent using a jig made from scrap plywood. If you don't want to make the jig, chances are you can rent a conduit bender to do the job.

To make the jig, trace the desired radius on two pieces of panel stock. Cut the radius using a sabre saw, then use a router to cut a $\frac{1}{2}$ -in.-rad. cove along the shaped edge. Screw the two pieces of panel stock together so that the coves oppose each other. This makes a bending form with a 1-in.-dia. cove along its edge.

Mark the beginning and end of the bend on the form. Use the marks and the dimensions in the plan to make the bend in the tubing at the correct place. Mark the tubing with a pencil, and align the tubing with the marks on the form. In bending the handle, the entire 10-ft. length of tubing is used. The leg, however, is bent to shape, and the excess material is cut off. You should bend the leg and then cut it to length. Bending the tubing at



17 Temporarily install the wheels and nuts. Dimple the axle using a centerpunch to mark the cotter pin hole.



18 Clamp the axle and support block to the drill-press table. Use cutting oil when drilling the cotter pin hole.



19 Clean off the burrs on the axle made from drilling the cotter pin hole. Install the axle, washer, wheel, nut and pin.



20 Align the marks on the tubing with those on the jig, and clamp the bending jig securely to the workbench.



21 Press the tubing caps on the handle and leg. Soften them, if necessary, in hot water or use a heat gun or blow dryer.



22 Use three washers between the leg and the sides. Cut off the excess screw shaft, and file it smooth.

full length allows you take advantage of the leverage the tubing provides (Photo 20). With both the leg and the handle, the form is clamped securely to the bench and the tubing is clamped to the form.

Press the plastic furniture caps on the ends of the leg and the handle (Photo 21). We bought these caps at the local hardware store. If the caps are difficult to press into place, soak them in hot water for a few minutes to soften and expand them.

Next, drill pilot holes through the leg and handle for mounting screws. Clamp them on the cart and use the

holes in the leg and handle as a guide when boring the pilot holes into the cart body. Use scrap blocks to prevent the drill bit from splintering the plywood as it exits.

Use 2-in. No. 10-32 screws (32 threads per inch) to install the legs and handle on the cart (Photo 22). Use three washers between the leg and cart sides, and use one washer between the handle and cart side to maintain proper spacing. The 2-in. screws are longer than necessary for this job, so cut off the excess screw with a hacksaw. Use a file to smooth the cut end of each screw.

FM

TOOL TEST

**Ryobi
 Cordless
 Mulching
 Mower**

TEXT AND PHOTOS BY
 THOMAS KLENCK, Associate
 Home Improvement Editor

● If you have a modest lawn, and don't mind tending it regularly, Ryobi's new battery-powered BMM2400 Mulchinator may be the shortest distance to hassle-free lawnmowing you're likely to find—barring a professional landscaper or a few goats.

This new addition to the ever-increasing list of cordless power tools features a 24-volt system that includes an on-board integral charger. When you're done mowing, simply wheel the machine into your garage and plug it in. In about 16 hours, you're ready to take on another ½ acre of turf.

The Mulchinator system requires a key that contains a circuit breaker to prevent overloading the motor. A sliding door prevents charging when the key is installed (Photos 1 and 2). Once the key is in, simply press a button and lift a handle-mounted lever to send power to the motor (Photo 3).

We used Ryobi's Mulchinator for a complete mowing season and found that, within the constraints of light-duty mowing, it's a pleasure to operate. Because it's a mulcher, and its power is modest, this mower isn't the best for high, dense grass. However, it easily dissolves a blanket of leaves in one pass (see lead inset photo).

On the down side, convenience and technology can be expensive—\$379, according to the manufacturer, although you'll find the mower on sale for less. And, while the battery pack carries a 2-year warranty (along with the motor), it costs about \$125 for a new one. Keep in mind that cool fall weather substantially slows down recharging.

Additional features include a fold-up handle (Photo 4), close-cutting deck design and dual-range height adjustment for cutting from 1 to 4 in. For more information, contact Ryobi Outdoor Products Inc., 550 N. 54th St., Chandler, AZ 85226. **PM**



Ryobi model BMM2400 24-volt cordless mulching mower has on-board battery charger. Two cutting-level ranges yield grass heights from 1 to 4 in. Mulching capability is evident in single pass through fallen leaves (inset).

PHOTO BY SPAN SLIVER



1 To charge battery, connect mower to the nearest outlet with an extension cord. A full recharge takes about 16 hours.



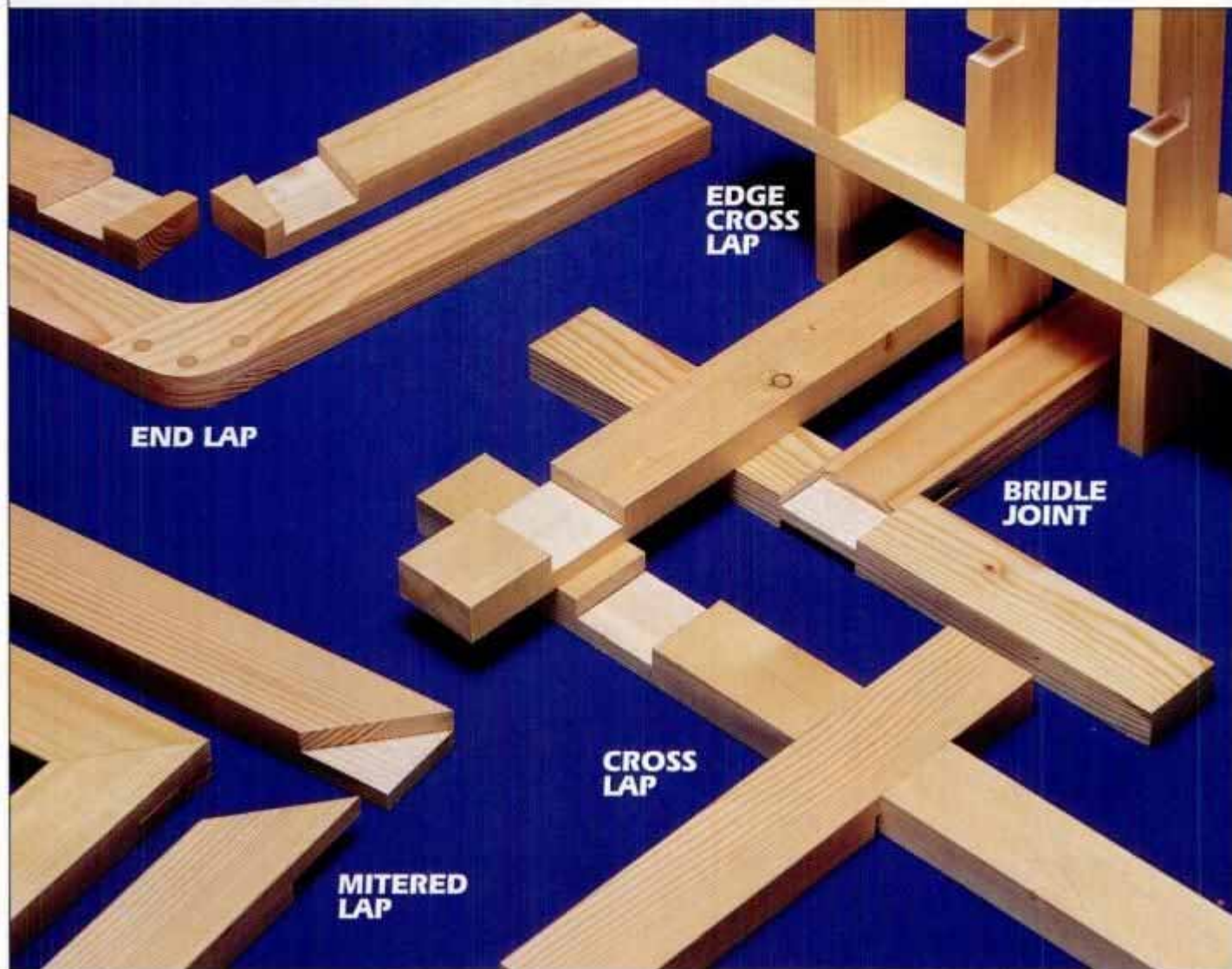
2 After removing extension cord, slide door over recharging port to insert ignition key. Key also acts as a circuit breaker.



3 To start motor, press button at side and move up control bar. Mower stops running as soon as control bar is released.



4 Handle folds up for easy horizontal or vertical storage. Handle is adjustable to three height positions.



SHOP TECHNIQUES

Lap And Bridle Joints

TEXT AND PHOTOS BY ROSARIO CAPOTOSTO,
 Contributing Editor

● If it seems to you that experienced woodworkers spend all their time making tightly fit handcut dovetails and chopping through mortises for wedged tenons, it's time to put things back into perspective. Although these revered joints have a place, and their mastery is a goal for any self-respecting craftsman, there's often a simpler way to get the job done.

It goes without question that the most basic way to join two pieces of wood at right angles is to simply nail, screw or glue them together. Known as a simple lap or overlap joint, this face-to-face union relies entirely on the strength of the fastener or glue.

With a little more ingenuity, however, this mundane lap joint turns into a small family of joints that are both easy to make and relatively strong.

One way to give a simple overlap joint more strength is to notch one member so the adjoining piece fits inside the notch. This improvement adds rigidity as the shoulders of the notch keep the lapped piece from moving from side to side.

Unless you're dealing with two pieces of different thicknesses, however, notching one to accept the other won't produce a flush surface. To achieve this, both pieces must be notched—usually half the thickness of

the stock. Called a half lap, this easy-to-make union has even greater mechanical strength and can be modified to suit a variety of situations.

When used in the middle of a board, the joint is called a cross lap. At the ends of two boards, it's called an end lap. Egg-crate construction utilizes the same half lap, but in this case it's laid out on the face of the workpieces to produce edge cross-lap joints. A mitered lap reinforces an ordinary miter joint by a hidden lap on the back surface.

For an even stronger version that resists a wider variety of loads, choose a bridle joint. Here, one member is notched one-third the stock thickness on both faces, and the mating piece gets a deep notch, or slot, along the edge that matches the width of the first piece. Often used as a simple substitute for a mortise-and-tenon joint, a bridle joint can be used at the end or middle of a board and is useful for joining rails and stiles in frame-and-panel construction.

Hand-Cut Half Lap

Before starting to cut a half-lap joint, first lay out the notches with a sharp pencil or knife. Whenever possible, use the actual pieces to mark the cut-lines. Align the mating pieces with a square and mark the width of the notch on the faces (Photo 1). Then, use your square to extend the lines across the edges. Lay out the depth of the notch (one-half the stock thickness) on each piece with a marking gauge (Photo 2).

Next, use a backsaw to cut the edges of the notch, or shoulders, just to the inside of the lines. Follow by making a series of kerfs to the notch depth within the waste area (Photo 3). Space the kerfs fairly close together—especially if the grain of the stock isn't straight. It helps to use a bench hook to hold the work. A raised and square backstop on the bench hook helps guide square cuts. Then, break out the waste by gently prying with a chisel.

Once the notch is roughed out, smooth and level the bottom notch surface with your chisel, bevel side up (Photo 4). When both notches are cut, test fit the joint for a tight, flush fit and adjust the shoulders or depth as necessary.



1 Lay out width of half-lap notch by scribing against mating piece with a sharp pencil or knife. Use a square to hold stock at 90°.



2 After extending lines across edges, use a marking gauge to lay out notch depth. Set gauge at one-half the stock thickness.



3 Use a backsaw to make shoulder cuts with stock held on bench hook. Then make a series of kerfs in waste area.



4 After prying out the waste with a chisel, pare the notch bottom flat and smooth. Then test fit and adjust if necessary.

Machine-Cut Half Laps

To make half laps with a router and straight bit, first make a frame to guide the router (Photo 5). Space two parallel strips to match the width of both workpieces laid edge to edge so you can cut both pieces at the same time. Nail or screw these strips squarely to side strips that limit the notch width. To determine the spacing of the side strips, add the router base width to the half-lap width, then subtract the bit diameter.

Set the bit depth to one-half the stock thickness, make a test joint and check for fit. Note that the position of the finished notch in the jig is indicated by the cut extensions in the two strips adjacent to the stock edges.

To cut half laps on a table saw with a dado blade, first install a wooden auxiliary fence. Set the blade height slightly more than the full thickness of the stock and cut a notch in the fence. Then, lower the blade to half the stock thickness, and make the shoulder cuts aligning the stock with the notch in the fence (Photo 6). Remove the waste with successive passes.

When cutting square or angled end laps, first make the joint near the end of the stock (Photo 7). After assembly (Photo 8), trim the ends flush.



5 Use a guide frame to cut half-lap joints with router. Place both pieces edge to edge and cut at the same time.



6 To cut joint on table saw, install dado blade and set height to half the stock thickness. Notch in fence indicates cutline.



7 Cut angled end lap near end of stock—trim overhang after assembly. Notch in fence helps position shoulder cut.



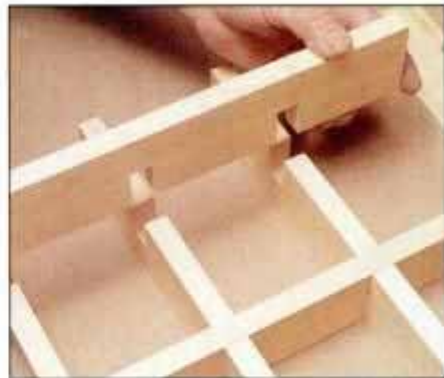
8 For added strength, pin end-lap joint with dowels after applying glue. When glue has set, trim ends flush.

Edge Cross Lap

To cut this joint on a table saw with a dado blade, first install a tall fence on your miter gauge and adjust the dado blade width to stock thickness. Set the depth of cut to one-half the width of the work. Then, cut a notch in the fence. Disconnect the fence, slide it over a distance equal to the desired notch spacing, resecure it and install a guide block in the fence notch. Make the first cut with the end of the work against the guide block. Then, position each successive cut by placing the last notch over the guide block (Photo 9) and assemble (Photo 10).



9 When cutting evenly spaced notches, use guide block secured to fence. Place last cut over guide block to position next cut.



10 Completed edge-lap assembly joins to create egg-crate design. Uniform cutting guarantees accurate alignment.

Mitered Half Lap

This is a novel joint that provides the increased glue area and strength of an end-lap joint while presenting the appearance of a miter joint on one side. The opposite side appears as an ordinary end-lap joint.

To make the joint, first cut one piece of stock squarely to length, and a second at 45°. Then, install an auxiliary fence and set your miter gauge for 45°. As with an ordinary half lap, set the dado blade height to slightly more than half the stock thickness and cut a guide notch in the fence.

Set the blade height at half the stock thickness, align the corner of the square-end piece with the guide notch and make the mitered shoulder cut (Photo 11). Make repeated passes, shifting the stock after each cut, to remove the rest of the waste.

For the mating mitered piece, set

up the fence and guide notch with the miter gauge at 90°. Make the first cut so the shoulder aligns with the obtuse corner of the mitered end (Photo 12). Then, remove the waste with successive passes.



11 Begin mitered half lap by making a mitered notch on the end of square-cut stock. Align shoulder cut with corner.

Because this joint requires resetting the miter gauge and installing a new auxiliary guide fence for each mating piece, it's a good idea to cut all like pieces at once when you're making several joints.



12 Set miter gauge to 90° and cut notch on end of mitered stock. Align the shoulder cut with the obtuse corner of miter.

Bridle Joint

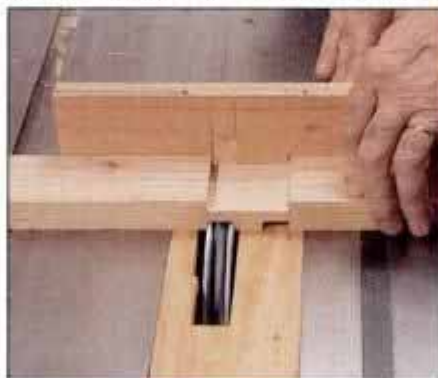
This versatile joint can be placed in the middle of a rail or stile, or at the end. When it's at the end, the notched piece becomes a tongue that fits in the slot of the adjoining piece. It's relatively easy to make, provided you align the shoulders of the top and bottom notches accurately.

After laying out the notches on the faces and edges of the work, install an auxiliary fence on your miter gauge and cut a guide notch as if you were making an ordinary half lap. Then, set the dado blade height to one-third the stock thickness. Clamp a stopblock to the fence to position the first shoulder cut. After making this cut, flip over the stock and make the matching cut on the opposite face. Then, readjust the stopblock to cut the other shoulders and remove the waste with successive passes (Photo 13).

To cut the deep slot in the mating piece, use a tenoning jig or simply clamp the work to scrap blocks that

straddle the table-saw fence. First, lay out the slot on the stock edge. Then, adjust the height of a standard blade to match the width of the notched piece.

Precisely adjust the fence to align the cut with the slot guideline. After making the first cut, flip the stock around and make the second cut. Fi-



13 Clamp a stopblock to a wooden auxiliary fence to accurately position shoulder cuts on both faces of workpiece.

nally, remove the remaining waste by making successive passes, shifting the fence over after each cut (Photo 14).

