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# Popular Mechanics

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TRADE CENTER**  
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Engineering It To  
Be Even Stronger

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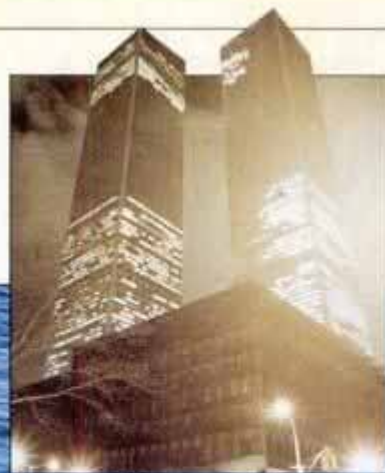
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# Popular Mechanics®

JULY 1993  
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# EDITOR'S NOTES

● In our July 1988 issue, we made a bold prediction as to what the U.S. Navy's surface warships would look like by the year 2000. We predicted that stealth technology would, by that time, have filtered down to surface ships, making their exteriors a lot smoother and a lot more invisible to enemy radar. We commissioned several pieces of artwork for that issue—for the cover, the article itself and a poster that we bound into the issue. We thought we were being pretty wild in our concepts, far out even. But recently, when the Department of Defense released photos of the experimental *Sea Shadow*, a surface ship built to explore the outer limits of stealth technology for surface warships, we realized how tame our predictions had been. The real thing is so much more radical than our wildest concepts of five years ago that it takes the whole idea of stealth ships to another dimension. We give credit to the guys at

Lockheed for thinking that is quantum leaps ahead of anything we could come up with. Science/Technology Editor Abe Dane's cover story, beginning on page 28, once again proves that truth is stranger than fiction—and a lot more fun to write about. . . . I recently had a chance to test Pontiac's Roadside Assistance program. I was driving a '93 Firebird test car and misplaced the keys. Luckily, the car was parked in my driveway so I wasn't actually stranded. But I thought it would be a good time to test the system. Pontiac's (and Cadillac's, Oldsmobile's, Chevrolet's and Mercedes-Benz's) Roadside Assistance program promises to help rescue any owner of any of its cars if stuck with a dead battery, if the car runs out of gas or if the keys are lost. Someone staffs an 800-number 24 hours a day, 7 days a week, and the service promises to rescue you within 2 hours. There are also other provisions for overnight accommoda-

Our July 1988 issue: too tame.

tions, meals, etc. under certain conditions. When I got to the office, I called Pontiac's rescue number—(800) 762-3743—and reached Rick Kingsbury at Pontiac's headquarters in Pontiac, Michigan. I told him the problem, the location of the car and its VIN number. He determined the location of a convenient local Pontiac dealer, and promised to have the dealer deliver a new set of keys in 2 hours. Sure enough, about 2 hours later, someone from Cunningham Pontiac in Queens, New York, delivered a set of keys right to my office. These roadside assistance programs have to be one of the great ideas of all time and should be considered as a real factor when thinking about your next new-car purchase. . . . Did you feel the same horror and revulsion as I did when you first heard about the World Trade Center bombing? I guess most people did. Luckily, it turned out about as well as something like this can turn out. What we all wanted to know in the aftermath was why the whole building didn't collapse the way you see buildings come down when they're being demolished. Why the twin towers still stand is a fascinating story of engineering prowess and foresight. Contributor Herb Shuldiner takes you inside the towers for the full story, starting on page 40. Till next time.



Joe Oldham

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

ASAP!

But how?

Weaving?

Not him.

Transplant?

Never.

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.

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TOPICAL SOLUTION minoxidil 2%

*Rogaine*<sup>®</sup> 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.

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.

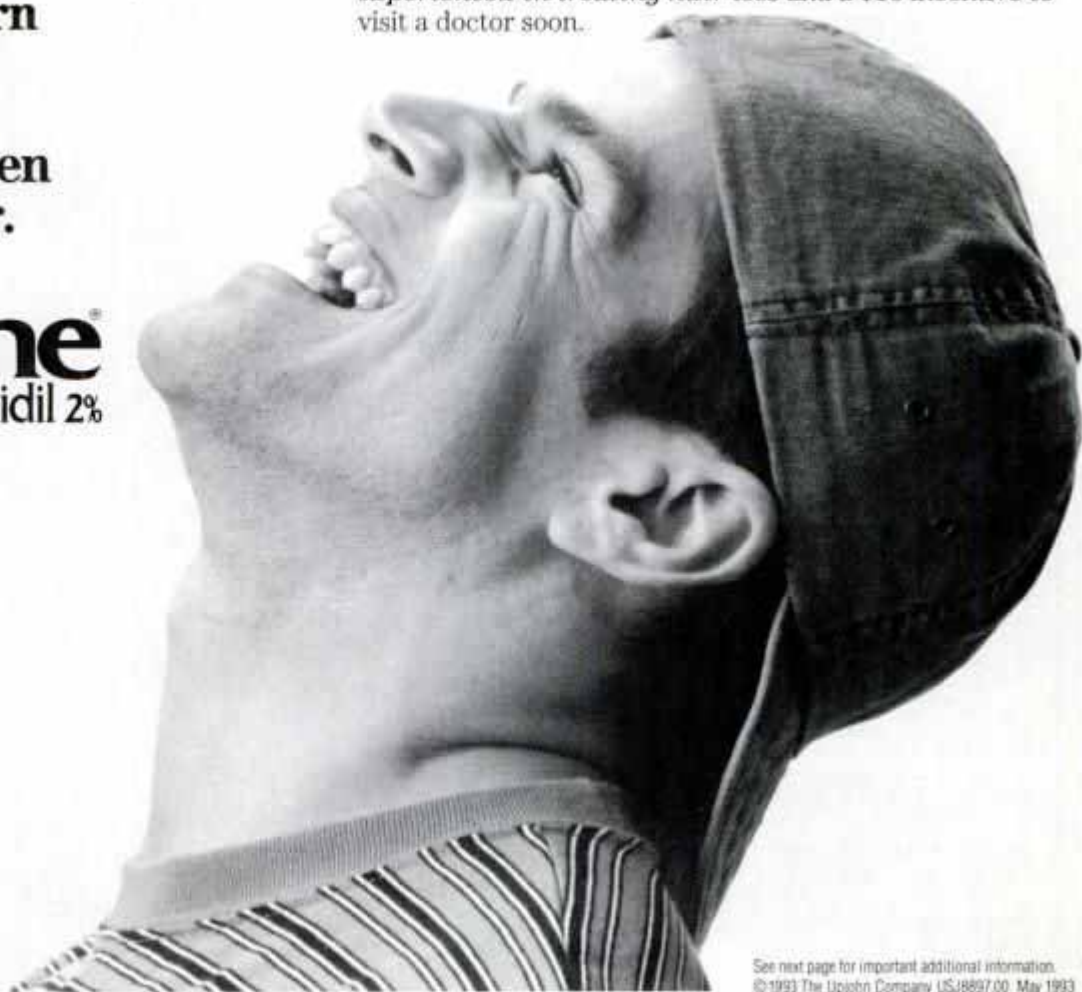
Side effects were minimal: 7% of those who used *Rogaine* had itching of the scalp. *Rogaine* should only be applied to a normal, healthy scalp (not sunburned or irritated).

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, balding longer, 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.

Why wait? Find out whether *Rogaine* is for you. Call **1-800-333-9199**. Today. We'll send you an informational brochure explaining all about the product and how to use it. And because only a doctor can prescribe *Rogaine*, we'll include a list of nearby *dermatologists or other doctors experienced in treating hair loss* and a \$10 incentive to visit a doctor soon.



See next page for important additional information.  
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**Rogaine**<sup>®</sup>  
TOPICAL SOLUTION minoxidil 2%

## The only product ever proven to regrow hair for male pattern baldness.

### 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 60% 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 medical centers involving 256 women with hair loss. Based on patient evaluations of regrowth after 32 weeks (8 months), 19% of the women using ROGAINE had at least moderate regrowth compared with 7% of those using a placebo. No regrowth was reported by 41% 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. If the spray applicator is used, avoid inhaling the spray.

### 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, lightheadedness—3.42%. **Musculoskeletal:** fractures, back pain, tendinitis—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:** 0.47%. **Psychiatric:** anxiety, depression, fatigue—0.36%. **Hematologic:** lymphadenopathy, thrombocytopenia—0.31%.

ROGAINE 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 was 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.

**Upjohn** | DERMATOLOGY DIVISION

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Publisher Robert B. Dillingham

Business Manager Agnes P. Maillaro

## ADVERTISING

Director John A. Pagliaro

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224 West 57 St., New York, NY 10019

Michael T. Campbell

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## PRODUCTION

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Adv. Prod. Mgr. Patricia A. Woods