When assembling this joint, apply glue and clamp the pieces to draw the notched member tightly into the bottom of the slot. Then, add a smaller clamp to hold the inside faces of the slot against the notch faces. **PM**

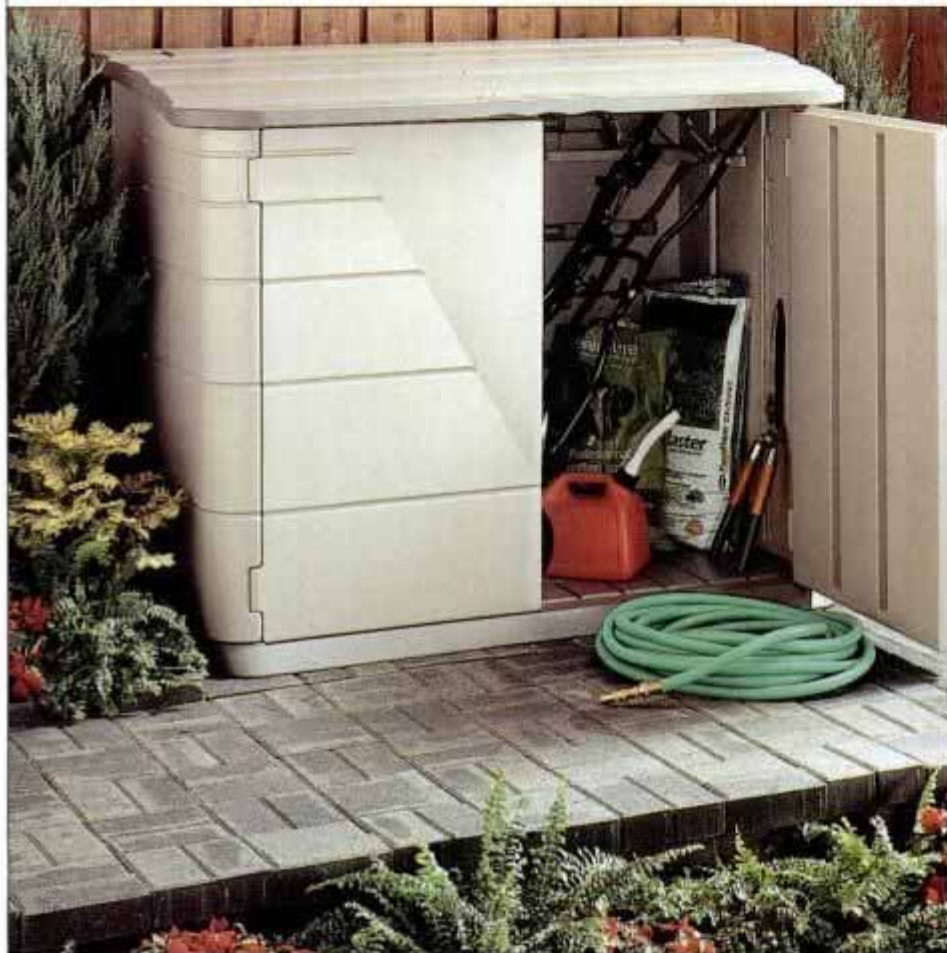


14 To cut slot, clamp work with scrap blocks to straddle fence. Make cuts with blade height at width of mating piece.

NEW PRODUCTS

Spring Training

BY ROY BERENDSOHN, Assistant Home Improvement Editor



Smaller Is Better

If you don't need a big storage shed but still want to store a few things outside, now you have another, more compact, option. Rubbermaid's storage shed is made of plastic panels and requires no tools to assemble. The shed measures 2½ ft. deep x 4 ft. high x 5 ft. wide. The shed is lockable, and it has grooves molded into its walls that allow you to install plywood shelves. You can open the shed from the top or front. It costs about \$180 at home centers and nurseries. For more information, write Rubbermaid SPI, 1147 Akron Rd., Wooster, OH 44691, or call (800) 347-3114.



Flexible

Teknor Apex feels confident enough in its Ultra Flexible garden hose that it has given the product a lifetime guarantee. The ¾-in.-dia. hose has 4-ply reinforced construction and heavy-duty fittings on both ends. Its manufacturer claims it coils and uncoils easily in high temperatures and remains flexible even in cold weather. A 75-ft.-long hose costs about \$18 at hardware stores and home centers. For more information, write Teknor Apex Co., 505 Central Ave., Pawtucket, RI 02861.



No Sweat Pruning

Most hand pruners struggle with a stem larger than ½ in. in diameter, but this large anvil pruner cuts stems up to ¾ in. in diameter without any hesitation, its manufacturer says. The pruner's anvil is plastic to reduce the wear on the hollow-ground blade. The anvil also has a tooth—which grips the branch—molded into its surface to prevent the pruner from sliding back as you cut. Also, the drop-nose design of this tool allows you to approach a branch for pruning without a cocked wrist. The AP75 pruner costs about \$10 at hardware stores, home centers and garden centers. Write True Temper Hardware, 465 Railroad Ave., P.O. Box 8859, Camp Hill, PA 17001.

Lawn Lunch

It may not sound appetizing to you, but your lawn might ask for extra helpings of Earthgro's Lawn Food. It's a blend of water-soluble nitrogen, insoluble composted plant materials and manure (but no synthetic fertilizer or composted sewage sludge). The product supplies compost, improves soil structure and is rich in microorganisms, the company says. A 20-pound bag costs about \$10, and a 40-pound bag costs \$18. It's sold at hardware stores, home centers and garden centers. For more information, write Earthgro, Route 207, Lebanon, CT 06249.



Rugged As They Come

These gloves were developed for handling rough wood in the lumber mills of the Pacific Northwest. The palm, thumb and forefinger are protected by two layers of split leather, and an extra piece of leather extends from the palm to the cuff for added protection. The safety cuff is a fiber-reinforced cotton drill. The Woodhandler's Black Mule gloves come in large and extra-large sizes, and cost from \$12 to \$16. They are sold at hardware stores. Write Wells Lamont, 6640 W. Touhy Ave., Niles, IL 60714.



Power Shovel

If you really put a shovel to the test, consider the Powerflex. Its handle is an ash lamination wrapped with fiberglass cloth, polyester resin and moldable plastic sheet. As if this weren't enough, the handle is secured to a heavy-gauge carbon-steel blade with two 1/4-in.-dia. rivets driven through an 11-in.-long socket. How much can it take? Union says the shovel handle has a 265-pound dynamic load limit. Depending on model, prices range from \$25 to \$30 at hardware stores and home centers. Write Union Tools, 500 Dublin Ave., P.O. Box 1940, Columbus, OH 43216.



Cut And Spread

Why make two trips when one will do the job? That's a good question, and one that Toro addresses with its Mow & Feed fertilizer and lawn-treatment attachment. The device just slides onto all Toro and Lawn-Boy mulching mowers, both self-propelled and push models, and it weighs less than 10 pounds. It uses the turning action from the rear wheels to distribute fertilizer, lime or top-dressing from the plastic hopper. Like other spreaders, you can adjust its flow rate depending on the product you are using at the time. It costs about \$50 at home centers and Toro dealers. Write The Toro Co., Attn: Mow & Feed, 8111 Lyndale Ave. S., Minneapolis, MN 55420.



Cart Blanche

According to Ames, using the Easy Roller lawn cart requires half the effort needed to move the same load in a wheelbarrow. The cart's wheels are under the tray instead of in front of it, and, because its handle is 30 in. high, you don't have to stoop to lift it. In fact, the handle is designed so you can move the cart with one hand. The cart is molded from high-density polyethylene, and costs about \$50 at hardware stores and garden centers.

This pocket-size tool (right) is called a flower pruner, but it's strong enough to cut 1/4-in.-dia. twigs and other tough materials like thick cardboard. It has serrated stainless-steel blades, and costs about \$7 at hardware stores and lawn and garden centers.

Write Ames Lawn & Garden Tools, P.O. Box 1774, Parkersburg, WV 26101.



Punch Some Holes

Aerating your lawn is a good idea, and if you own a small tractor, it gets even better, as this aerator illustrates. The 30-in.-wide model has core plug tines mounted on axle bearings that spin independently of one another. This way, the tines can turn at different rates to compensate for its turning radius. It aerates down to 2 1/2 in., and costs about \$200 at outdoor power equipment dealers and home centers. A 48-in. model costs about \$500. For more information, write Feldmann Engineering & Manufacturing Co. Inc., 520 Forest Ave., P.O. Box 908, Sheboygan Falls, WI 53085.

Tough Seed

EcoSystems grass seeds were developed to be not only rugged but also to need less fertilizer, water and mowing. The Summer Stress seed mixture is heat- and drought-tolerant and needs less fertilizer than Kentucky Bluegrass (bottom right). The Ecology seed mixture was designed to produce an attractive turf on as few as two cuttings a year, a handy feature for vacation homes (below). The Wildflower Meadow Mixture uses hard fescue seeds and Pinto Wildflower seeds (left). It comes in several types to suit regional climates. Prices range from about \$48 for a 20-pound bag of the Summer Stress seed to about \$70 for a 20-pound bag of the Ecology seed and \$20 for a 6-ounce bag of the Wildflower Meadow Mixture. They are sold at lawn and garden centers. Write Lofts Seed Inc., Chimney Rock Rd., P.O. Box 146, Bound Brook, NJ 08805.





Fog 'Em

A severe insect problem might call for drastic measures, but that doesn't mean you have to resort to highly toxic chemicals. This fogger sprays a fine mist of pyrethrum and water. Pyrethrum is a centuries-old—but highly effective—insecticide made from crushed chrysanthemum flowers. It is effective on a range of insects, and it is far less toxic than many synthetic pesticides. The fogger is powered by a double-insulated 3-amp motor that runs off a 2-wire extension cord and sprays a mist from 12 to 20 ft. It costs about \$60 at hardware stores and home centers. Write Flowtron Outdoor Products, 2 Main St., Melrose, MA 02176.



One Size Fits All

Don't throw out a perfectly good shovel just because you break its handle. Instead, you might consider these universal replacement handles to get your shovel back in service. The handles consist of an industrial-strength polypropylene adapter secured to an ash handle. There are two different handle configurations to choose from: a 48-in. straight handle and a 30-in. D-grip. Both cost about \$9 at hardware stores and farm-supply stores. For more information, write The IXL Group, P.O. Box 149, Bernie, MO 63822.

Once Is Enough

If you like to keep your lawn and garden chores short and sweet, then maybe this new line of fertilizers is for you. You make just a single application of Once time-release fertilizer—



there are no separate applications for spring, summer and fall. You don't need to mix the fertilizers with water, you simply apply them. The fertilizers are available in a variety of formulations for vegetables and bedding plants, roses, trees and shrubs, and lawns. They're sold at home centers and garden centers, and each costs about \$8.50 in the 5-pound box size. For more information, write Grace Sierra, P.O. Box 4003, 1001 Yosemite Dr., Milpitas, CA 95035.



A Slice Of Lime

You might be more likely to apply lime or gypsum to your lawn if the job is not a dusty nuisance. These two pelletized products are designed to make the job more precise and more pleasant. The limestone pellets add calcium, and are available in three types: for low magnesium soils, high magnesium soils and normal soil. The gypsum pellets add calcium and sulfur, and act as a soil conditioner to make fertilizer more available to plant roots. The gypsum pellets are sold in 50-pound bags, and the limestone pellets are sold in 40-pound bags. Both products cost about \$7 at garden centers. Write Ampel Corp., P.O. Box 3628, Des Moines, IA 50322.

Heavy Metal

If durability and longevity are your criteria for a yard product, and you're tired of lightweight plastic sprinklers, consider these all-metal lawn sprinklers reintroduced from Melnor. The sprinklers have features like brass couplings, gold anodized spray tubes or solid brass spray arms, and aluminum runners. They are guaranteed for as long as you own your home. Prices range from about \$32 for a 100-ft.-dia. pulsating sprinkler to \$38 for an oscillating sprinkler that waters a 46-ft.-wide x 70-ft.-long swath. The sprinklers are sold at hardware stores and garden centers. For more information, write Melnor, 1 Carol Place, Moonachie, NJ 07074, or call (800) 526-4631.



Tank Up

Gilmour has improved its tank sprayers by increasing the diameter of the mouth and adding a second carrying handle. The company added a clip to the locking D-handle on the cap, so you can clip the spray wand in an easy-to-reach location. A variation on these tanks is the 1½-gallon Easy Reach Spray Doc with a telescoping wand that extends from 16 in. to 30 in. The sprayers come in 1½-,



2½- and 3½-gallon sizes (about \$37, \$45 and \$50). The Easy Reach costs about \$45. All are sold at hardware stores and garden centers. Write Gilmour, 332 W. Broadway, Suite 815, Louisville, KY 40202. **PM**

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Some designs are so inspired, they just can't be improved. Like the revolutionary Series 2000 Tractors from Cub Cadet. This new generation of tractors is so advanced, no other tractor line can compete with its features and prices. You'll find a solid steel drive shaft at the heart of all seven Series 2000 Tractors. That means longer life and less maintenance than any belt-drive tractor. To give you more comfortable control of these powerful machines, we equipped them with Cub's exclusive AutoGear™ and AutoHydro™ transmission systems. And we've brought versatility and ease of use together with Quick Frame Attach systems for front and rear attachments — even for mowing decks. And while we left The Wheel alone, we actually did redesign the steering wheel and the tires. The result is a tractor line designed and built for the future, starting at just \$2099. See your Cub Cadet dealer and take one for a spin.



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HOME MECHANIX MAGAZINE 1994 BEST VALUE TRACTOR — SERIES 2000, MODEL 2160

900 MHz breakthrough!

New technology launches wireless speaker revolution...

Recoton develops breakthrough technology which transmits stereo sound through walls, ceilings and floors up to 150 feet.



Breakthrough wireless speaker design blankets your home with music.

By Charles Anton

If you had to name just one new product "the most innovative of the year," what would you choose? Well, at the recent *International Consumer Electronics Show*, critics gave Recoton's new wireless stereo speaker system the *Design and Engineering Award* for being the "most innovative and outstanding new product."

Recoton was able to introduce this whole new generation of powerful wireless speakers due to the advent of 900 MHz technology. This newly approved breakthrough enables Recoton's wireless speakers to rival the sound of expensive wired speakers.

Recently approved technology. In June of 1989, the *Federal Communications Commission* allocated a band of radio frequencies stretching from 902 to 928 MHz for wireless, in-home product applications. Recoton, one of the world's leading wireless speaker manufacturers, took advantage of the FCC ruling by creating and introducing a new speaker system that utilizes the recently approved frequency band to transmit clearer, stronger stereo signals throughout your home.



Crisp sound throughout your home. Just imagine being able to listen to your stereo, TV, VCR or CD player in any room of your home without having to run miles of speaker wire. Plus, you'll never have to worry about range because the new 900 MHz technology allows

150 foot range through walls!

Recoton gives you the freedom to listen to music wherever you want. Your music is no longer limited to the room your stereo is in. With the wireless headphones you can listen to your TV, stereo or CD player while you move freely between rooms, exercise or do other activities. And unlike infrared headphones, you don't have to be in a line-of-sight with the transmitter, giving you a full 150 foot range.

The headphones and speakers have their own built-in receiver, so no wires are needed between you and your stereo. One transmitter operates an unlimited number of speakers and headphones.



Recoton's transmitter sends music through walls to wireless speakers over a 75,000 square foot area.

stereo signals to travel over distances of 150 feet or more through walls, ceilings and floors without losing sound quality.

One transmitter, unlimited receivers. The powerful transmitter plugs into a headphone, audio-out or tape-out jack on your stereo or TV component, transmitting music wirelessly to your speakers or headphones. The speakers plug into an outlet. The one transmitter can broadcast to an unlimited number of stereo speakers and headphones. And since each speaker contains its own built in receiver/amplifier, there are no wires running from the stereo to the speakers.

Full dynamic range.

The speaker, mounted in a bookshelf-sized acoustically constructed cabinet, provides a two-way bass reflex design for individual bass boost control. Full dynamic range is achieved by the use of a 2" tweeter and 4" woofer. Plus, automatic digital lock-in

tuning guarantees optimum reception and eliminates drift. The new technology provides static-free, interference-free sound in virtually any environment. These speakers are also self-amplified; they can't be blown out no matter what your stereo's wattage.

Stereo or hi-fi, you decide. These speakers have the option of either stereo or hi-fi sound. You can use two speakers, one set on right channel and the other on left, for full stereo separation. Or, if you just want an extra speaker in another room, set it on mono and listen to both channels on one speaker. Mono combines both left and right channels for hi-fi sound. This option lets you put a pair of speakers in the den and get full stereo separation or put one speaker in the kitchen and get complete hi-fi sound.



These wireless stereo headphones have a built-in receiver.

Factory direct savings. Our commitment to quality and factory direct pricing allows us to sell more wireless speakers than anyone! For this reason, you can get these speakers far below retail with our 90 day "Dare to Compare" money-back guarantee and full one year manufacturer's warranty. For a limited time, the Recoton transmitter is only \$69. It will operate an unlimited number of wireless speakers priced at \$89 and wireless headphones at \$59 each. Your order will be processed in 72 hours and shipped UPS.

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The wireless speaker and headphones both contain a built-in receiver and amplifier. Signals are picked up and transmitted as far as 150 feet away through walls without the use of wires.



Don't take our word for it. Try it yourself. We're so sure you'll love the new award-winning Recoton wireless speaker system that we offer you the **Dare to Compare Speaker Challenge**. Compare Recoton's rich sound quality to that of any \$200 wired speaker. If you're not completely convinced that these wireless speakers offer the same outstanding sound quality as wired speakers, simply return them within 90 days for a full "No Questions Asked" refund.

Recoton's Design and Engineering Award.



Homeowners Clinic

BY NORMAN BECKER, P.E., Contributing Editor

Low Well Yield

We bought some land and had a well drilled on it. Good water was found at 130 ft. deep, but the flow rate from the 4-in.-dia. well is only 1½ gallons per minute. Are there methods that could be used that would allow us to use this well if we build a home on this property?