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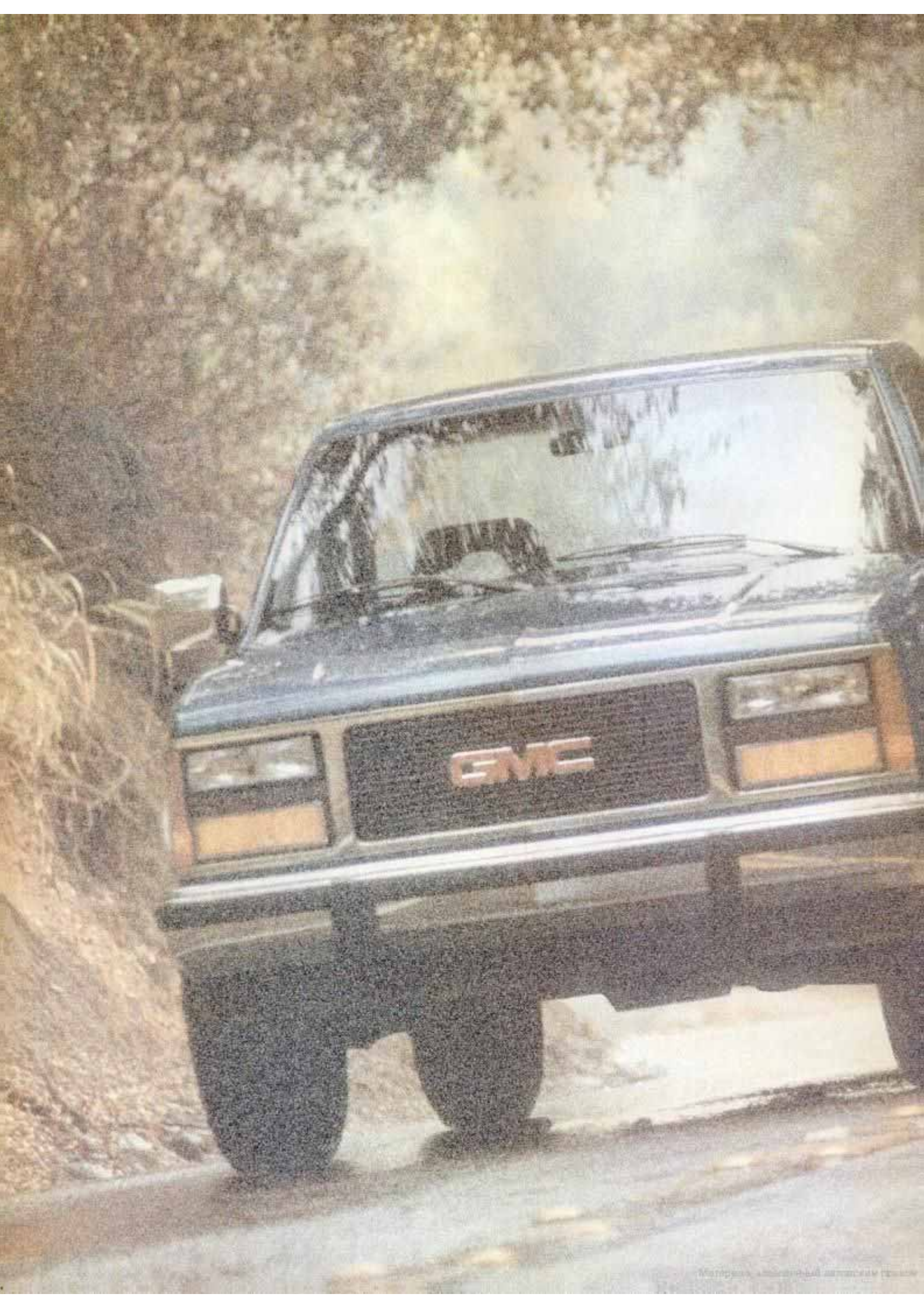
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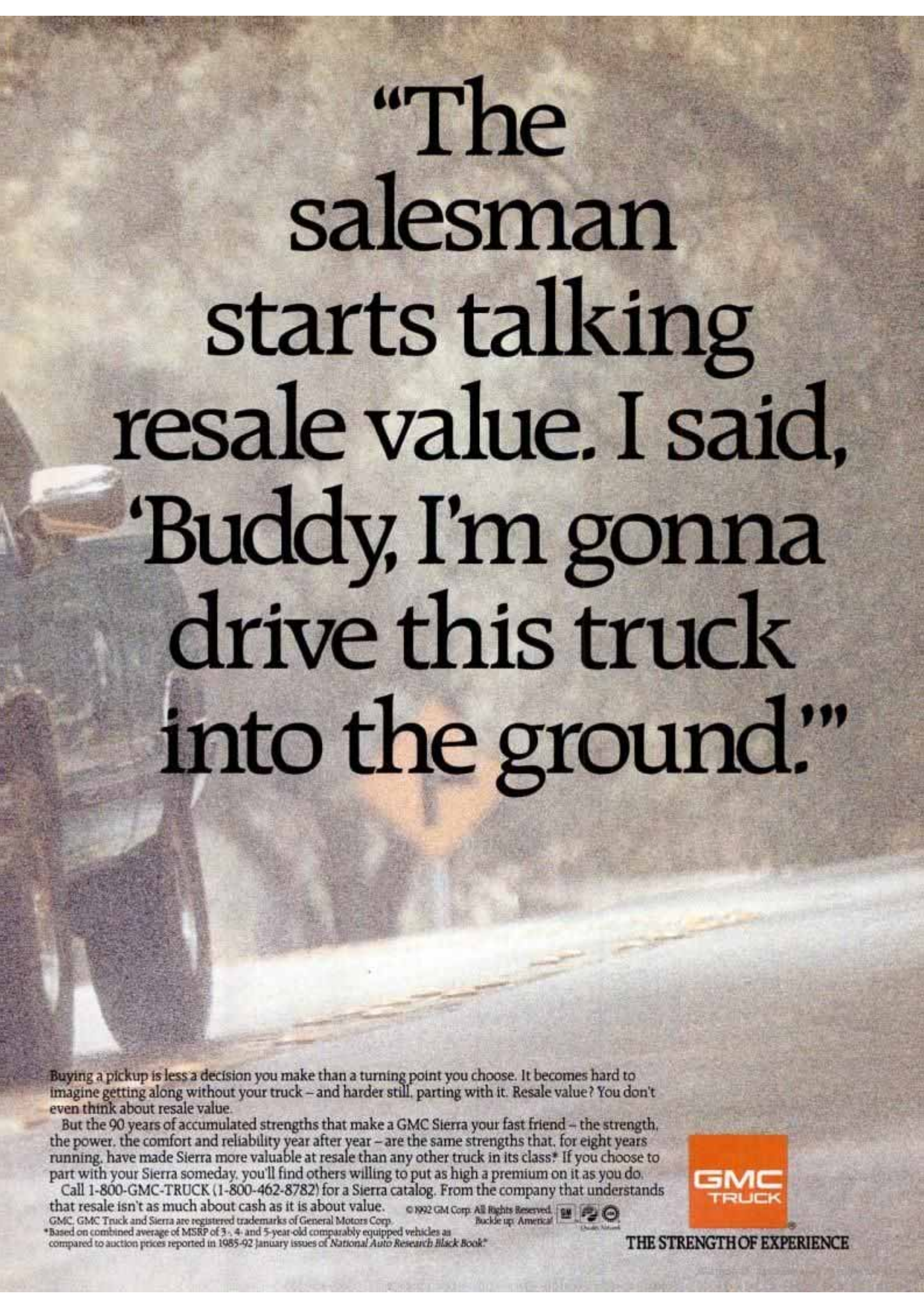
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starts talking  
resale value. I said,  
‘Buddy, I’m gonna  
drive this truck  
into the ground.’”

Buying a pickup is less a decision you make than a turning point you choose. It becomes hard to imagine getting along without your truck – and harder still, parting with it. Resale value? You don't even think about resale value.

But the 90 years of accumulated strengths that make a GMC Sierra your fast friend – the strength, the power, the comfort and reliability year after year – are the same strengths that, for eight years running, have made Sierra more valuable at resale than any other truck in its class.\* If you choose to part with your Sierra someday, you'll find others willing to put as high a premium on it as you do.

Call 1-800-GMC-TRUCK (1-800-462-8782) for a Sierra catalog. From the company that understands that resale isn't as much about cash as it is about value.

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\*Based on combined average of MSRP of 3-, 4- and 5-year-old comparably equipped vehicles as compared to auction prices reported in 1985-92 January issues of *National Auto Research Black Book*.\*

THE STRENGTH OF EXPERIENCE



# LETTERS

## Car Teasers



These "Dream Cars" are a tease from the auto industry. It's really too bad that some of them are not mass produced. The Dodge Viper is a really good-looking coupe as a concept car. Much better looking than the roadster that Dodge is now building. And it's really disappointing that the Ford Mach III is just a concept car. Also, what have the designers done to pickups? Have they ever worked on a farm or ranch?

CLIFFORD E. RININGER  
WHITE CLAY, NE

I'm glad to hear that Ford's executives are in a tizzy over powerplant choices for the upcoming redesigned Mustang. The future of the Mustang hangs in the balance depending on this decision. Many people who once bought 5.0-liter Mustangs are now buying high-performance high-tech vehicles with turbocharged multivalve powerplants. Unfortunately, many people will continue to choose other makes over the Mustang until a serious engine is offered, such as the 300-hp 4.6-liter dohc 32-valve modular V8 engine. The Mustang has always had an attractive price/perform-

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

ance ratio, but in light of other auto manufacturers' offerings lately, the performance portion of the equation has been steadily decreasing. The Mustang will become a mere relic of the past if it does not receive an engine with more horsepower and greater reliability to make it a serious car.

DON REDDEN  
APISON, TN

*We've just learned that the '94 Mustang, on sale Dec. 26, 1993, will be available only with the current V6 and 5.0-liter V8 engines. The 4.6 modular V8 may come later, like for '95.*

—Ed.

Although I will probably never purchase another new car, I find them intriguing and entertaining to look at. My wife, however, was bitten by the Detroit fever bug. She will be paying for it at \$300 a month for the next five years. What a waste of time, money and effort. I bought myself a 20-year-old Lincoln Mark IV for \$500. The car will probably run for another 20 years, and it's paid in full.

G. FRANK BRDA  
CLEVELAND, OH

*And it will come in handy as a float in the Rosebowl Parade.*

—Ed.

Concerning the Bugatti EB110, the marque is French, not Italian as stated in your caption. Ettore Bugatti was born in Milan, Italy, in 1881, but established his automobile factory in Molsheim, France, in 1909, due to the influence of his friend Louis Bleriot, the famous aviator.

FRANK BARBIER  
ATHENS, AL

### It's All Politics

It is not appropriate for POPULAR MECHANICS to be politicking for Clinton. Science/Technology Editor Abe Dane is out of line when he uses his column to trumpet Clinton's programs. Referring to Clinton's "Technology For America's Growth" policy as a sharp departure from earlier policies—particularly those of the last two administrations—is the type of material that belongs in a statement from Stephanopoulos, not in a magazine for practical people. Military people and retired folks on Social Security are those singled out to pay for most of Clinton's

schemes. And believe me, they are not about to swallow media garbage, even in POPULAR MECHANICS.

MILLARD F. ERICKSON  
WHITESBORO, NY

Clinton not only believes that government needs to play a big part in directing industry, but also in directing every aspect of our lives. His overt socialist views will prohibit business from prospering. For as sure as it does, he'll tax it. This will kill the huge amount of jobs that could have been created by leaving business alone. The definition of facism is government control of private business. Please stop printing this damage-control, Reagan/Bush-years-bashing garbage. I enjoy POPULAR MECHANICS very much. Ironically, because it generally doesn't pander to the politically correct crowd, and is usually quite balanced and responsible.

JOHN A. VINCENT  
CORRYTON, TN

*As a Reagan/Bush Republican, I respect the right of Abe Dane to use his own column occasionally to express his own opinions. Just as I respect your right to turn the page.*

—Ed.

### Custom Corner

I modified your plans for a wall-to-wall unit and built this corner bookcase with exposed ends. I didn't build the doors along the bottom. My wife preferred open shelves. To make the unit look even on both walls, I had to build a soffit on the left side to match the existing heating-duct soffit on the right.

CARL W. CONNER  
ROCKVILLE, MD



Reader Conner modified PM plans to build this bookcase.



## PM HOTLINES

# COMMUNICATE WITH US

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

### LETTERS

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

### FAX MACHINE

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

### ELECTRONIC MAIL

You can call the PM computer any day between 6 pm and 8 am (only Eastern time). The number is (212) 582-8369. Once you're 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.

New users get an identification number and password that allow you to access the system. Simply set your communications software to 8 bits, no parity and one stop bit (8-N-1), and set the baud at 300 or 1200. Please remember that we are not a professionally staffed, fully operational bulletin board. We're simply trying to make it easier for you to communicate with us. So please bear with us if it takes awhile to answer your message.

### READER SERVICE BUREAU

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

### HOTLINE PHONE NUMBERS

Unfortunately, our Hotline Phone Service is temporarily discontinued.



Lynchburg, Tennessee is a wonderful place to visit. We hope you'll do so soon.

**IN LYNCHBURG, TENNESSEE** you can still buy a 10¢ Coke.<sup>®</sup> But not a dime's worth of Jack Daniel's.

Our county was voted dry in 1909. Though we began making Tennessee Whiskey here in 1866, you have to buy it elsewhere. If you're ever in Lynchburg and in need of refreshment, we'll recommend a short walk to the Coke machine at the hardware store. But if you're looking for the kind of refreshment Jack Daniel's provides, the trip to the next county isn't far. Eleven miles, three blocks and five steps, to be exact.

**SMOOTH SIPPIN'  
TENNESSEE WHISKEY**

Tennessee Whiskey • 40-43% alcohol by volume (80-86 proof) • Distilled and Bottled by Jack Daniel Distillery, Lem Motlow, Proprietor, Route 1, Lynchburg (Pop 361), Tennessee 37352  
*Placed in the National Register of Historic Places by the United States Government.*





# TIME MACHINE

## 90 YEARS AGO: JULY 1903



### Two-Wheel Drive

Although Britain's high-speed passenger service was a paragon for American railroads, engineers considered single-axle drive an Anglo-Saxon eccentricity. The lightweight power units were deemed no match for the sure-footed iron horses in service here. Yet two English locomotives appeared on Philadelphia & Reading tracks. The elegant engines hauled three cars between Philly and New York without breaking a sweat.