RALPH BEATTIE
EAST CHINA, MI

It is feasible to use a well with a yield of 1½ gallons per minute to supply the water requirements for a house. A flow rate of 1½ gallons per minute (gpm) produces more than 2000 gallons of water per day. This quantity of water is more than adequate for most residences.

In order to supply a sufficient quantity of water to satisfy most simultaneous demands, you will need a flow rate of at least 8 gpm. However, a higher rate may be

needed depending on the number of fixtures in the house.

A high flow rate (at least 8 gpm) can be accomplished by pumping the well water into a storage tank that is open to the atmosphere and then pumping water from the tank into the house at a greater flow rate. This type of installation is not uncommon and is quite effective.

A typical installation consists of a 500-gallon storage tank that is equipped with two sensors—one for high water, which shuts the well pumps, and one for low water, which starts the well pump. The high-water sensor can be set at 450 gallons, and the low-water sensor set at 300 gallons. A larger tank may be needed if you have a large family.

In order to get the water from the storage tank into the house, you will need a booster pump and a bladder-type pressure tank. The cost for this

type of installation depends on the location. However, in the New York suburbs it costs about \$1500 to \$2000. Most well pump contractors and many plumbing contractors can install this type of system.

Are Gutters Necessary?

Are rain gutters absolutely necessary for a home? What happens if you don't install them? Are there advantages over having them to not having them?

J.J. MACKAY
CHARLOTTE, NC

Gutters and their associated downspouts (also called leaders) are installed on a structure to control and direct rain runoff from the roof. The absence of gutters might result in water seepage into the basement or crawlspace, rotting sections of wood trim, damage to foundation plantings and the erosion of topsoil adjacent to the house. Whether they are masonry constructed or have long overhanging eaves, most houses that are not in the Snow Belt would benefit from gutters. In the Snow Belt, gutters are considered a nuisance and require lots of maintenance. Often snow and ice will tear them from their supports.

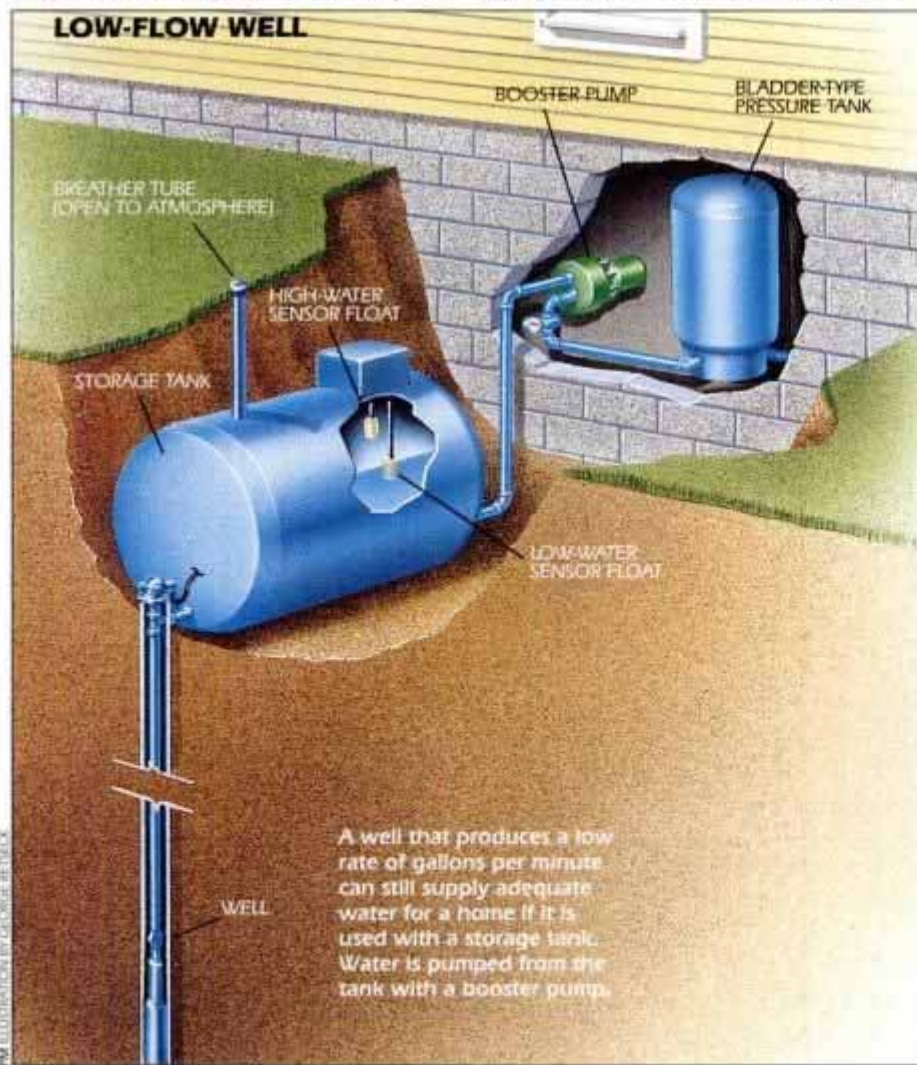
Faulty Light Fixture

We recently moved into an apartment building and I think our medicine cabinet in the bathroom is wired wrong. If you turn on the switch, both fluorescent tubes on the sides of the medicine cabinets will light up. When the switch is turned off, both lights glow in the dark. I suspect the switch is wired to the neutral and not the hot wire. What do you think?

THOMAS MILLER
WASHINGTON, PA

It is possible that the switch is wired to the neutral wire, but that alone would not cause the problem. Somehow there is a slight leakage of current to ground that is closing a path for the electrical circuit. This could be caused by deteriorated insulation around the conductor in the junction box or fixture, or even a faulty switch.

Of course, the switch should always be on the hot wire side of the circuit. If the switch is not faulty, it will open the circuit so that no cur-



rent flows. When the switch is on the circuit's neutral line, even when it opens the circuit, the fixture will be "hot." If there are stray leakage currents to ground, it would cause the lights to glow.

More On Roof-Shingle Moss

We have a problem with moss growing on our roof shingles. The moss is growing mainly on the north and east sides, which are shaded most of the day. We will be building a new home in a wooded (and shaded) area in the same community and would like to prevent this problem on our new home.

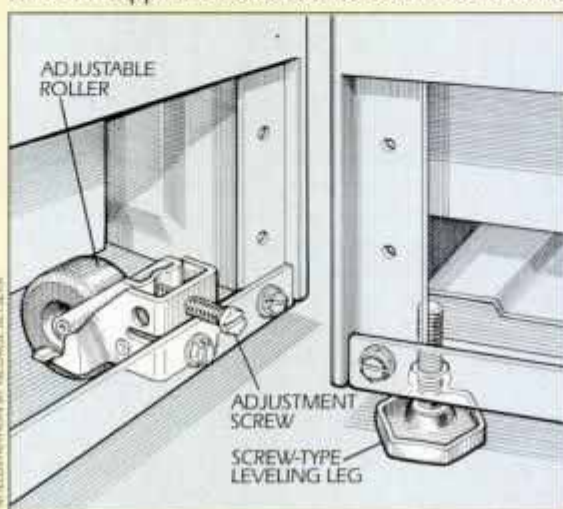
JAMES JOYCE
 SHADY SIDE, MD

Inquiries regarding roof moss are among the most common that we receive here. In discussing this in past Homeowners Clinics, we have recommended stretching bare copper wire horizontally about every 5 ft. across the roof. However, we've recently learned of a product that appears to be easier to install and more effective. And, as an added bonus, it can be used on new or old roofs.

Leveling A Fridge

● There are a couple of good reasons to keep your refrigerator level. Not only does it run more efficiently when it's level, but some models also have a condensation pan that can overflow if the unit is not level.

Most models have screw-type leveling legs at each corner. The remaining units feature a roller at each corner, with the front two being adjustable. These rollers are located behind the base grille and are adjusted with a socket wrench or a screwdriver. Turn the adjustment screw clockwise to raise the appliance and counterclockwise to lower it. The adjustable feet, on the other hand, need an open-end or adjustable wrench.



APPLIANCE CARE TIP

To make necessary adjustments, place a level on top of the refrigerator and check it from side to side, and adjust it as needed. Next, check for level from front to back. If the refrigerator doors do not swing shut by themselves with the appliance level from front to back, you may need to adjust the cabinet slightly higher in the front.

—Steve Toth

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The product, Z Stop, is a coil of zinc sheet 2½ in. wide x 50 ft. long. You fasten it to the roof on both sides of the ridge cap. A coil costs about \$30. Each coil comes with sufficient zinc-coated, rubber-gasketed roofing nails to apply it to the roof. An average roof requires about three coils. It can be used on a wood or composition roof shingle. However, it is not well suited for tiled roofs, because their shape does not allow rain water to flow continuously from the ridge cap all the way down the roof.

For more information, contact Z Stop, Wespac Enterprises Inc., P.O. Box 46337, Seattle, WA 98146. **PM**

Free Info

Fastening to stone, concrete, concrete block, brick and drywall can be tricky, but the Rawl 47M is an industrial-quality handbook that can help you do the job right.



It's 135 pages of the most thorough information we have seen on this subject. Of course, the Rawlplug company is pitching its products here, but at least it does a good job. Each of the company's fasteners is illustrated with clear drawings that show how the fastener is installed. Also listed is the fastener's length and the diameter of the drill bit needed to install it.

There's other information here, on corrosion and load limits, for instance, much of it industrial in nature. But if you pay close attention you'll see how this applies to fastening around the house.

Rawl anchors and fasteners are sold at hardware stores, home centers and industrial supply houses. To get a handbook, write Rawl Inquiry Handling Center, P.O. Box 8116, Trenton, NJ 08650-8116. —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 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems of general interest will be discussed in the column.

BUZZWORD Wear Layer

Picture this, you're shopping for vinyl flooring and the store manager hits you with the term "wear layer" and your eyes glaze over immediately. As the name implies, it's the top surface on a vinyl floor. It varies in thickness, often from .005 to .002 in., and it's made of clear vinyl or ure-

thane, the latter being more wear resistant and more expensive. It starts out as a liquid and is baked onto the sheet of flooring. It's one of several characteristics that influence a vinyl floor's cost. The thicker the wear layer, generally, the more expensive the floor. —Roy Berendsohn

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HOME
IMPROVEMENTMaking
Cabinets:
Part 2

Second in a 2-part series on modern cabinetmaking—frameless construction.

BY NEAL BARRETT

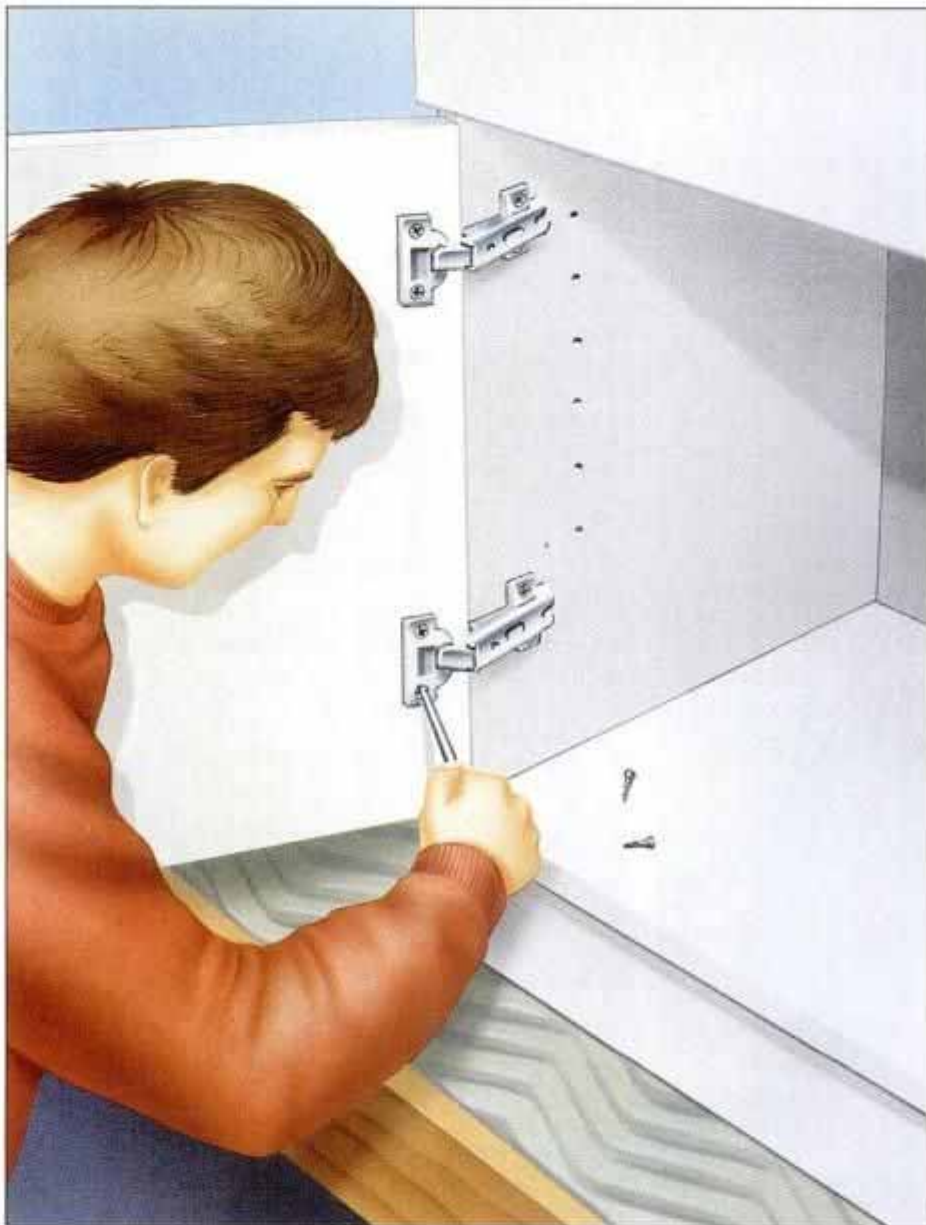
PM Illustrations by
George Retseck

● Making your own cabinets can be a great way to save money. But the real advantage lies in their custom construction. You can make kitchen cabinets that precisely fit your particular space and storage requirements, or construct a wall unit that's unlike anything you might buy off the shelf. For the design conscious, custom construction offers complete freedom in terms of style and appearance.

Last month, we showed you how to combine the traditional face-frame and panel-door look with modern techniques and materials. However, for the ultimate in contemporary styling, you want to take full advantage of modern manufactured panels and hardware. The result is frameless cabinet construction.

Frameless cabinets have several advantages over traditional face-frame designs. First, because these cabinets don't have a face frame, they're quicker to build and material costs go down. Second, by using European-style hinges, the entire cabinet area becomes accessible and hinge mounting is simplified. Finally, this type of cabinet allows for a wide variety of styles and materials. You can combine it with an updated frame-and-panel door design or use sleek plastic laminate for clean, easy-to-maintain surfaces.

To provide just one example of how this type of construction can be used, we chose to build our cabinets of 3/4-in. flakeboard that comes covered on one side—our interior surface—with white melamine plastic. The cabinet backs are 1/2-in. melamine on flakeboard. After assembly, we covered all exterior surfaces and edges with white plastic laminate. Keep in mind



that, like all veneered projects, both sides of a panel must be covered to prevent the panel from warping.

When it comes to assembling manufactured panels, a plate joiner is the obvious first choice. Not only is it fast, but finished stock sizes are easy to calculate because all parts simply butt together. You can also use dado construction, modifying your stock sizes to accommodate the dado depths.

Our drawing (see page 95) highlights the elements of a typical lower cabinet. For upper cabinets, eliminate the drawer components and toeboards and substitute a recessed top for the cleats that secure the countertop.

Before buying any material, complete a simple shop drawing of each cabinet you intend to build. From these drawings, determine the finished dimensions of all case parts. Then, make a cutting list.

Case construction

Begin by using a circular saw and an edge guide to cut all parts slightly oversize (Fig. 1). Cut the pieces to finished size on your table saw. Use a sharp, carbide-tipped blade designed for cutting plastic laminate to prevent tearout. Then, hold mating pieces together and mark the locations of all joining plate slots in case sides, bottoms, tops or top cleats and drawer divider rails.

To locate the plate slots for the base cabinet horizontal divider, use a spacer strip clamped to the work at the correct position (Fig. 2). The most accurate way to position the remaining plate slots is to rest both the work and the joiner on a clean, flat surface. Position the top and bottom slots in each side panel by placing both the edge of the stock and the joiner base on a flat surface (Fig. 3). Then, cut the

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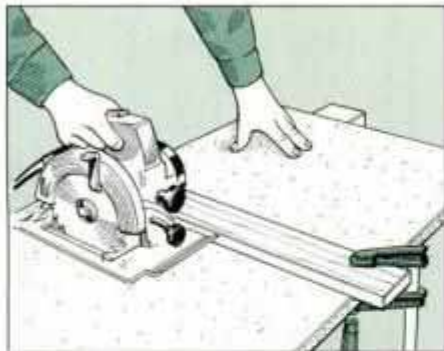


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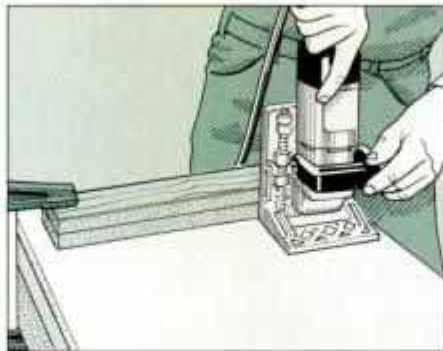
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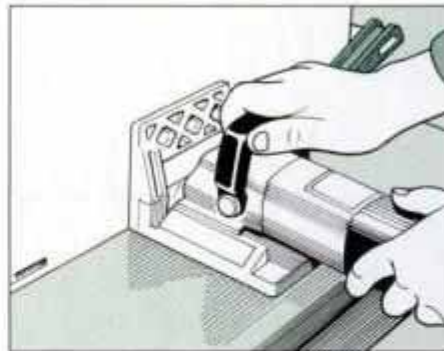
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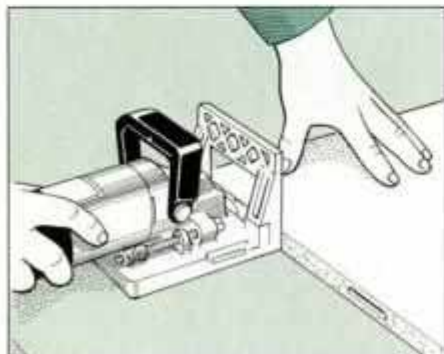
1 Start by cutting all stock slightly oversize in width and length with a circular saw and guide. Cut to exact size on a table saw.



2 Cut plate joints in cabinet sides for joining panels. Position divider slots with guide strip clamped to work.



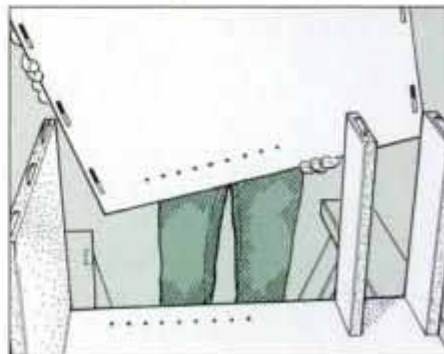
3 Rest edge of side panel and base of plate joiner on a flat surface to position slots for joining top and bottom panels to sides.



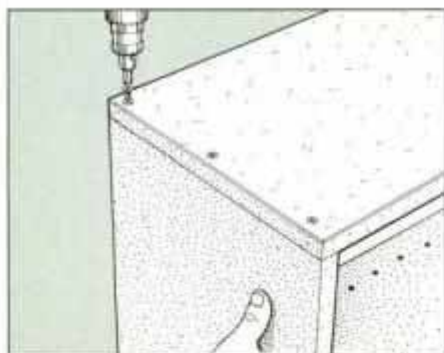
4 To position slots in edges of bottom panel for joining bottom to sides, lay outside face of bottom panel on a flat surface.



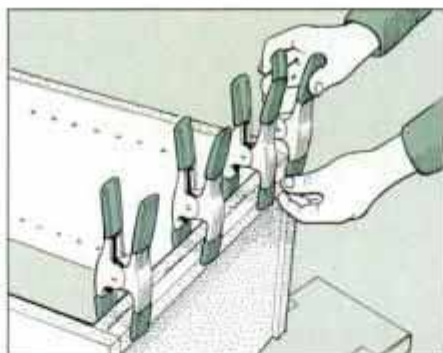
5 Bore pilot holes for drawing joints tight with screws. Then, countersink on outside face so screwheads lie flush with surface.



6 Apply glue to plate slots for joining top, bottom, divider and sides. Then, insert joining plates and assemble.



7 Drive 2-in. No. 8 fh screws to draw joints together. Screws replace awkward clamps and will be covered with laminate later.



8 Glue a softwood scribing strip to top front edge of upper cabinet. At installation, trim strip to match case to ceiling.



9 Secure back panel to the side, top and bottom subassembly with 1 1/4-in. No. 8 fh screws driven into countersunk pilot holes.

mating slots in the top and bottom panels with the outer face of each piece and the joiner on the flat surface (Fig. 4).

To ensure that the adjustable shelves lie flat, use a template to drill the two rows of shelf pinholes in each cabinet side. Clamp the template in place for each row, and use a depth stop on the drill bit to ensure accurate hole depth.

Since the exterior finished surfaces will be covered with plastic laminate, we used screws along with the joining plates for case assembly. This method eliminates the need for clamping and speeds the work. After the joining plate slots are cut, bore pilot holes for

the screws (Fig. 5). Then, countersink the holes so the screwheads will be flush with the panel surfaces.

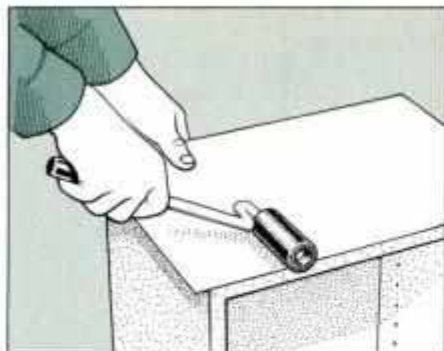
If you're using a material that will not be covered, such as hardwood-veneer plywood, clamp the cases together instead of using screws. (In this case, edgeband the front edges of all plywood parts before assembly.) You can use screws instead of clamps on any panels that will be hidden by an adjacent cabinet or wall.

Assemble each case by first joining the sides, top and bottom, along with the divider if the case is a base cabinet. Apply glue to plate slots, insert the plates and join the panels (Fig. 6). Then, screw them together with 2-in.

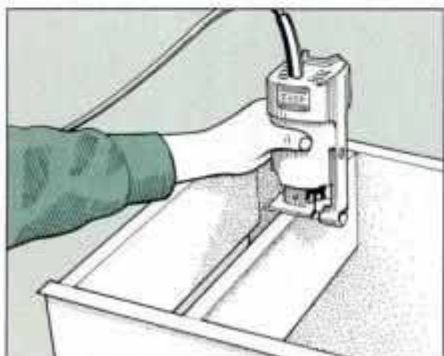
No. 8 fh screws (Fig. 7). Immediately after assembly, check to see if the case is square by measuring the diagonals and adjusting if necessary. Then, let the glue dry.

For an upper, wall-mounted cabinet, glue a 3/4-in.-thick softwood strip to the top edge so the case can be fit accurately to an uneven soffit or ceiling (Fig. 8). When mounting the finished upper cabinet, hold the unit in place while scribing the exact ceiling contour on the softwood strip. Then, use a sabre saw to trim to the line for a perfect fit.

Finally, install the case back with 1 1/4-in. No. 8 fh screws driven into countersunk pilot holes (Fig. 9).



10 After cutting laminate oversize, apply contact cement and let dry. Then, position laminate and roll with a rubber roller.



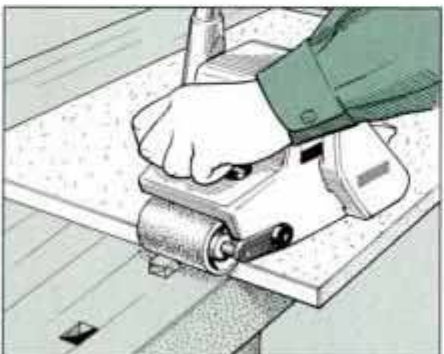
12 Trim laminate strips flush with a router or laminate trimmer and flush trimming bit. Keep router base flat on edges.

Adding plastic laminate

To apply plastic laminate, you need a router, a flush trimming bit and a beveling bit. You also need a file for smoothing the laminate edges, contact cement, a few disposable brushes, a cloth roller for applying a uniform coat of contact cement to broad surfaces and a rubber roller for pressing down the laminate.

First, cut the laminate oversize for each surface to be covered. Where edges will be laminated, cut strips 1 in. wide and oversize in length.

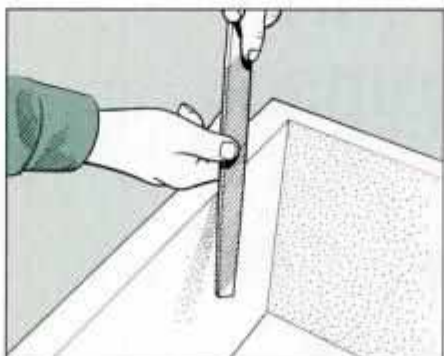
For upper cabinets, start with the case bottom. Use a cloth roller to spread contact cement on both the cabinet and laminate. After the ce-



14 To ensure that broad surfaces are flat, lightly sand with a belt sander. Apply contact cement to panel and laminate.



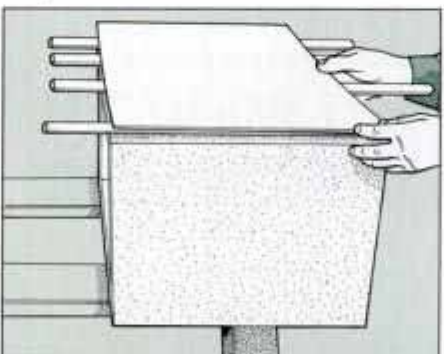
11 Use a brush to apply two coats of contact cement to the edges. Then, coat 1-in. strips, let cement dry and install on edges.



13 Use a file to ensure that laminate edges are flush with surfaces. Then, square rounded inside corners left by router.

ment is dry, position the laminate and roll over it with a rubber roller to ensure complete bonding (Fig. 10). Then, trim the excess laminate with a router and flush trimming bit.

Next, move to the vertical side panel edges and shelf edges of upper and lower cabinets. Use a disposable brush to coat the edges and the laminate strips (Fig. 11). After it's dry, apply an additional coat to the panel edges because of their porous nature. When the second coat is dry, carefully position the strip over the edge and roll with the rubber roller. Cut the strips for horizontal edges to exact length, apply and trim flush with your router (Fig. 12). Use a file to trim the round-



15 When cement is dry, lay dowels on surface and position laminate. Press down laminate as you remove each dowel.

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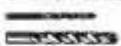
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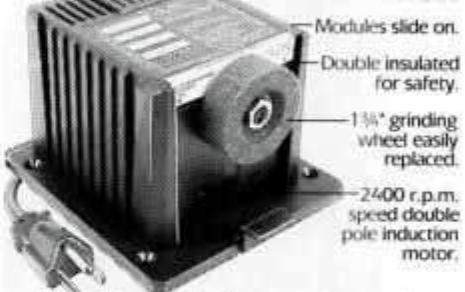


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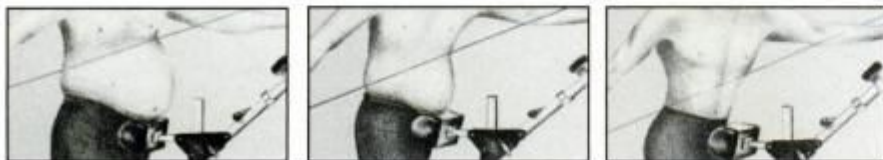
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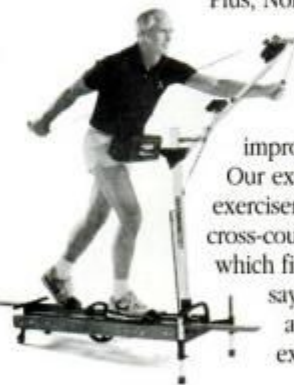
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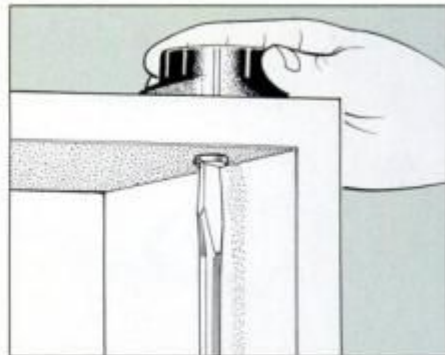
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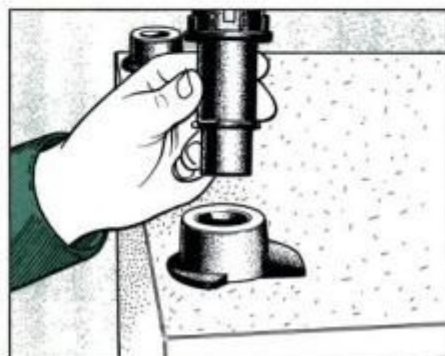
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16 After boring holes for cabinet leveler bases, secure with screws from inside. Then, cover screws with leveler caps.

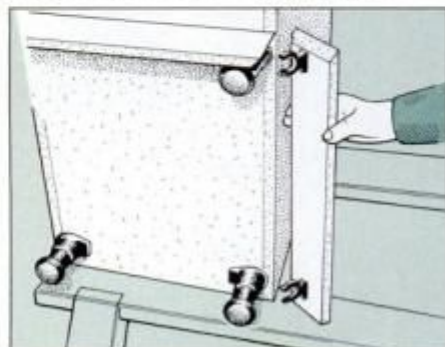


17 Install levelers in leveler bases. Cabinet levelers permit height adjustment at each corner and eliminate shimming.

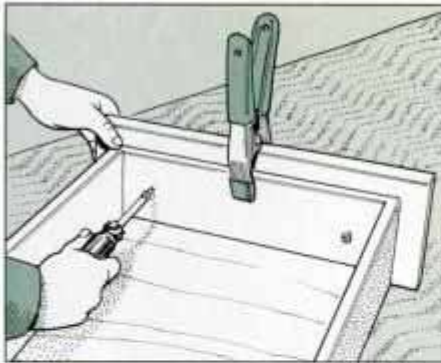
ed inside corners left by the router bit (Fig. 13). To ensure good contact when laminating broad surfaces, lightly belt sand these surfaces to remove any raised edge banding (Fig. 14).

Next, apply the laminate to case sides. First apply the contact cement, let dry and place dowels 8 to 10 in. apart on the surface. Then, position the laminate on the dowels (Fig. 15). Beginning at one end, carefully remove each dowel to bring the laminate into contact with the core. Use the rubber roller over the entire surface and trim flush.

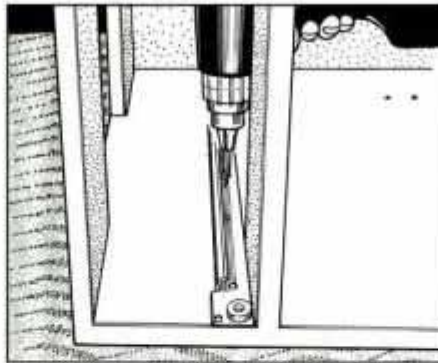
Use a bevel trimming bit in the router to ease all laminate corners, and use a file to dull sharp edges.



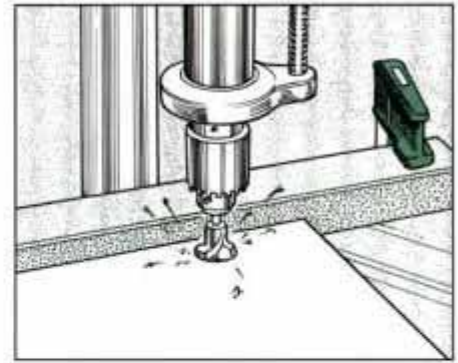
18 Use accessory clips to install toeboard panels to cabinet levelers. Screw clips to mitered panels and snap panels in place.



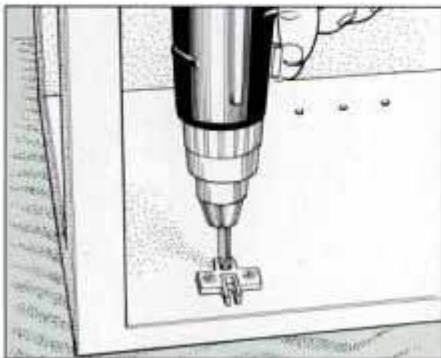
19 After assembling drawer box with 1-in. brads and glue, clamp drawer face in position and attach with round head screws.



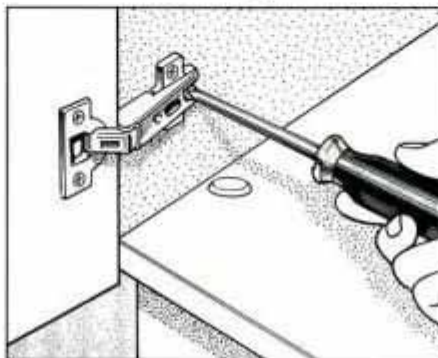
20 Next, attach the drawer slide hardware to the inside of the case side panels and to the drawer sides with supplied screws.



21 Use a drill press and a 35mm bit to bore blind holes on the inside of the door for securing European-style hinges.



22 Install the hinge base plates on the inside surface of a cabinet side to align properly with the holes bored in the doors.



23 Install the hinges, and adjust for proper operation and fit. Then, install drawer and door pulls to complete the cabinet.