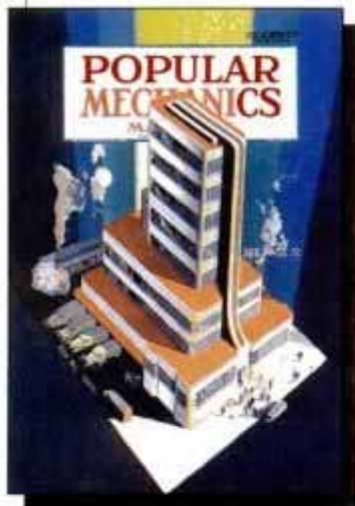


### Electric Eels

Long Island's Peconic Bay offered a sheltered proving ground for the Navy's first class of submarines, derived from the original *Holland*. The cigarlike

*Adder* cruised underwater for 3 hours at a 7-knot clip, while the *Moccasin* ventured out later for a 1-hour swim. Both subs fired torpedoes during trials. Neither hit its target.

## 60 YEARS AGO: JULY 1933



### Form And Function

The precepts of modern architecture were elbowing their way into industrial building design. For example, a new factory in Detroit—far from the sprawling structures of old—drew inspiration from streamlined skyscrapers. Broad windows provided maximum solar illumination, while upper-floor setbacks let in more air and light. The fluid silhouette mirrored the automotive-design thinking of the day.

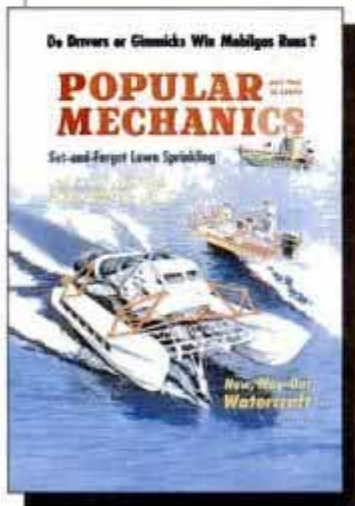


### Horsepower

"Dismount!" barked the commanding officer, and the First U.S. Cavalry walked away from their steeds for the last time. The newly mechanized

regiment traveled cross-country in armored cars, light tanks and trucks for machine guns and riflemen. Artillery was likewise motorized, now rumbling seven times faster than horse-drawn batteries.

## 30 YEARS AGO: JULY 1963



### Water Bugs

As the '60s got rolling, the get-wet crowd had a cornucopia of crazy craft to pick from. Catamarans and hydrofoils captivated naval architects, as the endless interest in Boeing's jetfoil prototypes bore witness. Meanwhile, civilians were scooting about on open-deck boats with unusual pontoon or tapered-keel hulls. One manufacturer even offered a flip-top cruiser, with a cabin that opened up like a huge mouth.

### Euro Chevy

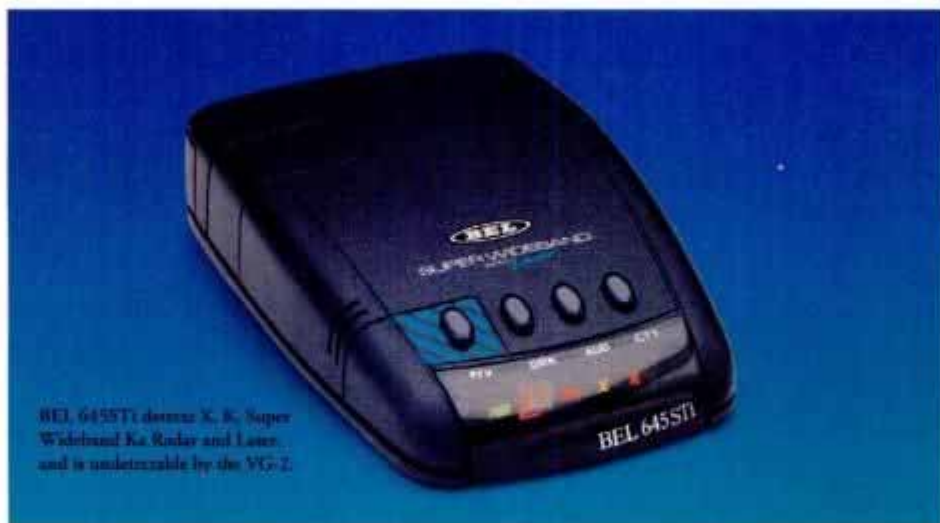
The sensible little Opel Kadette was about to make its American debut. An unobtrusive bantamweight, built by GM's West German subsidiary, the Ka-

dette weighed only 1477 pounds. This lightness brought fine fuel economy and nifty acceleration, but also left winter drivers pushing their Kadettes out of snowy driveways. **PM**





# The Only One of its Kind.



## Introducing BEL 645STi Undetectable Radar/Laser technology in one detector.

*BEL-TRONICS is once again proven the technology leader by producing the only Super Wideband Ka Radar and Laser detector that is also undetectable. BEL 645STi combines three technologies in one detector.*

### Undetectable

The press has called BEL "an engineering powerhouse," a powerhouse that offers Shadow Technology™—proven undetectable to VG-2.

### Super Wideband Ka

Don't be misled by other manufacturers' Wideband Ka radar/laser detectors. They don't detect Super Wideband Ka. BEL 645STi detects the entire 33.4 to 36.0 GHz allotted for police monitoring—including the new MPH BEE 36A radar gun currently in use throughout the U.S.

### Integrated Laser

The same laser technology rated "number-one" by *Car and Driver* magazine is incorporated into BEL 645STi. This technology offers the best in off-axis detection—the most common form of police monitoring and a laser detector's biggest challenge!

### Complete protection for the professional driver

BEL 645STi is available today for \$399.95. To order or for more information on BEL's other undetectable models, or for a dealer near you, call us today:

1-800-341-1401 USA 1-800-268-3994 Canada



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Leadership through Innovation and Technology

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DS645STi

BEL-TRONICS  
LIMITED  
1967-1992



25 Years of  
Electronics  
Excellence





# A Ceiling Fan You

Hunter is the original ceiling fan and the best. Other fans may look like a Hunter, but *none* are built with the precision and care that goes into every Hunter fan. Is it any wonder there are more Hunter fans in circulation than any other fan?

## Why Hunter fans are so quiet.

*In independent testing, our fans were proven to be 81% quieter than the five largest competitors.*



Every Hunter fan is built with a powerful, smooth-running motor engineered specifically for use in our ceiling fans. With precision ball bearings and special noise-reducing components between metal parts.

## Why Hunter fans won't wobble.

*Blade brackets are precisely measured to the perfect pitch.*



*Blade materials are properly sealed to keep out moisture and prevent warping.*

Because we use the finest blade materials available. Because we manufacture our rotors

to stay in balance. And because all blade sets are precisely weighed and measured for the same degree of pitch and balance.

## Why Hunter is the style leader.

Above is just a sampling. With over 278 styles to choose from, you may soon find yourself wanting a Hunter fan for every room in your home.

## Why Hunter fans move more air.



Hunter.

Others.

The greater the angle of the blade, the greater the air movement. And because we don't compromise on the motor or materials, we're able to set our blades at a more severe pitch for greater air movement. And greater comfort.

## Why the Hunter warranty is the best in the business.

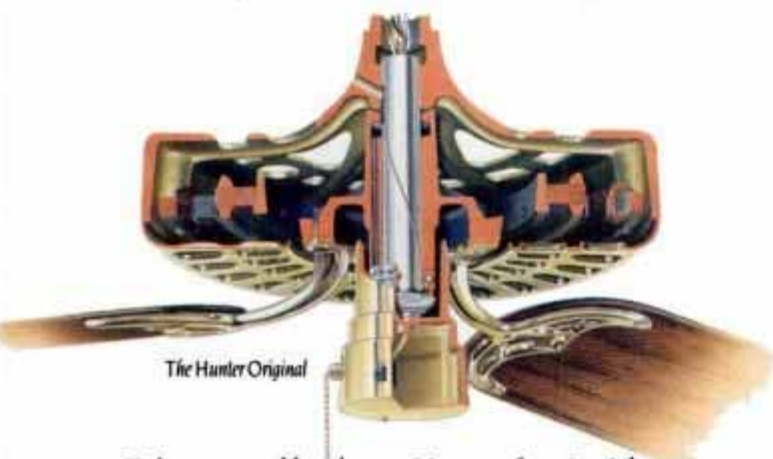
We back our fans with 20, 25 year and lifetime warranties. But just as important, your Hunter fan is backed by our company. A company that's spent over 100 years building a reputation for building the world's best fan.





# Can Look Up To.

## Why Hunter fans last longer.



Take a good look at a Hunter fan. Inside you'll find a powerful, rigorously tested motor with high quality shielded bearings that keep out dust and dirt. And outside, a finish second to none. Plus, of course, some of the smartest engineering in the industry.

## Was there actually a man named Hunter?

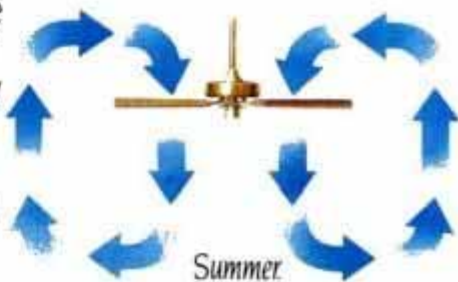
Yes. Two of them, in fact. Over 100 years ago, John Hunter and his son,



James, by making use of a new fangled technology called electricity, unveiled the world's first electrically powered ceiling fan. And from that point forward, made sure that the name Hunter stood for quality and craftsmanship.

## Why Hunter fans save you money all year long.

Because we move more air more efficiently than the competition, a Hunter fan can save you up to 40%\*\* on your air conditioning bills. In the winter, simply reverse the blade direction, and you'll enjoy even, comfortable heat.



While at the same time saving close to 10% of your heating costs.



For a free brochure, write to us at Dept. PM, 2500 Frisco Avenue, Memphis, Tennessee 38114. Or just give us a call today at (901) 745-9402.

\*\*Your savings may vary based on climate, building type and thermostat setting. \*On average at low speed settings.



The Quiet Fan



We have seen  
the future and are  
prepared to meet it,  
side on.

The 1993 Buick Roadmaster Sedan meets the 1997 federal side-impact standard — four years in advance.

By 1997, all automobiles will be required to meet a new federal safety standard for side-impact collisions. But you don't have to wait four years to have the assurance of a safer automobile. You can have it now.

### Safety

The 1993 Buick Roadmaster Sedan meets the 1997 federal

safety standard today, four years in advance. With a standard driver air bag, anti-lock brakes and a full-perimeter frame, the Roadmaster Sedan is a very safe car to drive.

### Luxury

Safety isn't the only impressive feature on this luxury automobile. With its patented DynaRide® suspension system, the Roadmaster Sedan can handle

the road with comfort, style and elegance.

### Commitment

Buick is committed to producing a safer luxury automobile. So to see what the future has to offer, take a test drive at your local Buick dealer today.



*Freeze frame of actual side-impact safety test*

Or call 1-800-4A-Buick for more details and information. The future is only a test drive away.




**BUICK**

The New Symbol For Quality  
In America.



*1993 Roadmaster Limited Sedan*

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Buckle up, America!



# TECH UPDATE

News Of Tomorrow's Technology Today



## Blastoff From The Middle Of Nowhere

CHANDLER, AZ—Nothing gives America's military an advantage quite like its reconnaissance satellites—particularly those that can pop up into orbit on a moment's notice. That's why the Air Force is anxious to preserve this capability even if a future adversary sabotages our launch sites in Florida and California.

A new launch vehicle, developed for the Advanced Research Projects Agency (ARPA), should put the Pentagon at ease. Called *Taurus*, the rocket is designed to blast off from anywhere, carrying a 1-ton payload.

Built by Orbital Sciences Corp., *Taurus* is the lower stage of an MX ballistic mis-

sile topped with a wingless version of the *Pegasus* air-launched rocket.

If a crisis flares, the *Taurus* team will congregate at the chosen spot, where a concrete slab has been laid. Once all the components arrive at the scene, engineers will work under a 5-day deadline to assemble the launch vehicle.