Toeboard, drawer and door

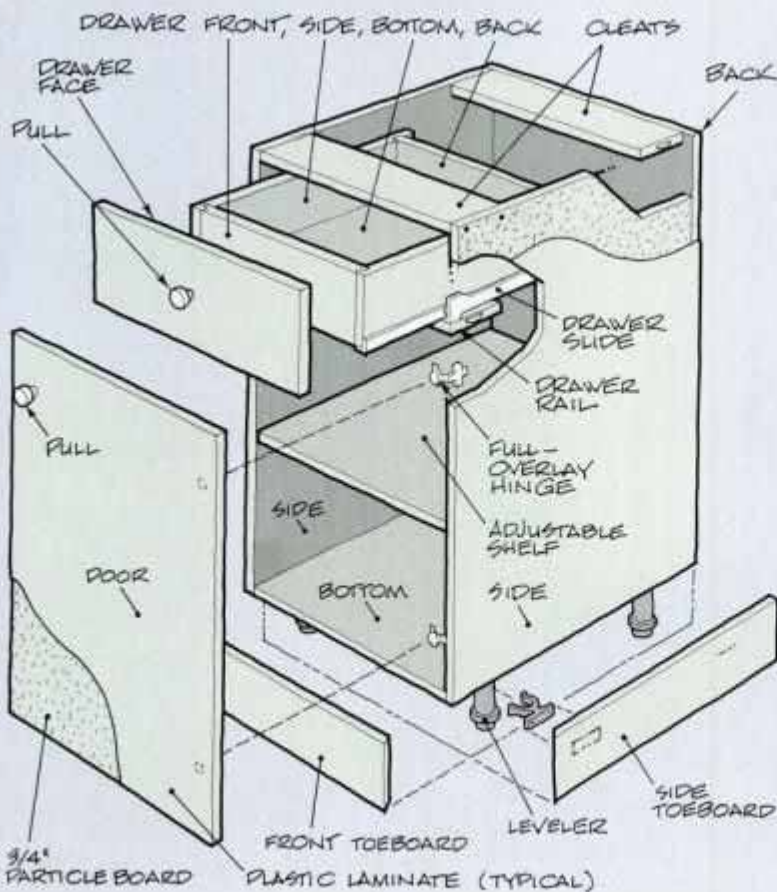
To eliminate the need for shimming the cabinet at installation, we used Blum cabinet levelers in place of a standard toeboard platform. These cabinet levelers mount through the bottom of the cabinet and allow up to 1½ in. of height adjustment at each corner. Accessory leveler caps are available to cover the leveler screws on the inside of the cabinet base. We also used special clips to mount the toeboards to the levelers. Simply screw the clips to the back sides of the boards and press in place. The levelers, caps and clips are available from Woodland Specialties Inc., 1216 Canal St., Syracuse, NY 13210.

Bore 13/16-in. pilot holes for mounting the levelers through the case bottom, and attach the leveler base plates (Fig. 16). Install the levelers to the base plates (Fig. 17), and slip on inside cover caps. After the cabinets are installed, miter the toeboards, install the clips and place the toeboards in position (Fig. 18).

Cut the drawer parts to exact size, remembering to leave appropriate clearance for the side-mounted drawer tracks. Use a dado blade in the table saw to cut the drawer joints, then assemble the drawer box with 1-in. brads and glue. Attach the drawer face with 1-in. No. 8 rh screws (Fig. 19), then mount drawer slides (Fig. 20).

European-style hinges require blind 35mm mounting holes on the inside of the door face. The bit and the hinges are available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, MN 55374. First, bore the mounting holes in the cabinet doors (Fig. 21). Attach the hinges to each door using 5/8-in. No. 6 fh screws. Drill pilot holes, and mount the hinge base plates to the cabinet sides (Fig. 22). Then install the doors on the cabinets (Fig. 23). Drill pilot holes, and mount the door and drawer pulls of your choice.

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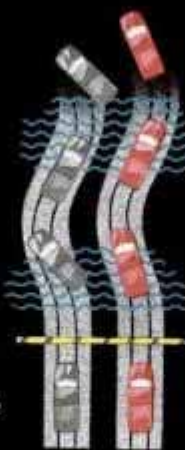
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CAR CARE

CAR CLINIC

BY MIKE ALLEN,
Associate Automotive Editor

A Weighty Problem

The owner's manual for my car says I can pull a 1500-pound trailer, but only have a maximum tongue weight of 250 pounds. What's the difference?

RON B.
(FROM THE PM COMPUTER
BULLETIN BOARD)

To find your trailer's total weight, you have to get weighed. Be sure you've got all the gear you'll be toting along already on board—you'd be surprised how big a difference a load of groceries, a tankful of gas in the boat or filling the water tanks in an RV can make.

Many municipalities have certified scales, but I've found that many transit-mix cement operations will let you weigh a trailer on their scales for a few bucks if you make an appointment for a slow time of the day. You need to unhook the trailer from the car to do this, of course.

Say your trailer weighs exactly 1500 pounds. You want the tongue to carry between 6% and 15% of this weight. That's the tongue weight—simply put the trailer's tongue jack right on your bathroom scale. (Be sure that the ground where you have the trailer parked is dead flat and level.)

In your case, shift the load inside the trailer to achieve this. Ten percent, or 150 pounds, would be about right. Yes, this is too much to comfortably lift singlehandedly from the ground onto the hitch ball, but too little tongue weight is just as bad as too much. Get a helper with a strong back or a jack for the tongue.

Those of you with a trailer heavier than 3000 pounds might wonder how to check the tongue weight without a scale that reads more than 300 pounds. Get a thick, stout board 3 ft. long or so and another board almost exactly as thick as your bathroom scale. Make three marks on the first board exactly 1 ft. apart. Lay this board on the scale and the



right-thickness board, with two pieces of round pipe or doweling directly under the two outer marks. Drop the tongue of the trailer on the center mark. You can now double the scale's reading to know the trailer's true tongue weight.

Got a really big trailer? Put the scale exactly 2 ft. from the trailer jack, leave the other pipe still 1 ft. away and triple the reading.

Needless to say, you need a tow vehicle rated for commensurately higher weights, both overall and tongue weight.

All Charged Up

Can charging a battery without removing the cables to the alternator or other in-vehicle components cause damage?

R.J. KINGSTON
PENTICTON, BRITISH COLUMBIA

Using an ordinary, low-amperage battery charger for short periods of time will not damage the battery or the car. Leaving most chargers connected after the battery has reached a charged state will boil off the water in the electrolyte and damage the battery.

Be sure to monitor electrolyte

CAR CARE

levels as the battery charges, topping up with demineralized or distilled water to the bottom of the filler.

High-current garage-type chargers have a voltage output high enough to potentially damage sensitive components such as computers and digital dashboards. The battery should be disconnected if you use a high-current fast charger.

Frankly, I prefer not to use these things at all except in emergencies. Lead-acid batteries last a lot longer if they're charged at a slower rate.

Arc or MIG welding can damage computers as well, but any competent repair shop should know this already. For what it's worth, some tow trucks can use 24 volts to boost a battery when it needs a jump-start. I don't recommend 24 volts for starting anything except aircraft with 24-volt electrical systems. If 12 volts won't start it, then there's some other problem that needs to be attended to.

Tired Out

There are four of us who have 4-wheel-drive trucks. We were debating

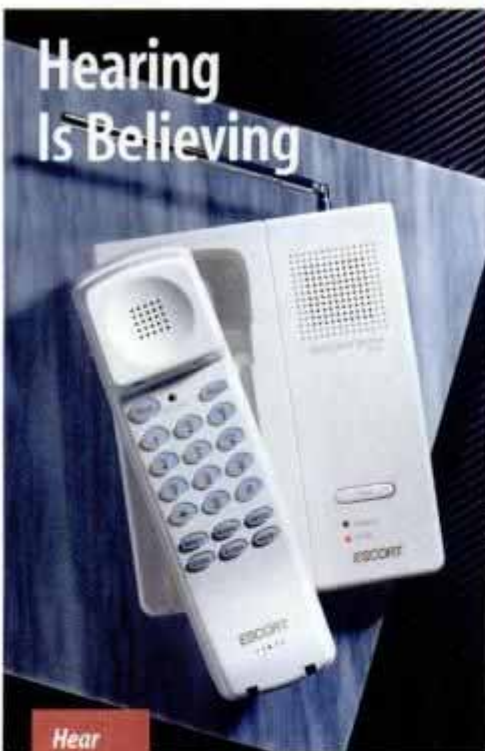
A Slippery Change

● It's been almost a year in coming, but you'll be seeing two changes in the packaging of the motor oil you use in your car or truck. In fact, most of the oil on the shelf is already changed.

First, you'll notice that the American Petroleum Institute rating has been recently upgraded to SH from SG for gasoline engines. New car warranties will reflect this, as well, requiring SH-rated oils. What's the difference, you ask? None, I say—the API's performance requirements for the two grades are identical.

The starburst symbol you see here, when printed on the can, certifies that the oil company has provided information to the API that will let them buy cans of oil at random from retailers and test them to see if they are indeed up to spec. That's a noble effort by the industry to keep substandard oil off the market. Previously, oil companies could simply say their oil would meet the API rating, with no sanctions likely.

On the other hand, if you've got six cases of SG-rated oil from a reputable manufacturer, go ahead and use it anywhere SH-rated oil is called for. I won't tell, and your engine won't be able to either.



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tire size and the potential for damaging the transmission or the transfer case. If we were to use the same size tire and wheel but the rear tires were a high profile and the fronts were a low profile, would this cause damage?

WARREN BOWERS
LIVONIA, MI

It's important that all four tires on a 4wd vehicle be matched as closely as possible in terms of the number of revolutions per mile. Otherwise, one end of the truck will be trying to travel faster than the other—wearing out the tires, u-joints and, in general, all of the drivetrain parts.

Tire sizing has a lot of Kentucky windage in it—two identically sized tires from different manufacturers may be a few percent different in several critical dimensions.

Otherwise, identical tires of different construction, i.e. profile, would roll differently.

Try to have four tires of the same size, brand, tread pattern and state of wear on your 4x4. Keep the inflation correct, too.

It All Adds Up

I have a 1991 Sedan De Ville that's supposed to use 91 octane gas. Even so, after it's good and warm it has some kind of a power rattle or ping.

I was wondering if I could use about 10 ounces of diesel fuel in every

tankful of gas to keep the combustion chambers clean. Does that rattle even hurt the engine?

HARVEY HARTS
ELLSWORTH, KS

Where did you ever get this idea, Harv? Diesel fuel will gum up your injectors and reduce the already inadequate octane you're feeding your Caddy.

If you must use an additive to clean your combustion chambers, use one intended for the purpose.

Your engine may or may not be injured by that pinging noise. I've seen engines ping so badly that one piston had a hole hammered into it. Yours is probably not as bad—but I'd get it looked into, you know?

Diesel fuel will also lower the octane rating of your fuel about 10 points, making your problem much worse, not better.

PM

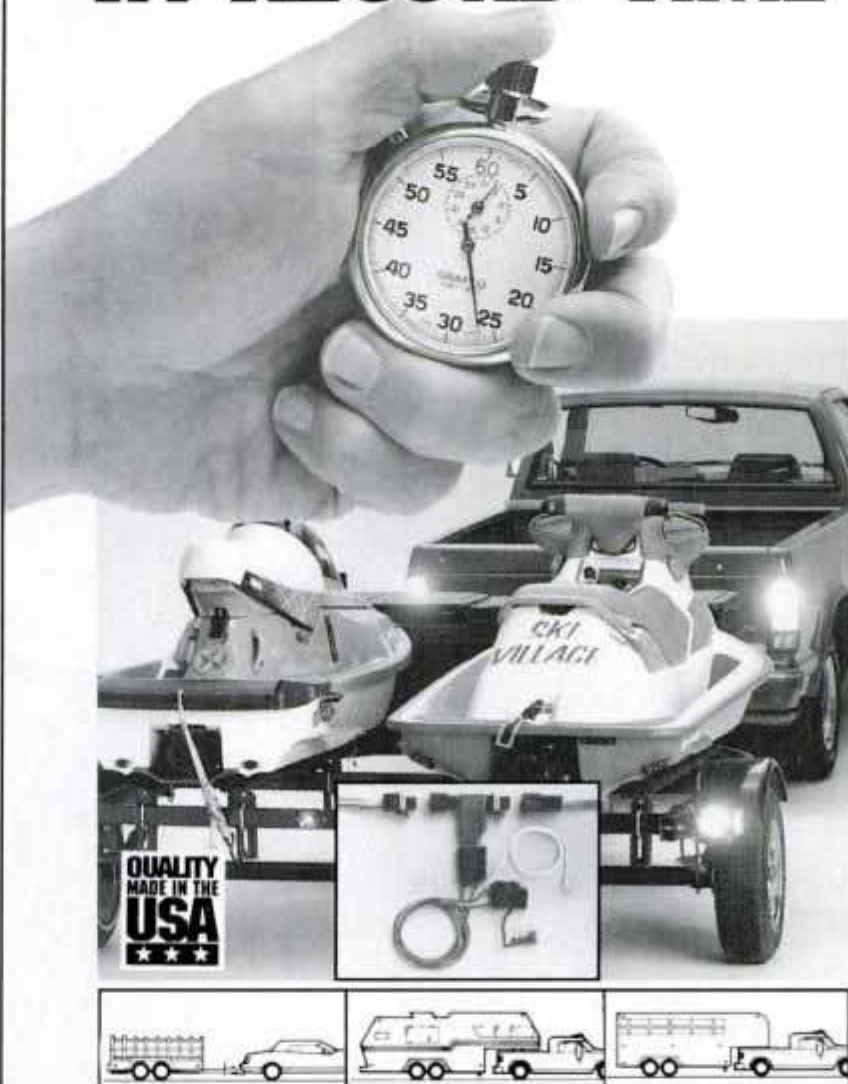
DO YOU HAVE A CAR PROBLEM?

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

SERVICE TIPS

- Some 1991 and '92 Buick Roadmaster wagons may exhibit a click or a whine in Third or Fourth gear, caused by transmission fluid passing over the friction plates of the Low and Reverse clutch. The fix is to replace the fiber plates with new ones that have a different groove configuration.
- If your 1991 or '92 Chrysler front-drive has a creaking noise in the steering column while turning the wheel from side to side, there's a TSB that calls for trimming some material away from the inside of the steering-column shroud.
- Does your late-model Chevy or GMC G-van's front suspension bottom out over bumps, especially at lower temperatures? A TSB says to install urethane air cylinders, PN367762, inside the coil spring to eliminate this.
- Some early 1992 Tauruses and Sables may spit gas back into your face during refill. There's a plastic tube, PN/F1DZ-9N277-A, to insert into the filler neck to correct this.
- Popping noises from the front end of late-model Subaru Legacys during turns may be the result of the pivoting front stabilizer bar bushing clamps. Subaru's TSB calls for bending the tab hook on the clamps and coating them with anti-seize compound.

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PM

SATURDAY MECHANIC

SERVICING CRUISE CONTROL

BY DON CHAIKIN, Contributing Editor

• The view through your windshield is of a long, straight stretch of empty interstate running into a cloudless blue sky at the horizon. You check the speedometer, set the cruise control and settle into the task of keeping the hood ornament pointed at the same spot on the road. As you relax your right foot, though, you realize that

your car is slowing down, despite the set cruise control.

An even worse scenario: You've been driving for hours, quite comfortable in the knowledge that your cruise control has been working just fine, thank you. So as you pass the police cruiser nestled in the shrubbery on the right shoulder, you're confident

that you've been steaming along at the speed limit. Needless to say, you're somewhat startled when you see the trooper turn on all of his lights and peel out in a very large hurry to catch up to you. You're downright flabbergasted as you check the speedometer to see that somehow you're now going a good 20 over the limit.

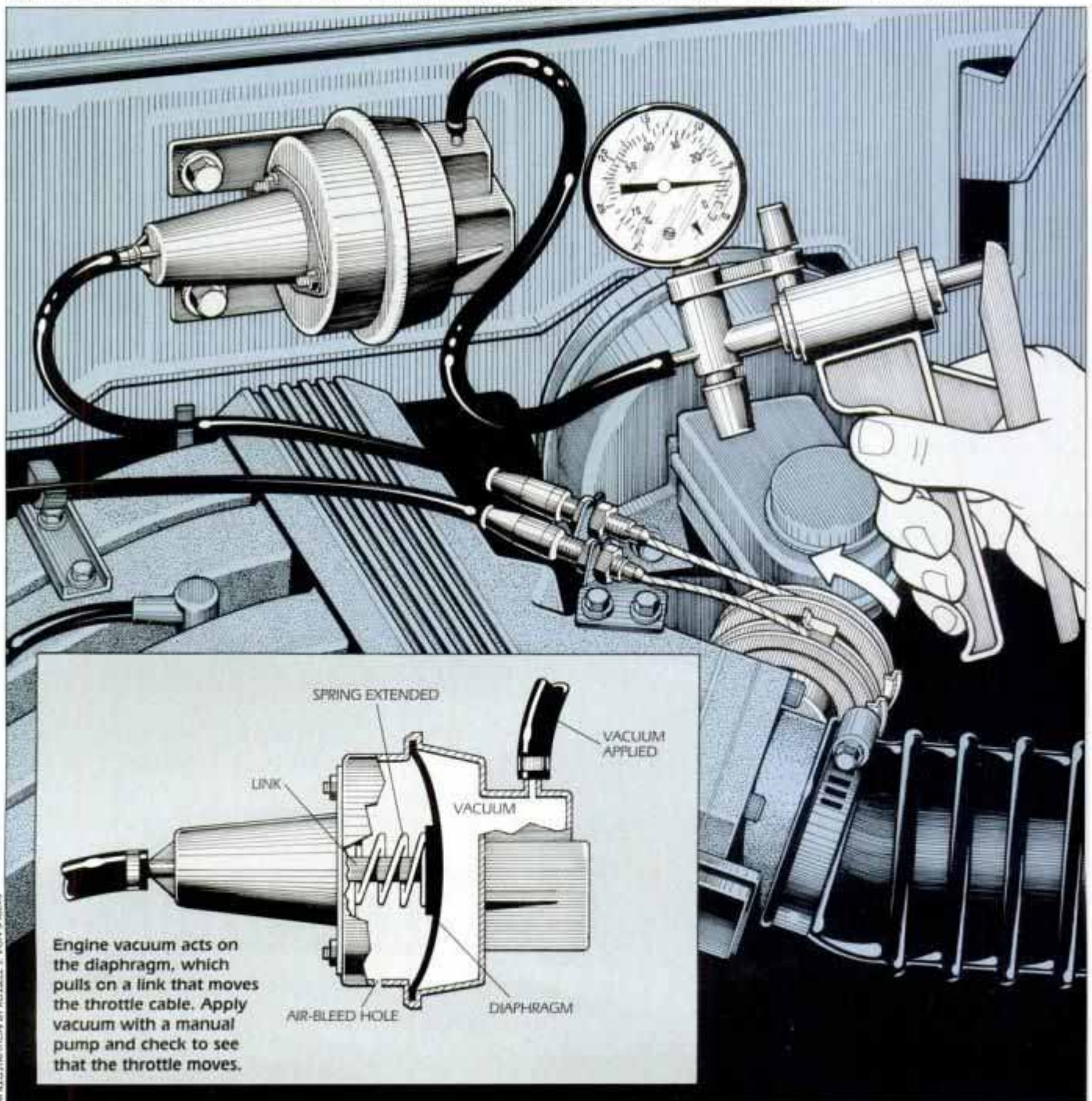


PHOTO ILLUSTRATION BY RUSSELL J. LONG SAUER

Engine vacuum acts on the diaphragm, which pulls on a link that moves the throttle cable. Apply vacuum with a manual pump and check to see that the throttle moves.