Forty-eight hours before launch, cranes will hoist the upper stage to mate with the booster. Then workers will whisk away the scaffolding and tower, and after a brief countdown *Taurus* will charge into space.

Editor: Abe Dane  
Writer: Greg Pope  
Reporters: Philip Chieri, Mike Fillan,  
Bob Scheier

The first *Taurus*—its mission classified—will go up this year from Vandenberg Air Force Base.

Twenty vehicles and a small crew can turn a remote, unprepared concrete slab into a launch site for *Taurus*.

## Highlights This Month

- **Ramming Speed**—Army's ramaccelerator previews hypervelocity guns.
- **World's Smartest Egg**—Disguised sensor checks on nests of endangered birds.
- **The Wheel Reinvented**—Spokes double as shock absorbers.
- **Tomorrow's Climate Today**—Huge weather station seeks global-warming clues.
- **Soil Boiler**—Electrodes vaporize buried hazardous waste.
- **Inspector Insects**—Walking machines will check jets for cracks.



## Army's Mach-8 Supergun



U.S. ARMY PHOTO: PAH ILLUSTRATION BY JEFF MANGRAV

ABERDEEN, MD—Old 120mm tank guns are gaining new life in the world's biggest ramaccelerator.

Built by the Weapons Technology Directorate of the U.S. Army Research

Laboratory, the machine will ultimately boost 15-pound objects to speeds greater than Mach 8.

A ramaccelerator (see [Tech Update, page 17, Nov. '91](#)) is a tube, filled with gaseous fuel and oxygen, into which a projectile is shot. As the gases ignite behind the moving projectile, combustion pressure accelerates the object through the tube.

The Army's project, called HIRAM (Hybrid Inbore Ramaccelerator), places a conventional tank gun at one end to launch the projectile at Mach 3.2. Currently the accelerator tube consists of two joined gun barrels, but engineers plan to tack on three more, stretching the



Aluminum projectile blasts out of ramaccelerator, borne of re-machined M256 tank guns.

device to 77 ft. in length.

At more than three times the bore of the original ramaccelerator at the University of Washington, HIRAM proves that the concept can

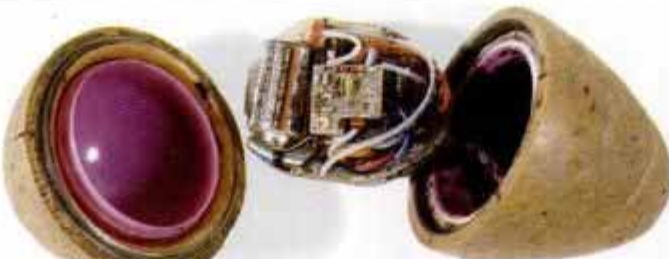
work scaled up.

The ramaccelerator will give the Army a means to test full-scale penetrators against future armor at hypersonic velocities.

## Smart Egg Joins Nest

BRONX, NY—Ornithologists recently laid a faux egg, stuffed with sensors and radio equipment, in the nest of an unsuspecting pair of rare white-naped cranes.

The idea was hatched at the International Wildlife Conservation Park, the former Bronx Zoo. Biologists there needed data on the nest conditions that prevail



Biotelemetric egg conceals sensors and radio transmitter.

as the cranes brood their eggs. This information—temperature, humidity and how often the birds turned

their eggs—is fed into artificial incubators, which helps boost the populations of rare birds.

Inside the egg, a miniature radio transmitter sent data pulses to an external receiver. A computer overlaid the data onto video footage of the cranes recorded simultaneously, so ornithologists could link the birds' behavior with the nest data.

The project revealed enough about the microclimate of a bird's nest that the researchers now want to duplicate the technology in a smaller egg case.

## New Look For Arches

FRANKLIN, TN—A unique arch bridge, taking shape near Nashville, crosses this ancient structural form with modern engineering.

Built on Natchez Trace Parkway, a historic National Park Service road, the 155-

ft.-high bridge spans a scenic valley and a state highway. Officials wanted to minimize its visual impact by omitting spandrels, those evenly spaced columns that transfer the roadway's weight to its supporting arch.



FISG ENGINEERING PHOTO



Cables hold segments of Natchez Trace Arches in place until each complete arch is created.

To compensate—that is, to spread the load away from the crown of each arch—Figg Engineering flattened the Natchez Trace Arches' curvature into a non-parabolic arch.

Construction crews are also using an unprecedented technique

to build the arches. Instead of casting the concrete in place supported by wooden falsework, workers are assembling each arch from precast segments. Temporary cables strung from a pier hold each block in place until the arch is closed.

The bridge is due to open at the end of this year.



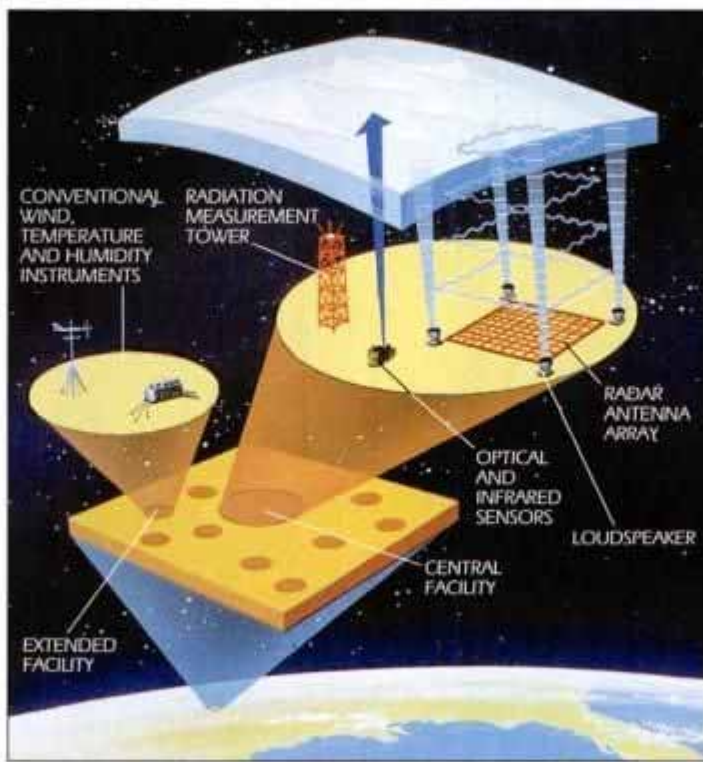
## Climate Central

GRANT COUNTY, OK—Amid wheat fields and cattle pastures, the world's biggest climate-monitoring effort is underway.

Called the Cloud And Radiation Testbed (CART), the new facility sprawls across 50,000 sq. miles. That's the acreage of a single "cell"—the area unit used in super-computer programs that predict global climate change.

These programs treat clouds simplistically. But whether clouds enhance or suppress global warming is a major wild card in climate prediction. Data from CART should provide more realistic computer modeling.

To bring in this data, CART is aiming an arsenal of instruments at the sky.



Lasers and infrared interferometers are measuring the amount of heat radiated from sky to ground. Meanwhile, wide-angle cameras are snapping cloud images.

In addition, a radio-acoustic sounding system is profiling air temperature at different altitudes. Loudspeakers blare soundwaves into the atmosphere. At the same time, a radar array determines the speed of these waves by bouncing signals off of air compressed by the sound. How fast the soundwaves are traveling provides a fix on the temperature of the air that carries them.

Four similar facilities will join CART in a 10-year Department of Energy research project.

**Mainstream weather instruments join sophisticated atmosphere profilers in vast weather station.**

## Re-Inventing The Wheel

HUNTSVILLE, AL—NASA's Marshall Space Flight Center has designed a wheel with built-in shock absorbers.

Working with Eagle Sportchairs for the National Easter Seal Society, Marshall engineers hope to give wheelchair users the ride of big soft pneumatic tires, without retrofitting a suspension system between the chair and the wheels.

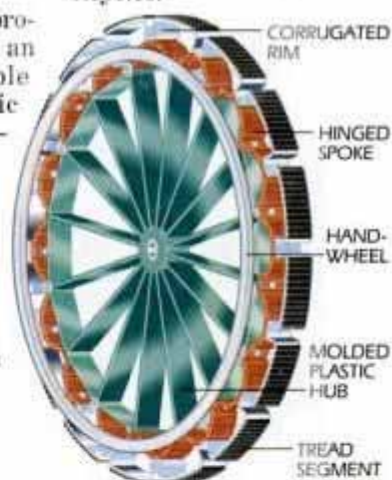
Instead of an inflated tire, a corrugated rim, broken into tread-lined segments,

girdles the wheel. What provides the suspension is an arrangement of flexible spokes—bars of plastic hinged by Kevlar fabric—that connect the rim with the inner hub. As the spokes pass over rough ground, they bend to flatten the rim, isolating the hub from the shock.

At 1½ in. wide, the wheel is narrow enough

**Flex-rim wheel is broken into segments, which push inward individually when traversing bumps.**

to be adapted for all-terrain bicycles.



**Boris the spider, choreographed by a microprocessor, walks with muscle wires.**

## Walk On The Wire

SAN ANSELMO, CA—Wires made of a shape-memory alloy are providing the muscles for the legs of a miniature, motorless walking robot named Boris.

The wire, a nickel-titanium alloy called nitinol, shortens when heated with a small current. When the current stops, the wire cools and returns to its original length.

Actuators made of this wire work silently and provide long life and a high strength-to-weight ratio compared to motors or solenoids, says Mondo-Tronics Inc., which markets Boris kits.



## Heads-Up Surgery

COLUMBUS, OH—The technique that keeps fighter pilots on top of their work—the helmet-mounted display—is now coming to the operating room. Surgeons who perform endoscopic procedures will be able to watch their actions with this device, developed by Battelle Labs.

During endoscopic surgery, doctors operate through tiny incisions. The surgeon

**Endoscopic surgeon can keep eyes and hands aligned with helmet-mounted video display.**

monitors his or her work inside the patient with a miniature camera at the tip of a fiberoptic tube. But, until now, the surgeon has had to turn away to check the television.

The Battelle device—a flat-screen panel mounted on a lightweight helmet—will change all that. The miniature color monitor is sharp enough to reveal subtle differences in body tissue.

The prototype device has been field-tested at a U.S. Health Corp. hospital.



## Steam-Cleaning The Ground

RICHLAND, WA—Electrodes could boil away toxic waste lodged in the earth in a scheme developed by the Pacific Northwest Laboratory.

The treatment process is known as Electrical Remediation At Contaminated Environs, or ERACE. The scenario calls for a hexagonal array of six metal pipes, driven into the ground to the depth of the contamination. A 6-phase alternating current would flow among these electrodes, heating the earth and boiling its moisture.

The resulting steam would strip away some hazardous chemicals from the soil, while the heat itself would destroy others. A seventh pipe would suck the

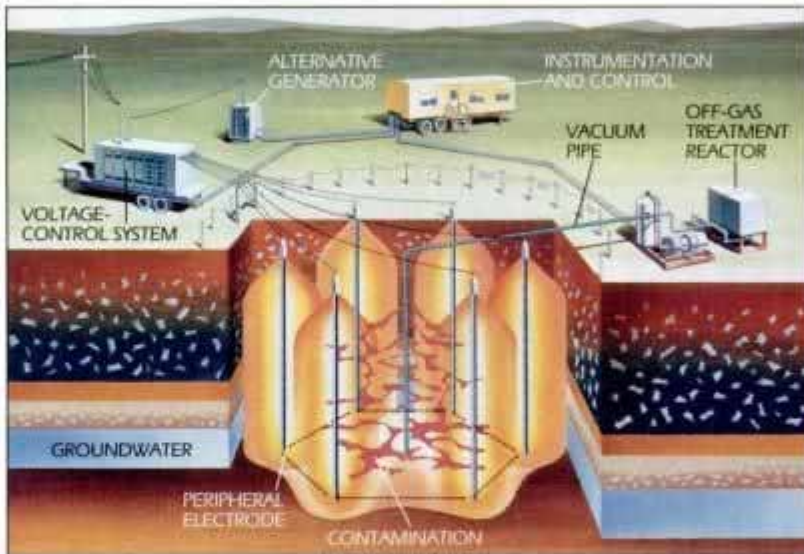


PHOTO ILLUSTRATION BY ADOLPH E. BROTHMAN; BATELLE PHOTO

contaminated vapor out of the soil and into a plasma reactor, where the toxic compounds would decompose.