Still cruisin'

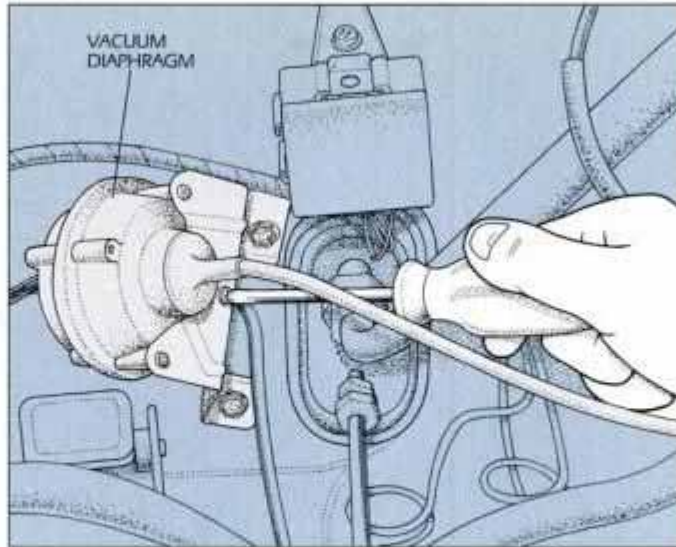
Cruise control is one of those features—often an extra-cost one—that is not used every day by most drivers. But when you want it to work, you expect it to work properly. While some new models have totally electronic cruise-control systems, most vehicles on the road still have an electrically controlled vacuum/mechanical cruise control.

Typically, when the cruise is engaged, a vacuum diaphragm operates the throttle independently of the accelerator pedal and its linkage. The diaphragm unit receives manifold vacuum via a solenoid valve, which is controlled by the cruise system's controller. The controller receives information about vehicle speed, either from a special speed sensor or via the speedometer cable. In addition to its ON/OFF switch, the power to the controller can be interrupted by safety switches, such as one at the brake pedal that instantly releases the vacuum diaphragm. These safety switches do not shut off the controller, but revert control of the throttle back to the accelerator pedal.

Problems with a cruise-control system can occur in any part of the system—the vacuum supply, diaphragm unit, controller, power supply and speed sensing.

Diaphragm control

The keystone of the cruise-control system is the vacuum-diaphragm unit. If the cruise control is operating erratically—not holding the set speed



A loose vacuum diaphragm cannot keep the throttle constantly steady. Check the tightness of the unit's mounting bolts.

or raising or lowering speed while you're driving on a level road—or if it is not operating at all, a likely culprit is the vacuum-diaphragm unit.

However, in the case of total failure, first check the obvious. Check the system's fuse. Replace it if it's blown. If the new fuse blows again, look for a short in the wiring or at one of the connectors or switches.

If the fuse is good, check that there is current to the control unit with the ignition and cruise control switched on. The simplest way to check for current is by disconnecting the lead to the controller and probing its terminals with a test light.

If you cannot find power to the connection, check your car's shop manual to be sure that it will flow current while the car is not moving. If not, connect a jumper wire to the connector and ground, run the jumper to the

dashboard where you can see it, and attach the jumper wire to the test light or ammeter. Then repeat the test while driving down an empty stretch of highway.

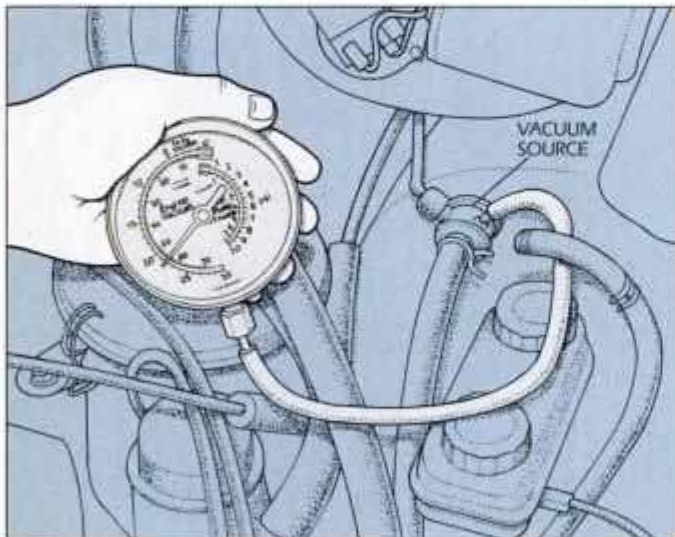
If there is no power to the controller, check the wiring between the fuse block and the controller, including the control switches. If all the wiring and connections are good, isolate each switch in turn, either with a simple jumper wire or with a continuity meter. Replace any defective switches and any bad wiring.

If there is power to the controller, check that the vacuum diaphragm is receiving vacuum. Attach a

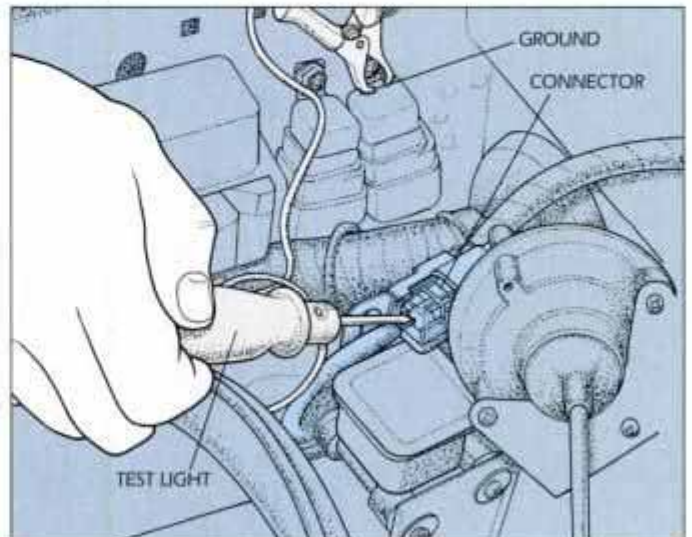
vacuum gauge to the controller's vacuum source. With the engine idling, the gauge should read normal manifold vacuum (about 15 to 18 in.). If not, check for a vacuum leak. Likely sources include the intake manifold gasket, throttle housing and all vacuum lines and connectors.

If vacuum at the controller's source is normal, reconnect the controller to its source and take another vacuum reading at the diaphragm itself to check the operation of the controller and vacuum solenoid.

Again, since the controller will not release vacuum to the diaphragm unless the car is moving above a set speed (which varies by make and model), you must make this check on the road. Attach your vacuum gauge to a long (3 ft. or so) length of tubing. Connect the hose between the vacuum port of the controller and the vacuum

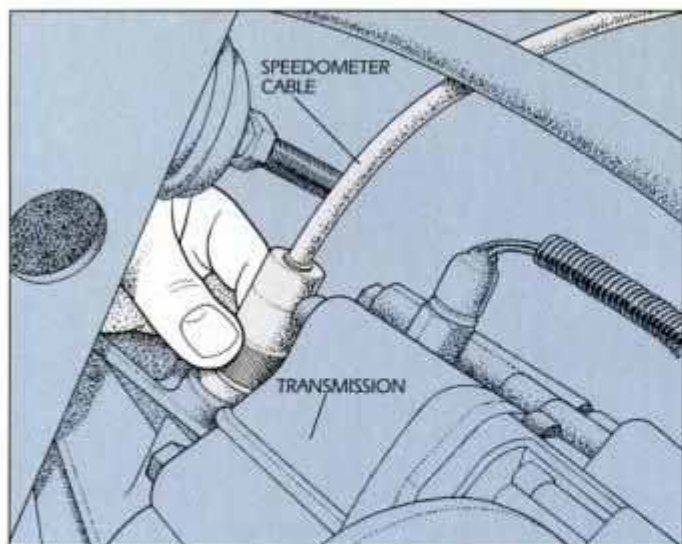


Take a vacuum reading at the cruise control's vacuum source to ensure that the unit is receiving adequate vacuum.



Ensure that the cruise unit is receiving power by connecting a grounded test light to the cruise's electrical connector.

CAR CARE



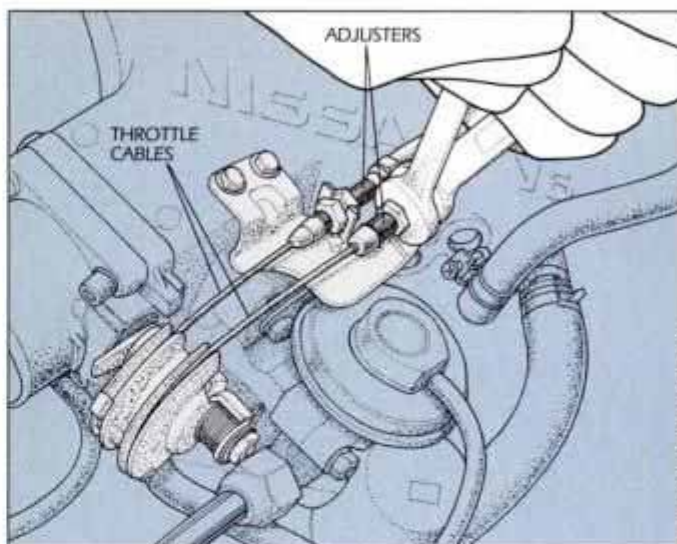
Check that the speedometer cables from the transmission to the speedometer and to the cruise control's speed unit are intact.

diaphragm. Route the hose around the engine compartment to temporarily mount the vacuum gauge near the windshield so you can easily read it as you drive.

The vacuum reading should remain constant once the cruise control is engaged and the car is moving at a steady speed. If the vehicle slows—such as when going up a hill—the vac-

uum should briefly increase and then stabilize. Going downhill, the vacuum should reduce, allowing the spring inside the vacuum diaphragm to reduce the throttle setting. The vacuum should then stabilize and the car should remain at a steady speed.

If the vacuum reading fluctuates as the car is driving on a level road, chances are the controller is receiving



Adjust the throttle cables so the cable for the accelerator pedal and the cable for the cruise-control unit are in sync.

a false or erratic speed signal.

With the car safely back in your garage and sitting on safety stands or ramps for access, check the speedometer cable connection to the transmission. If the cable is binding, broken or loose, it will give a false reading.

If the cable is loose, tighten its connection to the drive. If the connection is good, undo it and check the cable

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itself. Lubricate a dry cable, replace a frayed one. Also be sure that the speedometer drive itself is not binding. Remove it from the transmission housing if necessary and check that its gears are not binding and the cable sleeve is not slipping.

Similarly inspect the cable at the speedometer and at the controller.

If the speedometer cables and drives are all good but the cruise control is still erratic, check that the vacuum-diaphragm unit itself is solidly mounted to its bracket. Also check its throttle cable. Most cruise-control systems have a dedicated throttle cable to operate the throttle independently of the normal, pedal-operated throttle linkage and cable.

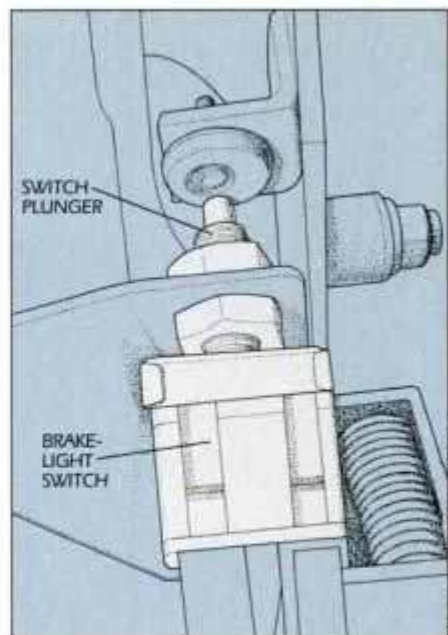
With the engine idling at normal temperature, check the adjustment and operation of the cruise's throttle cable and linkage. The cable from the cruise control should operate the throttle independently of the regular throttle cable. Also check that the cruise's operating cable is not frayed or sticking. Check the rest of the linkage and the throttle return spring as well. Adjust the free-play of the throttle cables, if necessary. Loosen the cruise control's cable and check that idle speed is un-

affected. If the idle speed changes as you slacken the cruise's cable, fully loosen the cable until idle speed is below specs. Then raise idle speed by adjusting the regular throttle cable. Then retighten the cruise's cable without raising idle speed. Replace anything that's suspect.

If there is intermittent power to the cruise's controller—such as from a faulty or improperly adjusted safety switch—the system will operate erratically and possibly shut down.

Most systems use the brake-light switch as the brake safety switch. Check the operation of the switch. Typically, it's mounted on the brake pedal linkage. Check that its wiring is intact and the connections are tight and corrosion free. Also remember to check the brake-light fuse.

If the wiring is good, see that the switch's plunger engages fully when the brake pedal is depressed only slightly—you should only have to tap the brake pedal to activate the switch. With the pedal free, the plunger should not be depressed. Check your shop manual for the size of the gap between the plunger and its stop, with the brake pedal untouched. To adjust the gap, loosen a locknut on the switch



Check that the brake-light switch plunger engages when the pedal is depressed.

and thread it in or out as necessary.

If the brake switch seems to operate properly physically, bypass it with a jumper wire or check it with a continuity meter to be certain that it's doing what it looks like it is. Replace a defective brake-light switch. **FM**



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New Cars



1995 Toyota Avalon

● Toyota considers itself a full-line auto manufacturer, with entries in every market segment and just about every niche. Last year, Toyota entered the once-sacred ground of the large-pickup truck segment. Now, with the Avalon, Toyota moves into another segment previously the domain of the domestic car companies—the large sedan. The Avalon will compete against the likes of the Chevy Caprice and Ford Crown Victoria.

The Avalon is the biggest Toyota car ever sold in this country and will be the flagship model. And it will have the highest domestic content of any Toyota ever. From the beginning of the project, Toyota wanted the Avalon to be built in America, by Americans, for American families, and with as much American influence as possible. Most of the car was designed here at Toyota's tech centers in Ann Arbor, Michigan, and Torrance, California.

The car will be built in the same Kentucky plant as the Camry and, in fact, is based on a stretched Camry platform. Wheelbase is 4 in. longer, and the car is longer overall, wider and higher than a Camry.

Toyota offers a front bench seat and column shift as an option—the first Asian car company ever to offer 6-passenger seating. Take it from your reporter, six big guys can fit pretty comfortably in an Avalon. Standard equipment is a pair of front buckets and a floorshift console, dual

airbags, 4-wheel disc brakes and power everything.

Under the hood will be a version of the all-aluminum V6 and electronically controlled 4-speed automatic found in the Camry and the Lexus ES 300. The engine will also be built in Georgetown beginning with the '95 model year.



When you look at the Avalon, what you see is a Camry in the large, economy size. If you like the Camry—and who doesn't?—you'll probably love the Avalon because you get so much more of it. The Avalon goes on sale in the fall of '94 as a 1995 model. No, no price yet. But with Camrys edging toward \$25,000, the Avalon will logically be somewhere north of there.

—Joe Oldham

Kia Sephia

Talk about an identity crisis. Try selling cars when no one has ever heard the name of your company or the model name of your car. That's what Kia, of South Korea, is facing in introducing its Sephia 4-door sedan.

While the name may be new, the hardware isn't. Kia has been cranking out Festiva models for Ford since 1987. And if you peek under Sephia's skin, what you'll find is essentially a Mazda Protegé chassis and drivetrain. That drivetrain consists of a 1.6-

liter sohc 4-cylinder that puts out 88 horsepower and 98 ft.-lb. of torque. The standard transmission is a 5-speed manual with hydraulic clutch, and an electronically controlled 4-speed automatic is optional.

Things will warm up this July, when a dohc version of the engine becomes available along with 4-wheel antilock disc brakes.

Kia's marketing strategy is to offer high content for the money. With a base price of less than \$9000, Sephia gives you a 60/40 split fold-down rear seat, a rear-window defogger and an



Sephia has cloth seats and lots of room.



Sleek aerodynamic styling sets the Aspire very far apart from the old Festiva.

Ford Aspire

Despite the lack of advertising or incentive support, Ford's tiny Festiva proved what the ill-conceived and ill-fated Yugo could not: There's a definite market for reliable, well-built minimalist transportation.

Now the Festiva has passed, replaced by Aspire. Derived directly from the Kia-designed Festiva, with engineering support from Ford's Japanese partner, Mazda, the new Aspire bears no visible resemblance to the Festiva.

Like its predecessor, the Aspire is small—very small. Despite its diminutive proportions, the Aspire is big enough for normal adults, honest. The exterior uses up precious little space

antitheft system. Moving up to the LS brings power steering, a tilt steering wheel and intermittent wipers. The top-level GS adds a sound system as standard equipment. Options include cruise control, tach and alloy wheels.