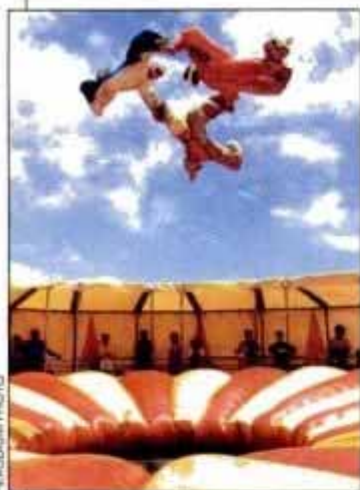
Lab tests suggest that ERACE could clear out tox-

ins like dry-cleaning fluids, PCBs, carbon tetrachloride, gasoline and jet fuels.

PNL plans to test the scheme at the Department of Energy's Hanford and

**Electrodes vaporize toxins. Plasma reactor (right) breaks down contaminants.**

Savannah River sites, both tainted with solvents from nuclear-weapon production.



AERODIUM PHOTO

Frozen in freefall, aerobats frolic on column of air from DC-3 propeller spun by 700-hp diesel.

## Human Fly Machine

MCAFEE, NJ—Cross a DC-3 propeller with a trampoline and you've got the Aerodium, an open-air wind tunnel for thrillseekers.

Body pilots don flappy jumpsuits and maneuver themselves into an X position. Arms and legs provide control. A safety cushion surrounds the air column.

A permanent Aerodium is part of Action Park in Vernon, New Jersey, but a cross-country tour is in the planning.

## Super Black Stuff

OAK RIDGE, TN—It started out as thermal insulation that swaddled the plutonium in a space probe's radioisotopic thermoelectrical generator. But now the same carbon-carbon material is proving that it soaks up light as well as it soaks up heat.

Oak Ridge National Laboratories developed the stuff. While it's not quite as light-thirsty as metal an-

odized with the Martin Black process (used for the barrels of military telescopes), the Oak Ridge ma-



OAK RIDGE PHOTO

terial is a lot tougher. It's 3-dimensional in structure and can be cut with a knife or machined. And beyond visible light, the material can also capture long-wave infrared radiation.

Edmund Scientific plans to distribute the material for civilian use in cameras, telescopes and lab instruments.

**Broad-band optical absorber may improve performance of guided weapons as well as backyard telescopes.**

## Solar-Powered Space Tugs

HUNTINGTON BEACH, CA—Tipped with solar-powered upper stages, rockets could loft payloads twice as heavy as those they currently hoist to geo-

synchronous orbit. McDonnell Douglas is investigating the concept for the Air Force.

Engineers believe that hydrogen-burning electric

arcjets, powered by solar panels, would provide the most efficient lifting power. The technology would make possible a Solar-Electric Orbital Transfer Vehicle (SEOTV), either expendable, reusable or integrated with the payload.

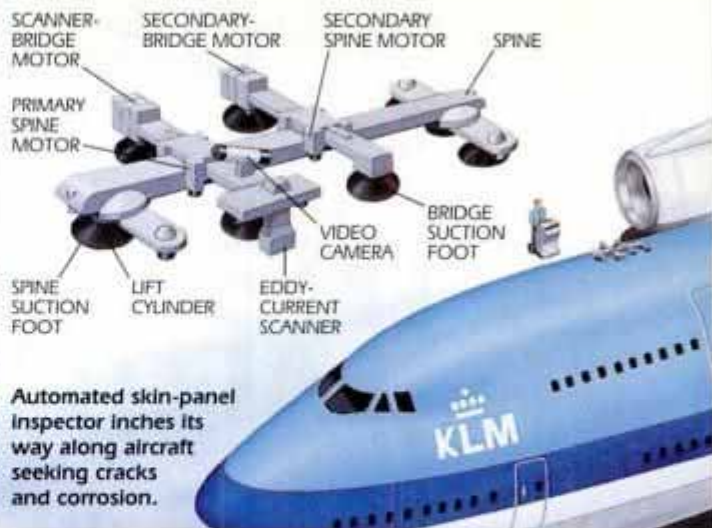
On a Delta, an SEOTV would replace the upper stage and apogee kick motor, giving the booster the strength of an Atlas. And on an Atlas 2AS, the SEOTV vehicle would ride above the Centaur stage and allow the rocket to lift the load of a Titan.

**Solar panels generate electricity to feed hot-burning arcjet in upper-stage motor.**



MCDONNELL DOUGLAS PHOTO





Automated skin-panel inspector inches its way along aircraft seeking cracks and corrosion.

## Inspector Robot

PITTSBURGH, PA—Like huge walking-stick insects, mobile robots may one day scuttle over aging airliners looking for structural flaws.

A prototype for such a machine is now taking its first steps at Carnegie Mellon University, funded partly by the Federal Aviation

Administration. It's called ANDI, for Automated Non-Destructive Inspector.

ANDI will cling to aircraft skin with seven suction-cup feet—three mounted on a beam called the spine, and two each on a pair of crossbeams called bridges. The robot will walk by alter-

nately lifting bridge and spine feet while two linear motors shift the bridges along the spine. A second pair of motors at the end of each bridge can drive the bridges perpendicular to the spine. A video camera helps ANDI navigate.

During a scan, the scan-

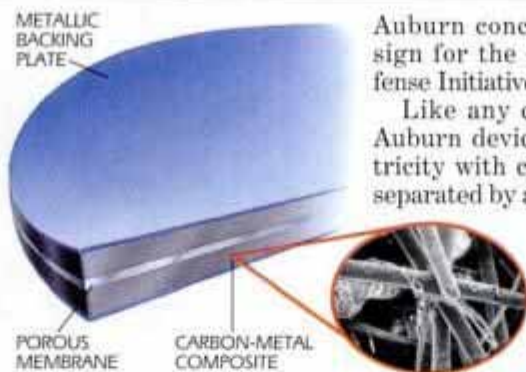
ner bridge moves along rows of rivets between skin panels. An eddy-current scanner—a coil that sends a current into the skin metal—looks for electromagnetic anomalies that signify flaws.

Commercial offshoots of ANDI should be available within three to five years.

## Capacious Capacitors

AUBURN, AL—Supercapacitors may give electric vehicles the pickup they need to compete with conventional cars.

Auburn University and San Diego-based Maxwell Laboratories are developing the devices under Department of Energy funding.



Auburn conceived the design for the Strategic Defense Initiative Organization.

Like any capacitor, the Auburn device stores electricity with charged plates separated by an insulator. In

**Supercapacitor stores 10 times the electrical energy of today's best capacitors.**

this case, the "plates" consist of an electrolyte-soaked carbon-nickel composite riddled with minute pores.

The porous material maximizes the surface area of the charged plates while minimizing the distance that separates them—key criteria for a strong capacitor.

Auburn envisions layers of supercapacitors stacked like fuel-cell elements,

## Coldest Day In Space

GREENBELT, MD—Colder than deep space itself, liquid helium chills orbiting astronomical sensors. But the liquid doesn't last long, because it boils away as it soaks up heat. Now NASA is probing how to refill liquid-helium containers in orbit, to stretch the lifespans of space probes.

The problem: Liquid helium is extremely messy. Below 2.2° above absolute zero, helium becomes a superfluid, flowing without viscosity, and literally crawls up the dewar walls.

**Thermos-like dewar's plumbing separates liquid and gaseous helium for on-orbit transfer.**

Nevertheless, an experiment called SHOOT (Superfluid Helium On-Orbit Transfer) was scheduled for a

Shuttle flight in June, with astronauts pumping liquid helium between two dewars.

Complex plumbing frees gaseous helium while liquid helium is pulled off one de-

war's walls. The dewars are so well insulated that they could keep coffee hot for decades. SHOOT should hit the lowest temperatures ever achieved in space. **TU**







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PRESENT

# THE NATIONAL AUTO QUIZ

1. This factory concept car, currently featured in major car shows is the:



A) Dodge Viper GTS. B) Chrysler Thunderbolt. C) Toyota AXV-III. D) Hyundai HCD-II.

2. What does the "W" stand for in 10W-30 motor oil?

A) Weight. B) Wear factor. C) All-Weather. D) Winter.

3. Blue smoke coming from your tailpipe is a sign of:

A) Worn rings and/or worn valve guides. B) Blown head gasket. C) Normal water vapor in the exhaust system. D) High oil pressure.

4. Which of these marques offered a 4-door convertible sedan in the 1960s:

A) Cadillac. B) Lincoln. C) Imperial. D) Packard.

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224 W. 57th St.  
New York, NY 10019

5. Which marque is generally regarded as having the most aerodynamic car in the 1950s?

A) Chrysler. B) Hudson. C) Studebaker. D) Mercury.

6. What is another name for the diesel engine?

A) Otto cycle. B) Wankel. C) Compression-ignition. D) Direct-coil.

7. As of the close of the 1992 Indy 500, which driver had chalked up the most wins in this annual race?

A) Al Unser. B) Rick Mears. C) A.J. Foyt. D) All three are tied.

8. Which car was the largest seller in the U.S. in 1992?

A) Ford Taurus. B) Honda Accord. C) Chevrolet Lumina. D) Toyota Camry.

9. Which is true about normally aspirated engine power output?

A) Engine power remains the same as altitude increases. B) Engine power increases about 3% per 1000 feet of altitude. C) Engine power decreases 3% per 1000 feet of altitude. D) Engine power decreases about 10% per 1000 feet of altitude.

10. On a tire sidewall that reads 195-70R14, what does the "70" refer to?

A) Maximum sustained speed rating. B) Aspect ratio (tire height in relation to width). C) Maximum pressure (psi). D) Maximum load capacity (x 100 Kg).