The Sephia does strike us as good value in a basic transportation package. There's more interior room than in the Corolla or Civic. Standard upholstery is cloth. The floor as well as the trunk are covered with good-quality carpeting. All Sephia owners get 24-hour roadside assistance.

After a day of driving the Sephia, we came away with the impression that this is a good car, though not a great car. The interior is comfortable, and the ride quality is acceptable. The compliant suspension and 13-in. wheels are not conducive to a sport driving style, but you can still push to make that late appointment and find the Sephia cooperative. The engine is definitely noisy at its upper limits. However, performance overall is good for the car's intended purpose.

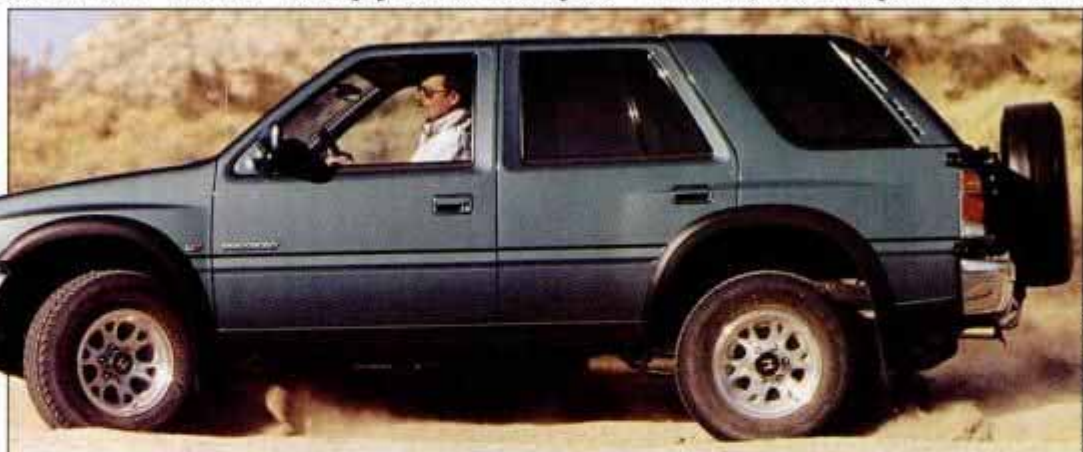
While Sephia may fall a bit short in some areas, one is certain, this South Korean econocar doesn't lack Seoul.

—Cliff Gromer

Honda Passport

Honda doesn't make trucks. However, trucks—including sport/utility vehicles—are on their way to accounting for a third of the new-vehicle market here in the United States. To grab a share of that burgeoning market quickly and with a minimum of investment, Honda has opted for the increasingly popular route of buying vehicles from another manufacturer. Voilà, 20,000 Isuzu Rodeos are now Honda Passports.

The Passport has two engine options: a 120-hp 2.6-liter Four or a 175-hp sohc 3.2-liter V6. Honda is marketing the Passport in both 2-wheel- and 4-wheel-drive configurations. In addition, the Passport comes with



Other than the Honda badge, the body-color rear pillar identifies this as a Passport.

in the garage or out on the road.

We drove a variety of Aspires, and we can report that Aspire has crisper handling, more horsepower and more interior room than its prime competitor, the Geo Metro.

Look for stripper models to list for about \$8500, with more reasonably equipped versions between \$10,000-\$11,000.

—Mike Allen

three trim levels, versus Isuzu's two.

Some fairly serious rock-hopping through the Mojave foothills demonstrated to us that the Passport's off-road manners are as excellent as its on-road behavior.

Prices range from under \$16,000 for the 2wd 4-bangers to well over \$28,000 for a 4wd Passport with the V6 and all the trimmings.

—M.A.

When Worlds Collide

BY GREGORY T. POPE, Contributing Editor

● Swiftly, inexorably, they fly through the solar system like a volley of icy buckshot from some cosmic-caliber gun. A runaway train of comets, they're on a collision course with Jupiter.

Picture a chain of mountains hurtling through space at 100,000 miles per hour, and you just begin to imagine the kind of punch they pack. Now watch as they cannonball into a roiling gaseous planet. One by one the comets punch through Jupiter's ammonia clouds and plunge deep into its atmosphere. They plow hydrogen and helium ahead of them, leaving a near-vacuum wake behind them, until the pressure differential becomes unbearable. Then they explode. In fact they vaporize instantly. Blast waves shatter the clouds, and gases rush into the holes punched by the speeding missiles. Shock heating cooks the Jovian molecules into new species. Huge plumes of atmosphere roar out into space.

The equivalent of a nuclear-bomb explosion? Much more. Current estimates suggest the equivalent of 100 million megatons of TNT.

Quite a show by any standard. Too bad we can't watch. It's all happening on the night face of Jupiter, between July 18 and 24. Fortunately, though, the big planet spins quickly. And it's safe to say that nearly every Earth-bound telescope will be trained on Jupiter, waiting for the collision sites to swing into view 90 minutes after each impact. The spacecraft *Galileo*, now catapulting toward Jupiter, may also be poised to detect the detonations at the planet's edge, fireballs bright enough to flashlight Jupiter's moons.

The impacts will yield a bonanza for planetary scientists, who normally concede such cataclysms to colleagues studying deep-space mon-

sters like supernovas and black holes. What will happen? Will Jupiter change its stripes? Will the Great Red Spot—the raging, centuries-old ammonium-hydrosulfide hurricane that could swallow Earth whole—be scrambled? Will colorful new climate phenomena erupt? Astronomers can't wait to find out.

But the event holds more than mere academic interest. The collision will hammer home a conclusion that many astronomers have recently reached—that Earth's immediate neighborhood is a lot more lively than once thought. It's beginning to look like a huge arcade game, with loose comets and asteroids pinballing from one chaotic orbit to another until they plunk an unsuspecting planet.

The pinballs bound for Jupiter—a comet gang known as Shoemaker-Levy 9—shot into astronomers' consciousness in March 1993. Telescopes are currently tracking 21 of these bodies. They appear to be fragments of a much larger nucleus that shattered when it sideswiped Jupiter's gravitational field in June 1992. Passing 28,000 miles above the planet's clouds, the mother comet felt only the same pull of gravity that we feel on Earth. Yet that tidal force was enough to crumble the comet like the big, dirty snowball that it was.

Since then, the chain of comet fragments has loosened until it now stretches 500,000 miles long. All in all, the ice balls will take six



Jupiter and comets: destined to meet.

days to pepper Jupiter.

"There'll be about a dozen good, big impacts," predicts Paul Chodas, an astronomer at NASA's Jet Propulsion Laboratory (JPL). "We'll learn things about comets—how they break up, for example—and we'll learn things about Jupiter, its atmospheric chemistry and density. And we'll learn about impact dynamics—what happens when a solid body moving at 40 miles per second hits an atmosphere."

Bringing the story closer to home, Chodas adds that the impacts will be comparable in size to the crash of a comet or asteroid here on Earth 65 million years ago. That event, many geologists now believe, brought an end to the age of dinosaurs by blanketing the atmosphere with dust, decimating vegetation.

"There's a new awareness that asteroids pose a threat to Earth," notes Chodas. "Although it's highly unlikely that in any given year one will hit Earth, the consequences are so severe that it's prudent to try to find them."

And that's exactly what as-

tronomers are doing. JPL is forming a Near-Earth Asteroid Center, stockpiling data on near-Earth asteroids, their sizes and trajectories. Meanwhile, at the automated Spacewatch telescope on Kitt Peak, in Arizona, a group led by Tom Gehrels has catalogued more than a dozen small asteroids or comets that might potentially cross paths with our planet.

Although none loom wider than half a football field, these bodies could nevertheless explode with the energy of a Hiroshima bomb if they slammed into Earth.

Does this mean that our planet is trapped in an orbiting minefield? Not necessarily, says Christopher Chyba, an ex-NASA planetary scientist who is currently a White House Fellow. Comets, made mostly of weak ice, would explode too high up in our atmosphere to affect us, according to a recent analysis by Chyba. So would carbonaceous asteroids, which have the cohesiveness of firmly packed soot. A stony asteroid would scream through the air and detonate in a low-altitude airburst. (In fact, that's what Chyba believes flattened hundreds of square miles of Siberian forest in 1908, in what's been called the Tunguska event.) Only the comparatively rare solid-metal asteroids could actually penetrate the atmosphere, strike Earth and leave a smoking crater.

True, one of these space boulders could still lay waste to a large city. But the chances of that happening are slimmer than the odds of a more mundane disaster, such as an earthquake.

Even less likely—but far more devastating—would be an encounter with a bigger asteroid or comet, on the scale of Shoemaker-Levy 9. Scientific oddsmakers reckon a 1-in-10,000 chance of such an event in the next century. But what an event! According to the dinosaur-demise scenario, the impact would loft enough dust to blot the Sun from the sky and trigger global agricultural failure.

"We have discovered about 100 such objects out there," says David Morrison, chief of the space science division at NASA's Ames Research Center, "and we can say with confidence that none pose a threat. But what about the 1900 that we haven't found?" Statistics suggest such a hidden number, says Morrison, who chaired a workshop that presented a report to Congress on the subject last year.

The panel's recommendation: a network of telescopes programmed to detect tiny points of light that slip across the sky's background of stars. Six such telescopes, running for a decade, should provide a census of Earth's

little neighbors. NASA has already begun developing prototypes of the automated signal-processing and detection hardware. Should the telescopes detect an incoming collider, says Morrison, there would be plenty of motivation to assemble a means of deflecting it, such as a nuclear-tipped interceptor.

Of course, the near-Earth objects under scrutiny are believed to be mainly asteroids. By contrast, comets, such as Shoemaker-Levy 9, are wildcards in the overall picture. They can always lurch unexpectedly out of the solar system's deeper reaches. Within the past decade, in fact, astronomers have identified several huge cometlike bodies—known as the Centaurs—that circulate around the outer planets.

Even if these giants never touch Earth, they can still terrorize our planet. At Oxford University, astrophysicist Victor Clube has developed a controversial theory on that point. Clube hypothesizes that thousands of years ago one of these 150-mile-wide snowballs broke loose from a wobbly orbit and careened toward the Sun. This object, says Clube, disintegrated into a stream of debris that now sweeps across the Earth's orbit twice a year, producing the well-

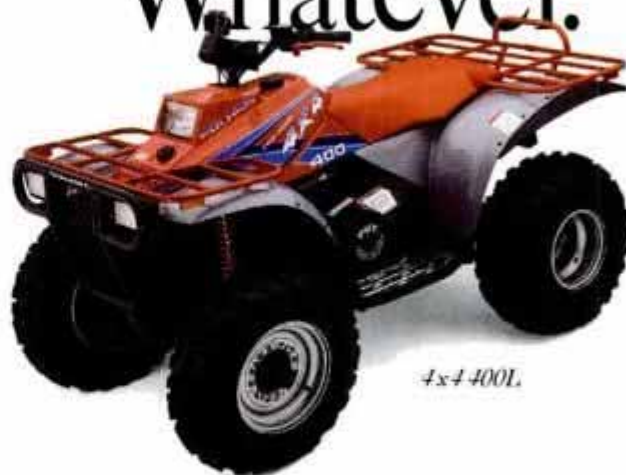
known Taurid meteor showers.

But the giant comet may also have unleashed bigger fragments. Some of these cometary chunks, he argues, are in fact what are thought to be the near-Earth asteroids. Meanwhile, others may have already meddled with Earthly affairs.

Records kept over the centuries by Chinese astrologers indicate that the Taurid meteor showers occasionally produced spectacular light shows. These, Clube believes, arose from the large cometary fragments breaking up and thickening the Taurid debris stream. Clube contends that the breakups coincide with major disruptions in history—the advent of the Dark Ages, the post-Renaissance Reformation, the English Civil War, and the French and American revolutions. Observers may have perceived the flashy meteor showers as heralds of the apocalypse—"They called them providence, or divine intervention," says Clube—and reacted with social upheaval.

While other astronomers voice skepticism of Clube's historical connections, they agree that renegade comets deserve far more study. And the coming bombardment of Jupiter has alerted many to the possibility of intervention from the heavens. **PM**

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BOATING

Jet Speed

BY JIM YOUNGS



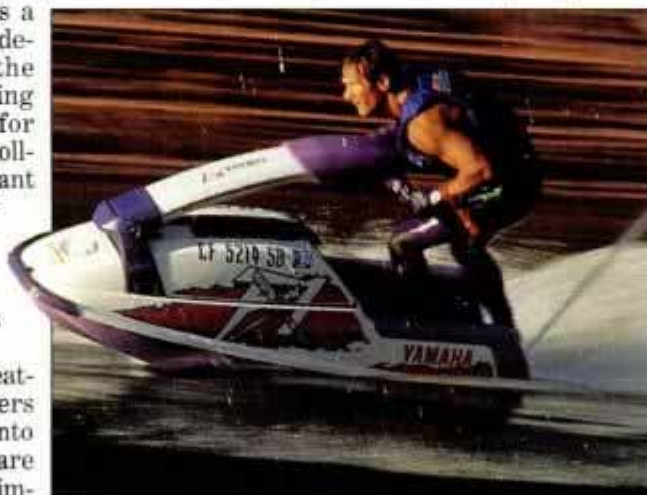
● It felt like repeated shotgun blasts to the face. It was only a little rain, but combine it with the high-performance speed of Yamaha's new WaveRaider and the pelting felt like buckshot. We were on Northern California's beautiful Lake Shasta in the late fall in less than optimal conditions. Still, it was exciting. We were in the process of getting a first look at a hot new water bike and couldn't resist the temptation to pull back the throttle. Amid the pain, we discovered that the new Yamaha WaveRaider is a serious jowl-distorting, hang-on-and-shut-up vehicle unlike anything else on the water. More about this later.

First, make a mental note: When the spray finally settles on 1994, this year will be remembered as a turning point in water-bike development. It's the year the PWC industry began catering to the water bikers' need for speed. This year's product roll-outs reveal a definite penchant for performance. The new machines are pushing the outer edge of the mid-century speed envelope and relegating former speedsters to entry-level status.

The racing scene, too, is heating up as more manufacturers throw their safety helmets into the ring. Racing programs are fertile breeding grounds for important R&D work, and this is

clearly evident in this year's models. In addition to being characterized by big motors and raw power, the new water bikes are faster and more exciting because of innovative high-performance features.

What all these signs indicate is that a performance war has broken out among water-bike manufacturers. It's something that has happened in other motorized industries over the years,



Expert riders will eat up Yamaha FX1's maneuverability.

and it's finally happening with water bikes. Don't you love it?

As mentioned, Yamaha's newest screamer is the exciting WaveRaider, a 2-up runabout powered by a 701cc oil-injected engine fitted with a pair of Mikuni Super BN38 carbs. The engine churns out a whopping 80 horsepower, and drives a new axial-flow pump fitted with a stainless 17° to 20° variable-pitch impeller.

The WaveRaider, appearing in photo at left, has a performance feature rarely seen until a few years ago but now quickly becoming standard equipment on fast, high-end models—a 3-position trim system that's driver actuated. This system is called the QSTS (Quick Shift Trim System). It works by adjusting the angle of the pump nozzle up or down 5° from a neutral position.



Sea-Doo SPX: top-of-the-line performance, hold-the-line pricing.

Trimmed up, the boost in performance is very noticeable.

The hull of the WaveRaider is also intriguing. It has a double-chine, deep-V configuration with a rounded stern, multiple strakes and a pronounced step or notch at the rear quarter of the hull. In addition to maximizing performance, the well-conceived hull gives the WaveRaider outstanding handling characteristics. The unit turns so crisply in either direction that minimal leaning is required to get it to hook through tight turns.

Thanks to a wide, soft seat, the machine provides a comfortable ride, and overall ergonomics are good. Features include full-length step pads for sure-footing, a big cooler, seat strap,

adjustable mirrors, LCD multifunction gauge and a 10.6-gallon fuel tank.

Acceleration is gunshot quick and at top-end the WaveRaider is thrillingly fast at 55 mph, at least on the preproduction models we drove. Price is \$6399.

In a surprise move, Yamaha also introduced a new stand-up machine, called the FX1. It is shorter and narrower than the company's other stand-up model, the SuperJet. With these specs one might think the FX1 would be an entry-level machine, but its 63-hp engine and penchant for speed say otherwise. The 267-pound FX1 has a unique pivot position for its handle pole that allows great leverage for quick turns and freestyle maneuvers. To novice riders, this responsiveness may feel twitchy, but to experienced riders the flickable maneuverability will be a major bonus.

Acceleration is impressive with the FX1 because of its single-carb 2-cylinder 701cc twin engine and an adjustable steering nozzle—18° to 22°—that enables the machine to be tailored to individual riding styles. The FX1 pump is an all-new component aimed at increasing midrange and top-end performance. Price is \$5399.

While the headline-grabbing news

at Sea-Doo this year is an aggressive pricing policy that reduces sticker prices or holds the line from last year, this isn't the whole story for 1994. The real excitement comes from Sea-Doo's new generation of sit-down runabouts that carry SP designations and feature all-new hulls and deck designs. Dubbed the SP series, the new models are the SP (\$4499), SPI (\$4999) and SPX (\$5499).

The SPX model is an interesting departure, because it's basically the top-of-the-line Sea-Doo XP minus 8 horsepower, Ninja Turtle-like trim and a few other upscale bells and whistles. The SPX is powered by a 72-hp version of the 650cc Rotax engine used in the XP. Its performance is equally sterling and comes for about \$500 less. The SPX benefits from a new twin-Mikuni carb setup, tuned exhaust pipe and a progressive-pitch stainless impeller. Other models in the SP series include the 55-hp standard model and the 60-hp SPI. All three of these machines feature Sea-Doo maneuverability and performance, which is second to none.