ANSWERS  
1. B 2. D 3. A 4. B 5. C 6. C 7. D (each having four wins)  
8. A 9. C 10. B



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- Protects engine parts at ignition
- Hangs tough in extreme driving conditions
- Flows in severe cold
- Keeps its cool in extreme heat
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Star Molecules



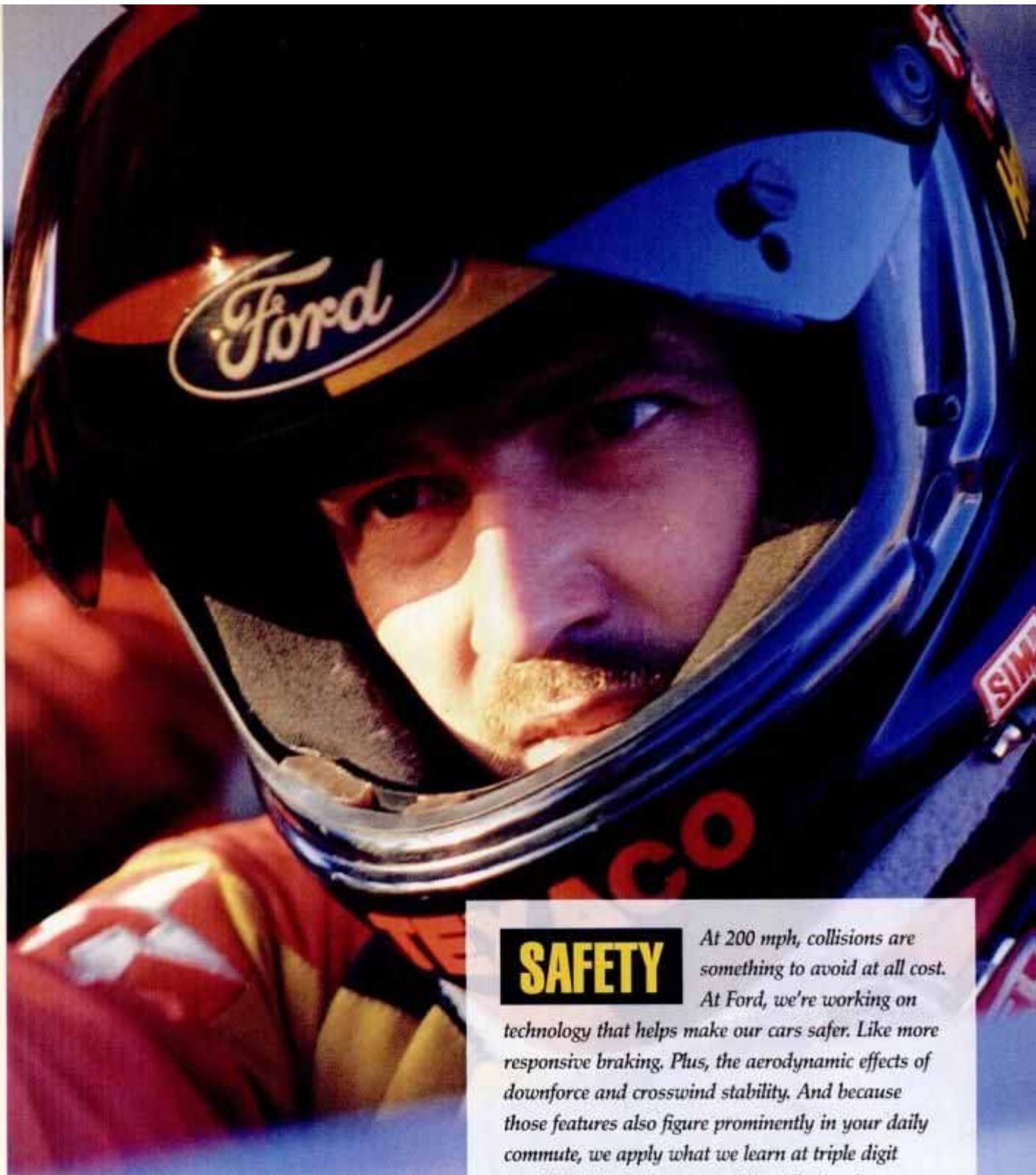
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A FORD LATELY?**

# **Why We Race**



# JEEP GRAND CHEROKEE

Another home run for the home team.



● It's no exaggeration to say that Jeep wrote the manual on sport/utility vehicles. The 1993 Grand Cherokee traces its roots all the way back to the Willys quarter-ton 4x4 that served America so well during World War II. Following up on its popular civilian version of the original Jeep, Kaiser-Willys introduced the 4-door Jeep Wagoneer in October of 1962, a date that marks the beginning of the modern sport/utility era. The Grand Cherokee, launched in 1992 as a '93 model, is the latest chapter in this remarkable success story.

According to the owners we polled, the new Grand

BY MICHAEL LAMM,  
Contributing Editor  
PM Photos by Mike Gaspar

Cherokee manages to provide a considerably smoother, more carlike feel and ride than any of its predecessors. It does this partly by using unitized body construction, instead of the traditional ladder frame.

This approach has obviously paid off, since ride and comfort were two of the things our owners liked best about their Grand Cherokees.

Structural rigidity also enhances handling during strenuous on- and off-road maneuvers. The Grand Cherokee unibody, although 8 in. longer than the standard Cherokee's, is 25% stiffer.



# JEEP GRAND CHEROKEE



Grand Cherokee is first airbag-equipped SUV.

Front-seat comfort got high ratings.

With V8, tow rating climbs to 6500 lb.

The Grand Cherokee is the first SUV among its 4-door competitors to offer a driver's airbag, three different types of 4-wheel drive and a V8 engine option. Compact SUV engine options from Ford, GM and other

manufacturers top out with V6s. Because the V8 came after the initial introduction of the new Grand Cherokee, 93.9% of our respondents own vehicles with the standard 4.0-liter inline Six. The Six delivers 190

hp, 225 ft.-lb. of torque and was broadly praised for its performance. There can be no doubt why owners bought the Grand Cherokee. Our data shows that styling motivated nearly 52% of all purchase decisions.

## SUMMARY OF JEEP GRAND CHEROKEE OWNERS REPORTS\*

<b>Total miles driven</b>	1,878,508	<b>5-speed manual</b>	0.4	<b>Comfort</b>	38.6	<b>Mechanical trouble?</b>	
<b>Average miles driven</b>	6906	<b>Engine power:</b>		<b>Ride quality</b>	37.1	No	52.0%
<b>Purchase price:</b>		Excellent	54.7%	<b>Handling</b>	35.1	Yes	48.0
Average	\$24,544	Good	41.7	<b>Engine power</b>	19.7	<b>What type of trouble?</b>	
Range	\$20,000-\$30,000	Average	3.6	<b>Braking</b>	15.8	Liftgate latch	28.4%
<b>Why did you choose the Jeep Grand Cherokee?</b>		Poor	0.0	<b>Safety features</b>	13.9	Electrical	11.9
Styling	51.9%	<b>Handling:</b>		<b>Specific dislikes:</b>		Cruise control	8.2
4-wheel drive	22.3	Excellent	65.7%	<b>Mpg less than expected</b>	18.3%	Speedometer	7.5
Previous Jeep ownership	21.2	Good	32.5	<b>Engine and wind noise</b>	17.4	<b>Repair it yourself?</b>	
Ride quality	17.3	Average	1.8	<b>Spare tire location</b>	13.8	No	96.9%
Handling	12.3	Poor	0.0	<b>Not enough storage space</b>	9.4	Yes	3.1
Price/value	10.7	<b>Braking:</b>		<b>No complaints</b>	8.9	<b>Dealer repairs satisfactory?</b>	
Comfort	11.9	Excellent	71.8%	<b>Price too high</b>	7.1	Yes	67.9%
<b>Model choices:</b>		Good	24.5	<b>Engine power (4-cylinder)</b>	4.4	No	32.1
Grand Cherokee Laredo	70.8%	Average	2.9	<b>Suggested changes:</b>		<b>Dealer service opinion:</b>	
Grand Cherokee Limited	26.4	Poor	0.7	<b>Relocate spare</b>	14.2%	Excellent	43.7%
Base Grand Cherokee	1.8	<b>Overall performance:</b>		<b>Eliminate engine and</b>		Good	35.6
Grand Cherokee Wagoneer	1.1	Excellent	62.7%	<b>wind noise</b>	12.3	Average	15.8
<b>Options/Accessories:</b>		Good	36.2	<b>Add passenger airbag</b>	9.8	Poor	5.0
Air conditioning	100%	Average	1.1	<b>No changes</b>	8.8	<b>Number of vehicles owned:</b>	
Quadra-Trac 4wd	50.9	Poor	0.0	<b>Better mpg</b>	8.8	This vehicle only	16.8%
Trailer-towing package	39.8	<b>Control layout:</b>		<b>More and bigger storage spaces</b>	5.9	Two vehicles	42.7
Selec-Trac 4wd	28.9	Excellent	57.0%	<b>Sunroof option**</b>	5.4	Three vehicles	26.2
Command-Trac 4wd	27.7	Good	38.7	<b>Workmanship opinion:</b>		Four or more	13.4
Up-country off-road suspension	29.4	Average	3.9	Excellent	61.2%	<b>Principal driver:</b>	
Trac-Lok locking rear differential	29.4	Poor	0.4	Good	34.4	Male	56.1%
2-wheel drive	4.3	<b>Instrumentation:</b>		Average	3.6	Female	39.5
<b>Avg. mpg, city/hwy:</b>		Excellent	61.6%	Poor	0.7	Equal	4.4
4.0-liter Six	16.2/20.3	Good	35.5	<b>Comfort opinion, front seats:</b>		<b>Age distribution of owners:</b>	
5.2-liter V8	14.6/17.9	Average	2.5	Excellent	67.3%	Under 29	11.9%
<b>Engine choices:</b>		Poor	0.4	Good	30.2	30-49	57.9
4.0-liter Six	93.9%	<b>Driver sightlines:</b>		Average	2.5	50-plus	30.1
5.2-liter V8	6.1	Excellent	59.5%	Poor	0.0	<b>Based on your experiences, would you buy a Grand Cherokee if you had it to do over again?</b>	
<b>Transmission choices:</b>		Good	35.5	<b>Comfort opinion, rear seats:</b>		Yes	81.1%
4-speed automatic	99.6%	Average	4.7	Excellent	40.4%	Maybe	16.4
		Poor	0.4	Good	53.3	No	2.5
		<b>Specific likes:</b>		Average	5.6		
		Styling	54.4%	Poor	0.7		

\* Percentages might not equal 100% due to rounding up or insufficient data. \*\* Sunroof option became available in January 1993.



Like its competitors, the Grand Cherokee is a versatile 4x4 that offers the creature comforts of a sedan, plus a certain measure of suburban respectability.

These are not, however, inexpensive vehicles, and in theory there should be more room for customers to dicker. But demand has been so great that dealers don't seem to be making many price concessions. The average price paid by our owners—more than \$24,500—bears this out.

Most of our owners bought their vehicles loaded. All of them, in fact, ordered a/c and 4wd, even though a 2wd version is available. Only 0.4% chose a manual transmission.

Owners reported fuel mileage ranging from 14.6 mpg in the city to 20.3 on the highway. Owners of V8-equipped Grand Cherokees reported 1.5 to 2.0 mpg less than the Six, and 18.3% of our respondents griped that their fuel economy was less than expected, regardless of which engine they ordered. However, EPA estimates put the Six at 16/20 mpg city/highway and the V8 at 14/18, so in the real world our sample showed mileage figures pretty close to the EPA projections.

Nearly a third of our owners—those with early-production Grand Cherokees—reported problems with the liftgate latch and seal, a problem Chrysler has addressed with a recall, and dealers are replacing the seals and latches. Jeep has since changed the durometer of the rubber seal, which solved the problem.

Nearly half of the owners in our survey reported mechanical troubles of one sort or another, including the hatchback latch. By way of contrast, only 18% of the Explorer owners we surveyed (January, 1992) cited mechanical problems.

Dealer service shops didn't measure up particularly well, either. More than 32% of our respondents expressed dissatisfaction with dealer repairs, meaning they didn't get it fixed right on the first try.

There weren't many complaints otherwise. The spare tire takes up too much space, said some, but an aftermarket mount can ease that pain. Other owners noted that the glovebox and binnacles ought to be bigger. And a few thought the 6-cylinder engine could be a little quieter.

The Grand Cherokee's safety features received a solid round of owner applause, and the vast majority seemed highly pleased. Many owners, in fact, called it the best vehicle they ever owned, and 81.1% told us they'd make the same purchase if they had it to do all over again. **PM**



Although owners praised the Grand Cherokee's ride quality, agile handling, antilock brakes and 4-wheel-drive systems, its styling tipped the balance on over 50% of purchase decisions.

#### EDITORS REPORT

### Stylish Versatility

● Like everything else connected with Chrysler Corp. these days, Jeep is a revitalized, leading-edge concern that seems incapable of turning out anything but winners. And the Grand Cherokee is the latest proof. Conceived to counter the Ford Explorer challenge, the Grand Cherokee has been a winner from day one, in spite of some small startup glitches like the rear-hatch latch problem that showed up in early models.

While the Explorer phenomenon continues unabated, the Grand Cherokee has claimed its own following, and we're not surprised. Beyond its distinctive styling—a surprisingly big factor in purchase decisions for a vehicle of this type—it's an exceptionally able all-around performer, on-road and off. Not all compact sport/utilities measure up to this standard.