When we last told you about the awesome Sea-Doo XP, the flagship of the Bombardier line, we cautioned that this speed demon was not only a screamer but it required full attention

and judicious body English. Those who didn't heed the advice often found themselves unseated at full tilt. Well, Sea-Doo engineers not only tamed the beast for '94 by correcting its penchant for chine walking, but also added 10 horsepower and upped the industry leader's top speed.

The '94 XP is wickedly fast but accomplishes this feat without significant driver fiddling, coaxing or scary behavior. Part of the fix was to add a pair of concave sponsons, or stabilizing strakes, to the sides of the hull at the stern. It's a simple solution that's a bit curious, but it works. The horsepower boost is the result of a new twin Mikuni carburetor design that's exclusive to Sea-Doo plus a new tuned exhaust. The pump also got some revision with a manganese bronze housing to reduce cavitation and a progressive-pitch stainless impeller.

Other changes in the Sea-Doo line include boosting the power in the 3-up GTX machine to 72 hp. Bombardier now offers an optional, comfortable 2-up touring seat for the GTX that serves both the driver and passenger—often a neglected component.

As you can see, the performance wars are heating up in the PWC ranks. Choose your weapon. **FM**

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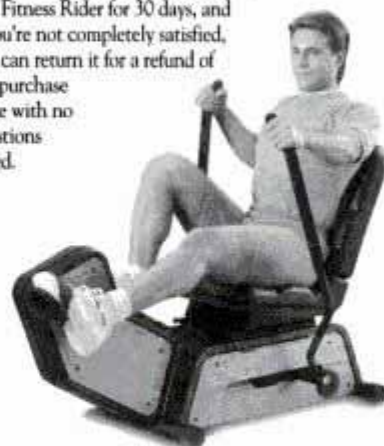
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Detroit Spy Report

BY JIM DUNNE, Detroit Editor



1995 Chevy Cavalier

• This very-long-range photo (taken with a 1000mm mirror lens) of a prototype shows the new look on Chevy's best-selling model. The angles and straight lines are gone, replaced by smooth curves. The 1995 version of the Cavalier will have a shape much like Chrysler's heralded Neon. However, the Chevy's trim features are similar to the Saturn. You can see the paint disguises on this prototype, which camouflage the shape of the wheel openings, the rear windows and the headlights. Plans include a nearly full line of Cavaliers for next year, including a convertible and a sporty Z24. However, the station wagon is going to be dropped.



Ford's Crown Victoria will have wide, Thunderbird-like taillights.

1995 Crown Victoria

Ford is wasting little time in freshening the looks of its full-size sedan. The Crown Vic will sport updated rear styling next year with this minimal change to the taillights and trim pieces. It is no coincidence that the wider taillights are similar in shape to the Thunderbird's. Ford is edging the Thunderbird closer to being a 2-door version of the Crown Vic. Note that the bright trim on the Crown Vic's lower trunk lip has been dropped.

Continuing Saga Of The 4-Door Van

GM plans to replace its plastic-body front-drive Lumina/Silhouette/Trans Sport minivans with steel-body models in early 1995. These new minivans will still use front-wheel drive, but the radical "Dustbuster" styling of current models will be gone. In its place will be a conventional 2-box shape, with a defined hood bulge at the front. Among the other changes will be a second sliding door, this one on the driver's side, as an option.

Electric To Gas

GM's Impact electric-car program may pay energy-saving dividends in gas-powered cars. Aside from sharing the aerodynamic advantages of the Impact, your future car could benefit from the Impact's high-pressure tires, electrically powered accessories and a new type of heater/air conditioner. The Impact's tires are built to hold 50 psi, which reduces

rolling resistance, a big drain on fuel economy. The electric-powered accessories operate only when needed, and do not put a constant drain on the engine. Also interesting is the Impact's heat pump heater/air conditioner. It's a new approach to comfort that seems to work well in fairly extreme temperatures.

Astro/Safari For '95

Both the Chevrolet Astro and the GMC Safari rear-drive minivans will offer two trim levels, each identifiable by their noses. The uplevel models get composite headlights and brighter trim, which we showed in February on page 94. The base version, pictured below, shows a simpler appearance with standard rectangular headlights. Note the simplicity of this version's bumper design. The '95 minivan appears to be simpler than the current one as well—it has only a fraction of its predecessor's number of parts.



GM's base-version vans get a familiar front.

1995 Jaguar

A major exterior styling change is slated for Jaguar sedans next year. The front end will be extensively revamped and taillight styling will be altered. Up front, Jaguar will revert to the dual round headlight arrangement of past years. To emphasize the change, Jaguar stylists will shape the hood and fenders with curved bulges that conform to the shape of the headlights, giving the new models a definite retro look. A chrome grille will be the only sign of brightwork in the front, as Jaguar drops the steel bumper and headlight surrounds. Body and chassis remain essentially unchanged, though Jaguar is planning a new V8 engine for the coupe and the sedan in the 1996 model year.



New Jaguar XJ6/XJ12 looks more like older ones with round headlights and curvaceous front fenders. Ford had a say in the redesign.

Headlights Of Your Choice



Here are two versions of the 1995 Chevy Astro. One van has rectangular headlights, the other the composite type. Both will be offered to customers. If you want smooth styling, and are not concerned with replacement costs, you can choose the composite type. You could pay \$125 to install a new composite headlight. Or you can choose the rectangular type. They cost less than \$10 and take less time to install.

The Well-Dressed Crash-Test Dummy

Those human-like dummies used in car-crash tests are better dressed these days. The instrumented dummies wear pink T-shirts and shorts that cover the parts of their bodies that touch the seats of the crash vehicles. In addition, each dummy now wears a pair of regular, off-the-shelf shoes. The new coverings are used in all crash tests required by the government. The pink underclothing presents a uniform texture to the seats. The standard shoes present identical friction to the floor of the vehicle. The purpose is to make everyone's test results as closely comparable as possible.

Future T-Bird

Look for big, big changes in Thunderbird when the current body style is replaced in 1997. At that time, the sporty coupe will adopt Taurus' front-drive chassis, abandoning its current frame-and-body construction. The change comes about for a couple of reasons, most of all because the current T-Bird weighs too much. Also, the cost of building a special chassis for the sporty coupe class is just too expensive. Finally, look at the new Monte Carlo. That vehicle uses Lumina's high-production chassis and drivetrain, and is hundreds of pounds lighter than the Thunderbird.

Cougar, Too

With Thunderbird making a major design change for 1997, the Mercury Cougar must either follow suit, or find some other way of becoming less expensive and more fuel efficient. One strong possibility is to build the new car on the Mazda 626 chassis. This scenario would have Mazda build the Cougar for Mercury just as it already builds the Probe for Ford. Some of the appeal of this plan is that it would give Mercury dealers a Probe-like car that does not compete with either the Thunderbird or the Mark VIII.



Instrumented crash-test dummies are now sartorially and anatomically correct.

and snugly follows every bulge and crevice in the seat surface. In addition, different-colored threads in the knitting machines can produce any number of interesting designs. While the knitting machines are expensive to purchase, they can turn out a seat cover in as little as 2 minutes. A cut-and-sew seat cover that may be made of seven different pieces can take up to 45 minutes to finish. **PM**

Knit One...

Or knit them all, since knitted seat upholstery is a cost-efficient way of offering a wide variety of interior colors and design flavors. GM, for one, is planning to install knitted upholstery on lots of its car seats in the near future. The upholstery is made in one piece to fit over the seat cushions. Knitted to shape, the material accurately

TELECOMMUNICATIONS

(Continued from page 59)

ling from PM could sandbag CV signals. Girth has nothing to do with it: The density of liquid in the human body will shortstop the transmission signal. On the other hand, the dispersed moisture of rain, snow or fog won't interfere with CV signals—something that can occur with standard terrestrial or even direct broadcast satellite transmissions.

No distortion

Because CV's signals don't travel through miles of wire or need amplifiers to boost them on the way, the system isn't prone to the distortion or variable quality that sometimes afflicts cable TV. We watched a variety of programming—live and taped, network and local, premium channels and public access. The quality after transmission was crisper than regular broadcasts or cable links, probably what you would see on studio monitors before transmission.

Sound was exceptionally good, too, and soon will be even better. Audio comes down from satellites in digital form. CV plans to relay the signal digitally all the way to the set-top converter, which will translate the bits to analog soundwaves.

Also, because CV doesn't need the physical infrastructure of cable, service can be cheaper. There are no trenches to dig or cables to string. Besides an array of small, differently sized antennas—the largest being about the size of a Sicilian pizza square—the retransmission apparatus for local cell sites is about the size of a suitcase. Hovnanian tells PM the company rents relatively inexpensive and amply available roof-rights for the cells.

The price

What do you get for your money? Subscribers in Brighton Beach can get 40 channels of TV for \$30 a month—including premium pay channels, Showtime and The Movie Channel. A comparable monthly package goes for \$50 from the local cable utility.

CV's one-time installation charge is \$50 for antenna and remote-controlled set-top converter. Installation for additional TVs is \$25 per converter. Extra antennas aren't necessary, though available. The company says it has run 300 ft. of wire between antenna and converter with no measured signal loss.

At press time, CV planned to fill out its 49-channel capability with premium offerings, including Cinemax, Disney, HBO, SportsChannel and three in pulse pay-per-view channels. **PM**

roll. The company is doing this by varying the shape of the core of each ball, within the same family, depending on its weight.

Generally, ball weight affects reaction on the lanes. If you roll a 16-pound ball and a 12-pound ball with identical core shapes on a lane, the 12-pound ball will "hook long" or go straight longer than the heavier ball and make its break to the pins later. The Quantum balls are designed to react or break the same way regardless of weight.

When it comes to releasing the ball,

there are as many styles as there are bowlers. But among professionals there are two basic methods: the power swing or the traditional swing. Many pros stick closely to one or the other, while most amateurs mix and match.

Resin balls allow "stokers," accurate bowlers who lack a powerful strike ball, to "blow out the rack" with the best of the "crankers." Despite his 6-ft. 2-in. frame, last year's hottest bowler and top money winner Walter Ray Williams Jr. is considered a stoker. By using Ebonite's Crush/R resin

ball for his first shot on most of the bowling tournaments he was in last year, the 33-year-old transformed the reaction of his ball into that of a cranker's. He was able to strike consistently on light hits to the pocket that would have left some pins standing were he using a non-resin ball.

For crankers, or big-hook bowlers, however, resin balls have not had a major impact on their scores. Take unlikely power-bowler Chris Warren. His physique is reminiscent of a Charles Atlas "before" photo, yet the 30-year-old Texan, who weighs 115 pounds and stands 5-ft. 4 1/4-in. tall, throws the ball as hard as anyone on tour—18 mph.

Warren says he's always been a cranker. The keys to his success are foot speed and arm swing, which create momentum and leverage.

Warren's quick foot speed, uncommon for many short players, allows him to raise his right arm quickly on the backswing. At the top of his swing, Warren opens his shoulder to gain the leverage necessary for a quick follow-through.

Additionally, power bowlers like Warren cup their wrist when releasing the ball so the ball rotates more, resulting in greater ball impact when it hits the pins. The final step occurs at the point of release, when a quick upward bend of the elbow produces what's known as "lift" on the ball. Lifting the ball complements "cupping" the ball in creating rotation.

Accuracy and consistency are keys to Brian Voss' success. Voss, winner of 13 PBA titles and more than \$1.2 million in his 12-year professional career, is a cross between a cranker and a stoker. At 5-ft. 10-in. tall, his picture-perfect style generates the consistency to make him a perennial money winner. He too uses a resin ball.

"You cannot *not* use a resin ball these days. I'd be losing 10 pins per game if I didn't use them," Voss says, "and that's too much when you have guys hitting the pocket with these balls."

For better or worse, resin balls have changed the game for good. Two years ago, resins were perceived as a fad, but now they have become a mainstay, said Jim Mailander, president of ball manufacturer Champions Bowling Products Corp. in Baltimore, Maryland. "People thought the resin-ball popularity would die. If that were true, it's been one of the longest wakes in history." **FM**

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LONG-TERM TEST CARS (Continued from page 69)

extra cam timing kicks in. We really haven't flogged it yet, as we love every only a few days before but we can tell already called humiliate a lot of taxicab auto- In deference to the specified muting through, help soothe the Lincoln T-4-wheel disc matic trap and mirrors, the high—all standard new. This all stickered as we pile up the you know if the new ed, setting any new

partner to Villager's 3.0-liter Nissan-based V6 engine. If there is a drawback in the powertrain, it's the slow shifts during hard acceleration. An electronic control for the transmission would fix that.

But minivans are more about kid shuttling, cargo hauling and grocery toting than performance. That's where Villager holds some surprises.

Among minivans, Villager is one of the smallest in exterior size. Still, its carrying capacity is equal to just about any family task. Fold the rear seats down and you get space to spare. Yes, the trend is to larger vans. But

the advantage of Villager's shorter overall length—almost a foot shorter than Ford's new Windstar—pays dividends every time you drive in traffic or park in tight spaces.

As long-term test vehicles go, the Villager certainly wasn't one of the most exciting we've ever driven. But it was totally reliable and one of the best minivans we've ever tested. It always gave us a comforting feeling to climb into its cockpit and set out for a destination. It was always friendly and carlike, and we liked it very much. And that's saying a lot about any car.

—Jim Dunne

Subaru Impreza L

If you were to judge our long-term Subaru Impreza by the attention it gets, you might be disappointed. Except for occasional comments about its somewhat unusual looks, the Impreza slips through the daily grind almost invisibly.

Judge it by the attention it has required, however, and a completely different picture emerges. To date, nothing has gone wrong. Not even a wiper blade or lightbulb has caused problems. The worst you can say about the Impreza is that it gets dirty—and that doesn't exactly qualify as a complaint.

The Impreza's all-wheel-drive system got its first workout recently, and showed its worth by pulling us through an unexpected snowstorm. The system's downside, increased fuel consumption, seems to have most to do with who's driving. The Impreza's overall fuel economy has settled in at a perfectly acceptable 26 mpg.

"Perfectly acceptable" is, in fact, a good summation of our Subaru so far. A little more horsepower would be nice, but that's about the only complaint we can make about this comfortable, well-built and thoroughly reliable little wagon.

—Ray Thursby

Mercury Villager LS

Inside, the driver's seat has the sheen of good leather used often. Outside, the sliding door has an elongated dent. And the mini-hood suffers one minor stone bruise.

But after a year and 24,000 miles of mixed city/highway driving in the Midwest, the Mercury Villager performs just about like new: never hesitates to start on the first crank, and never stumbles during acceleration.

Over our 12-month test period, fuel economy stayed steady at 21-plus mpg, while running on any grade of gasoline. The 4-speed automatic transmission is smooth, quiet and a fitting

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Grown-Up Games

BY FRANK VIZARD, Electronics Editor



● Amid increasing concern that we live in what some observers are calling a culture of violence, videogames are coming under increasing scrutiny as to their level of violent and sexually suggestive content.

Games like *Mortal Kombat*, in which characters are bloodily decapitated, and *Night Trap*, in which villains threaten scantily clad women, have been pilloried in many quarters, not the least of which being the U.S. Senate. Toys "R" Us, the large retail chain, went so far as to pull *Night Trap* from its stores.

The maker of *Night Trap*, Digital Pictures, seems to agree that the game isn't appropriate for anyone under the age of 17. All this seems to be leading toward the creation of an industry-wide ratings guide similar to that used for movies. This shouldn't be too surprising since many videogames now resemble films, even though they have a higher level of interactivity. A new CD-ROM boxing game from Sega called *Prize-Fighter*, for example, uses black-and-white film clips in a style reminiscent of the fight film "Raging Bull."

One wonders, though, if all games for adults have to be violent or contain sexual themes. Kudos, therefore, go to a New York City company called Eidolon Inc.,

makers of a game called *Millennium Auction*. The idea here is to get away from the handplay, i.e. point-and-shoot approach, of most games. *Millennium Auction* is designed to offer visually interesting mindplay.

The *Eidolon* game takes place in the not-too-distant future. Up to four players compete to collect the world's great art objects. While these objects include some recognizable works by artists such as Van Gogh, there are some tongue-in-cheek collectibles to be had as well. These include Bill Clinton's saxophone and "faked" footage of the 1969 Moon landing.

Other aspects of the game are positively inspired. One character, for example, is a young Japanese cyberpunk entrepreneur who sports a pull-down

visor that operates as a datalink.

Another inspired aspect of the game is the holographic infolink, or future data highway. Information agents zoom down the appropriate funnel in search of critical information. Visually speaking, this is one of the best graphic representations yet of how a worldwide communications network would operate.

The \$100 *Millennium Auction* game is available this spring as a CD-ROM computer game, but plans exist to make it available on other platforms such as 3DO. This can't happen soon enough, since at this writing the software for the \$700 3DO system is underwhelming. CD-ROM game systems, in fact, are proliferating. Commodore, for instance, bows its \$399 Amiga CD³² system this month.

One new CD-based game system avoiding any software problems is the new X'Eye machine from JVC. It lists for \$500.

X'Eye plays all Sega CD-ROM games and can also be used to play audio CDs, CD+Graphics karaoke discs, Electronic Book discs and educational software such as *Compton's Interactive Encyclopedia*—which indicates educational software is moving toward game platforms thanks to the multimedia capabilities of CD-ROM.



Scenes from *Millennium Auction* (top); JVC's multiuse X'Eye system (above).

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