We agree with owners who think the Grand Cherokee's basic 4.0-liter straight-Six is more than enough motor for most applications. It's got plenty of grunt and it's the smoothest sport/ute Six you can buy. But we also have to admit we've been seduced by the optional 5.2-liter V8, which gives the Grand Cherokee more versatility than its competitors, particularly in towing applications.

We also agree with owners who are delighted with this vehicle's excellent street manners. Anticipating that the Grand Cherokee, like all compact sport/utes, would spend most of its time performing conventional family wagon chores—on pavement—the chassis design team prioritized ride quality in its suspension tuning. As a result, the Grand Cherokee is considerably more supple than many of its competitors. It's also quieter than most.

Consistent with other recent Chrysler products, the Grand Cherokee's handling development began with an exceptionally stiff chassis. A stiff chassis means that suspension components don't have to spend as much time compensating for chassis flex, making it easier to strike the right balance between ride and handling. In terms of the latter, the Grand Cherokee manages to be more carlike than most. As with other sport/utes, the limiting factor is the extra ground clearance needed for off-road use, which makes hard cornering maneuvers a little more dramatic than in a contemporary family sedan.

Considering its civilized behavior around town, the Grand Cherokee's off-road capabilities are particularly impressive. Its compact shape and wide track help to make it a nimble rock-hopper, and the optional Quadra-Trac full-time 4-wheel-drive system is just about the best in the business, particularly in this price range.

There are really only two areas where the Grand Cherokee doesn't quite measure up to some of its competitors. The first is its spare tire location, which eats up a big percentage of its cargo bay. Jeep should at least offer the option of a rear-mounted spare.

The second criticism—relatively limited rear-seat legroom—isn't as easy to address, without a complete redesign. Some of the Grand Cherokee's competitors are roomier in this respect, simply because they're bigger. But this is not to say that the Grand Cherokee's rear seats are cramped. And if the designers traded a little space to help achieve distinctive styling and all-around agility, it seems clear they made the right choice. —Tony Swan





# AMERICA'S 'INVISIBLE' WARSHIP

After 10 years perfecting sea-going stealth,  
the U.S. Navy reveals the *Sea Shadow*.

BY ABE DANE, Science/Technology Editor; PM Illustration by Paul DiMare





In fleet air defense role, future *Sea Shadow* spinoffs could ambush attacking planes before they reach the main battle group.

● If on a certain night the moon were full off the California coast, and you could somehow infiltrate the encircling picket line of military vessels to get within a few hundred yards of the right spot, you might see with your naked eye what you could see no other way.

Disgorge from a hulking, barge-like mothership, a thin, prismatic shadow glides silently out onto the shining water like a splinter of obsidian. It is a ship of some kind, but there is something baffling about its shape. As it slowly turns to head for open water, its faceted surface presents the silhouette of a different object with every few degrees of rotation. One moment, it is a long, sloping trapezoid, then it foreshortens into a jumbled gemstone, then it resolves into a truncated letter A standing upright on the water. If you happened to have with you a battery of sonar, radar and infrared sensors, they would have told you that what you were seeing wasn't there at all.

### Out of the black

Until Friday, April 9, of this year, the U.S. Navy would have told you the same thing. The vessel is the *Sea Shadow*, America's only known attempt to disappear as effectively on water as the F-117 Stealth fighter can disappear in air. Construction took place in total secrecy nearly a decade ago at the Lockheed Missiles & Space Co.'s closely guarded Redwood City, California, facility. As one of the Defense Department's "black" programs, the whole \$200-million undertaking officially did not exist.

That changed this spring with a terse, page-long memorandum issued from the Pentagon. The need to conduct testing in daylight, it said, had forced disclosure of the program. Beyond that, the Navy kept a lid on the details. Except for a single "media availability" at 8 am on Easter morning, reporters' questions met with brief answers from a script that public affairs



## 'INVISIBLE' WARSHIP

officers were forbidden to stray from.

Among the sparse facts made available were these: length—160 ft., width—70 ft., draft—14 ft., displacement—560 tons. The ship's purpose, according to the memo, was "to explore the application of a variety of advanced technologies to surface ships. These technologies involve ship control, structures, automation, seakeeping and signature control." Signature control is another way of saying stealth.

One look at the ship confirms that escaping detection was the dominant design concern. It has been shaped according to the same principles that led to the F-117, another Lockheed product. "If you put wings on it and cut off the pontoons, you could probably fly it," joked Stan Zimmerman, a veteran Pentagon watcher and editor of the newsletter *Navy News & Undersea Technology*.

So why did the Navy decide to build a stealth ship? How did they do it? And what will they do with the capabilities thus gained?

### Exocet's impact

Part of the Navy's motivation can be read in the grisly headlines that have followed the sea skirmishes of the past decade. The radar-guided, sea-skimming missile, most notoriously the French Exocet, has shown itself to be a deadly equalizer, giving the small navies of the world a way to draw blood from much larger, better-equipped forces. Launched from a small patrol boat, helicopter or attack plane, these missiles close in on a target at near-supersonic speeds,



From above, hexagonal hatches are visible at each end of the *Sea Shadow's* weather deck, with what may be an air intake between. Front hatch aids docking operations, such as entering the *Hughes Mining Barge* (below).



while presenting a radar cross section the size of a sea bird. They fly so low that they're less than a minute from impact by the time they pop over the horizon and into view of even the most powerful radars. Under these circumstances, currently available countermeasures—chaff decoys, and defensive gun and missile systems—are far from foolproof.

Moreover, with a few hundred pounds of high explosive aboard, sea-skimming missiles pack a tremendous bang for their relatively few bucks. Although, as was the case with the U.S. frigate *Stark*, heroic damage-control measures may prevent a ship from actually sinking—that's about the best that can be hoped for. "If a ship gets hit by a cruise missile, I think it's fair to say that their fighting for the day is over," says U.S. Navy Capt. John McGillvray, who recently researched stealth ship technology at the Naval War College. He estimates that there are more than 15,000 sea-skimming missiles of one type or another in the hands of more than 50 navies around the world.

Little wonder, then, that there are times when a ship's commander would like nothing better than simply to disappear.





## Mystery barge

On Nov. 4, 1982, an astute reader of the San Francisco papers might have been puzzled by a brief item on the impending departure of a tremendous floating drydock from the Todd Shipyard there. Known as the Hughes Mining Barge, the 4700-ton vessel was originally built for a secret CIA project in the early '70s, and had been in mothballs for years. The CIA project, it has since come out, was an attempt to recover a Soviet nuclear sub that sank off the coast of Hawaii in 1968. This time, about all a Navy spokesman would say was, "I can assure you it is not going to be used to go after a submarine."

Inside the barge is a 180-ft.-long, 70-ft.-high enclosure covered by an arched roof, where work can be conducted out of sight. By flooding ballast tanks, operators can sink the interior floor beneath the level of the surrounding seawater and float vessels in and out. The barge left Todd in the summer of 1983 and arrived at Lockheed Missiles & Space in Redwood City shortly afterward. Hardly anyone knew why until this spring.

According to the sketchy history released by the Navy, construction of the *Sea Shadow* took place inside the barge, apparently between 1983 and '85. Night tests were conducted in 1985 and '86, with the barge keeping the ship under cover for repairs and replenishment during daylight. The tests were suspended in 1986 and not resumed until this spring, when the ship was unveiled.

## Shaping a shadow

Although few specifics have been given on the reasoning behind the *Sea Shadow*'s design, its stealthy shape and unusual twin-hull configuration give clues to the intentions and past experiences of those who built it.

Creating useful shapes with very small radar cross sections is still a black art, but such shapes do have recognizable trademarks. *Sea Shadow* appears to be a product of first-generation stealth technology, which would explain its resemblance to the F-117. The shapes of both bear the imprint of a computer program called ECHO I. Developed by Lock-

heed in the mid-1970s, this program was key to the company's success in winning the F-117 contract.

ECHO I was a breakthrough because it permitted designers to predict the radar cross section of a shape before building it. The program limited options, however, because it could only analyze shapes made up of a finite number of 2-dimensional panels. This accounts for the faceted appearance of early stealth designs.

Since then, more powerful computers and software have made it possible to create more complex stealth designs like the B-2 Stealth Bomber. But stealth ships have tended to stick with the older approach. According to naval architect Harold Armstrong of Dowty Signature Management, an

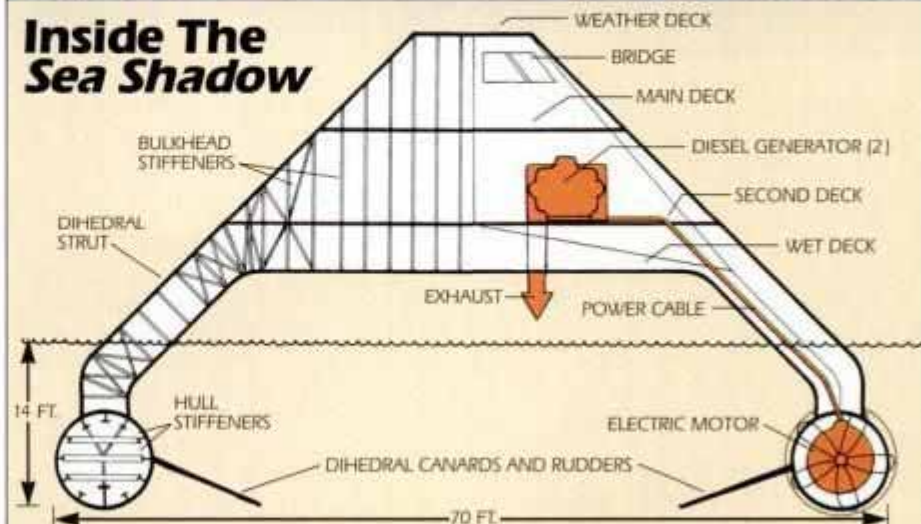
English maker of radar-absorbing materials, it's mostly a matter of cost. "Welding together flat plates is much easier than anything which is curved," he points out.

## Stealth on stilts

Of course, stealth at sea requires much more than just reducing a ship's radar cross section. Sonar and infrared sensors can be equally threatening. And even if the ship itself could be made completely undetectable, its wake might still give it away. Modern radars can spot the waves kicked up by small speed boats, and the Navy has long worried that Russia might be working on satellite-borne wake sensors that could watch vast expanses of ocean.



## Inside The Sea Shadow



Frontal photo shows engine exhaust between dihedral struts. McDermott's Joseph McMahon used his experience on the TAGOS-19 to come up with a speculative cross section (above), showing the complex bracing *Sea Shadow*'s shape would require.



## 'INVISIBLE' WARSHIP

The *Sea Shadow* addresses all of these concerns with a single neat design stroke. The two thin struts that support its main hull stand on a pair of submerged, torpedo-like pontoons in what's known as a small water-plane area twin hull (SWATH) configuration. SWATH designs have long been known for exceptional stability in heavy seas, but in the case of the *Sea Shadow*, there are important additional advantages.

First, with only the knife-like struts slicing the water's surface, the wake is reduced to almost nothing. Secondly, the noisier components of the propulsion system can be placed high above the water, where they're difficult to hear with passive sonar. The Navy says *Sea Shadow's* propulsion is diesel electric, so the probable layout is one electric motor in each pontoon, powered by one or more diesel generators up above. Photos show exhaust venting between the SWATH hull's struts, where the heat would be masked from infrared sensors.

SWATH also appears to help in evading radar because it provides a wide base of support, from which the ship's sides can slope inward. Nor-



The Navy says experience from the *Sea Shadow* was used in sculpting the *Arleigh Burke's* low observable shape (top) and in designing the TAGOS-19's SWATH hull (below).



mally, a ship's sides are nearly vertical, meeting the water at close to 90°. This produces a bright radar echo called a broadside flash, which is easy to home in on.

Unfortunately, all this capability has a price. A look at the Navy's TAGOS-19 SWATH surveillance ships, which are said to incorporate lessons from the *Sea Shadow*, illustrates the tradeoffs. Built to tow sub-hunting sonar arrays at high latitudes, where punishing seas damage equipment and wear out crews aboard conventional ships, the 3397-long-ton TAGOS-19s are the largest U.S.-made SWATH vessels. According to Joseph McMahon, a naval architect at McDermott International where the vessels are built, the SWATH

configuration is well suited to the TAGOS-19 mission, but suffers weight-carrying and calm-water speed limitations that would be a problem in other roles.

Looking at pictures of the *Sea Shadow*, McMahon commented particularly on the inward slant, or dihedral, of the hull struts. This would damp out heaving motions in heavy seas by creating vertical drag. It also requires a nightmarishly complex structure. "It's outstanding hydrodynamically. It's awful for the builder," says McMahon.

### What's it for?

So in the *Sea Shadow* the Navy has a ship that's stealthy, but difficult to build, capable of only 13 knots, and

unable to carry a heavy weapons load. It's fair to ask, then, What do they want with it?

At the very least, they want information. According to what's been released, *Sea Shadow* is strictly a one-off research tool. It's credited, for instance, with insights that helped reduce the radar cross section of the *Arleigh Burke*-class destroyers (see "Navy's Newest," page 32, Dec. '92). But, like several other new warship designs under construction around the world, the *Arleigh Burke* is better described as low observable than as completely stealthy. *Arleigh Burke's* builders made the ship hard enough to track that its other countermeasures are more effective, but couldn't make the performance compromises needed to make it disappear from radar.

That brings us to the question of whether there is a role for a ship that, like *Sea Shadow* or the F-117, puts stealth above almost everything else. Maybe there is. Although critics of the idea point out that with nuclear submarines the Navy can already operate undetected at sea, a stealth ship would have at least two key advantages. One, it could be used for air defense of convoys, which subs presently cannot. Two, it could operate in a number of areas—some of them strategically important—where the water is too shallow for subs to get close to shore.

The bottom line is that, given how little we knew of the *Sea Shadow* until the moment of its unveiling, there's no telling what other "invisible ships" the Navy may have lurking at sea.

PM



# THESPIAN GAMES

Real actors bring a new realism to videogames.

BY JAMES K. WILLCOX

● If leading-edge videogame developers have their way, "Lights, camera, action" will no longer be three words exclusive to the lexicon of Hollywood motion-picture studios.

Increasingly, high-tech game developers are utilizing television and film production techniques—as well as producers, directors and a live cast of actors—to make the next generation of games more realistic and exciting.

Until recently, videogames were created using either hand-drawn animation or simple computer-generated images, with displays limited by low-power game system hardware.

But with newer systems now using 16-bit processing and graphics power, and



Acclaim overlays an actor's movements with computer graphics to create a videogame superhero.





## THE SPIAN GAMES

games being stored on higher-memory cartridges and even compact discs, programmers are now able to use increasingly sophisticated techniques to make game characters and objects appear more lifelike. This makes games more compelling to players.

The result is that videogames are beginning to look more and more like the feature films coming from movie studios.

There are a number of reasons why next-generation games will resemble interactive movies. For one, new high-speed computers, such as those made by Silicon Graphics, are allowing videogame developers to create complex, detailed backgrounds and seamlessly blend them with foreground figures and objects.

Another is the growing use of live videotaping and the adaptation of an old film and broadcast technique called rotoscoping, which gives characters' movements an added dimension of realism.

Essentially, rotoscoping takes a 2-dimensional image, usually on film or video, and crops out that image from the background of the shot. Then, the rotoscoped figure either can be traced—usually by hand but increasingly on computer—for animation effects or digitized and placed against a realistic, 3D background created by a high-power computer.



A CD player is a game-playing accessory for Sega's Genesis.

Today, most rotoscoping efforts require actors to be filmed alone against a blue backdrop. This makes it easier for hand-drawn or computer-generated backgrounds to be added later. For this reason, the technique is called blue-screening.

At U.S. Gold, a U.S.-based game publisher working to produce CD-like games using regular ROM game cartridges for Sega's Genesis system, rotoscoping makes the on-screen movement in its new game, "Flashback," flow with the smoothness usually associated with television-quality cartoons.

Robert Botch, U.S. Gold's presi-

dent, explains that the company first videotaped an actor running, jumping and performing other movements that the on-screen character would be performing. Then, using an overlay, artists hand-drew the animation cels individually—a process which, though time consuming and costly, resulted in realistic, cartoon-like animation. Botch says the 24-frames-per-second animation is tough to distinguish from Saturday-morning-style cartoons, which run at 30 frames per second.

Moving games from ROM cartridges to compact discs—which contain more than 4300 megabits of space, compared with the 8 to 16 bits in game cartridges—provides game developers with enough room to be even more creative in making realistic games. Adding to the realism is CD-quality digital audio for real voices and the soundtrack.

Late last year, Sega introduced a \$299 CD-player accessory that plugs into its 16-bit Genesis videogame system. The company—and a number of third-party game developers—offers several CD-based games that use digitized video, as well as well-known actors and performers.

In "Night Trap," for example, a CD-based adventure game with the look and feel of a B-grade slasher movie, players must help a bevy of beautiful young women avoid attacks from zombies and other scary intruders. The game includes digitized footage of real actors, including actress Dana Plato, formerly a star on the TV series "Diff'rent Strokes."

Sony Imagesoft, the videogame arm of the Japanese consumer electronics giant, is offering a game called "Sewer Shark," which also uses digitized footage of real actors and sets to create the feel of an interactive movie.

According to Mary Ann Norris, an



Games like "Night Trap" use digitized video footage for added realism.



MIT-trained producer at Imagesoft, Sony is currently working on a number of properties in which digitized video will play an important role. For instance, the company is currently negotiating with Vanna White for a Sega CD "Wheel Of Fortune" game, which will use Vanna's digitized image and voice.

Other CD-based games in the works include games based on the soon-to-be-released action movie "Cliffhanger," starring Sylvester Stallone, and the Arnold Schwarzenegger flick, "The Last Action Hero." Both games will incorporate footage from the movies.

In addition, Sony will be releasing a game based on the movie "Bram Stoker's Dracula." Sony has rotoscoped a real actor for the character of Harker, who was played in the movie by Keanu Reeves.

"What's exciting is that games are becoming less cartoons and more realistic, interactive adventures," Norris says. "That allows us to bring players more into the game's world and have them become more involved." Norris adds that movie directors and producers are increasingly providing input during the development of games based on theatrical releases.

Taking advantage of the high audio performance of CD-based games, both Sony and Sega currently have a series of "Make Your Own Music Videos," which feature popular musical acts such as Kriss Kross, INXS, C&C Music Factory and Marky Mark. Players can cut an MTV-style video using three songs and footage from concerts, the band's real videos and backstage interviews, and then be judged by an on-screen critic.

Activision, however, which has been in the game business since the old Atari days, has taken the process even one step closer to a full-blown Hollywood production with a new computer game called "Return To Zork."

To give the graphic adventure the look and feel of an interactive movie, the company mounted a production similar to that of a low-budget movie, hiring a veteran screenwriter and director, well-known movie and television actors



CD-based games let you make your own music videos using clips from acts like Kriss Kross.

and makeup, costuming, scenery and camera crews.

Due out this summer on floppy disks for both IBM-compatible and Macintosh personal computers, "Return To Zork" features video clips of actors and actresses set against extraordinarily realistic computer-generated 3D backgrounds. Players

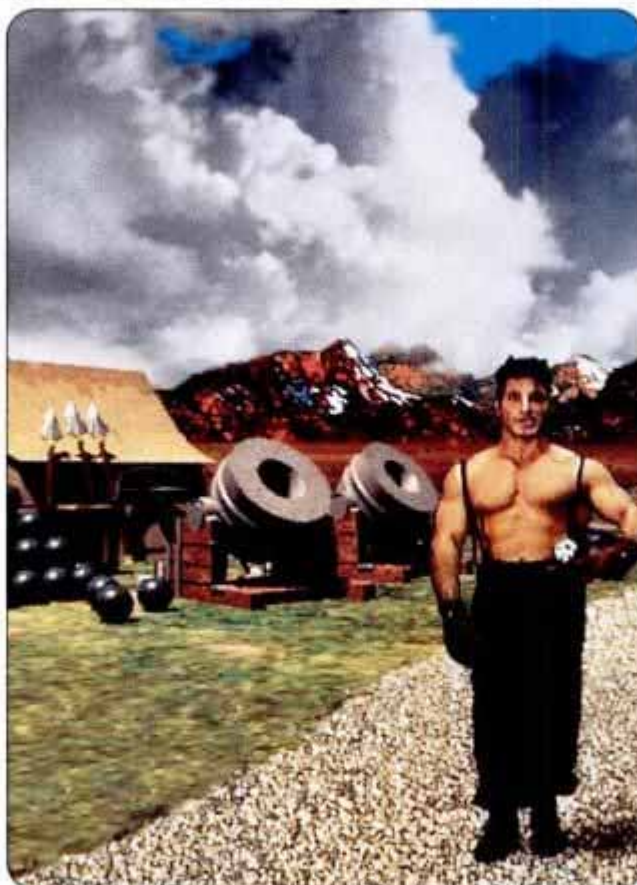
must save humanity from an evil tyrant by picking up objects and solving clues from real-voice dialogue.

In the game, which will be sold under Activision's Infocom label, sitcom fans might recognize Ernest Lively, Cooter from "The Dukes Of Hazard," Robyn Lively from "Twin Peaks," Jason Hervey from "The Wonder Years" and movie actor Sam Jones.

According to Activision producer Eddie Dombrower, the company used a rotoscoping technology called chromakey, which he refers to as "the next generation of blue-screen." Using chromakey equipment, game developers are able to remove anything that is a specific color—not just blue—from the background. In addition, the chromakey method allows developers to match cameras and light between the live video and computer-generated backgrounds.

However, the cost of mounting such an involved production can be daunting to many game developers. In addition, since there is no compatibility between the numerous CD-based game platforms that currently exist, it is difficult for game developers to commit their resources to one platform that may or may not prove to be commercially successful.

Those issues are being ad-  
*(Please turn to page 107)*



Activision's "Return To Zork" features realistic backgrounds.



## COMPARISON TEST

# WATER

As the booming water-bike industry battles for performance supremacy, the five hottest jet jammers converge in a head-to-head shootout.

BY JIM YOUNGS; PM Photos by Skip Gandy

● The gloves are off for water bikes. Once a minor player in boating, personal watercraft are now the industry's hot ticket. Instead of struggling for respect, the new PWCs are aggressively strutting their stuff. And what stuff it is. Half-century top-end speeds. Hole shots that pull the handlebars from your grip. Turns that hook with enough g-force to throw riders over the side.

Let's cut to the chase. The PM test team put the master blasters through their paces off Florida's Captiva Island. Here's what we found.

### Sea-Doo XP

For several years now, speed has been like air to the people at Sea-Doo. So, it's not surprising that the new XP once again dominated the performance categories. Suffice it to say the XP is fast, scary fast.

Like a little V-bottom race boat, the XP demands complete driver attention and requires expert tweaking to reach speeds of more than 50 mph. It also requires skill to compensate for a loose ride, a tendency to hook in lumpy water and general tippiness with a passenger aboard.

A new 70-hp 650cc feeds the XP with plenty of heart-pounding power. But even with a new hull configuration, the XP requires the rider to lean unnaturally in corners to keep water flowing to the pump. Once you get used to the outside lean, however, the XP carves up a storm.

Aside from a color scheme designed by the Teenage Mutant Ninja Turtles, the XP is sleek and handsome. A pair of adjustable mirrors is integrated into the cowl.

Like previous Sea-Doo models, the XP satisfies Bombardier's penchant for speed. Unlike previous models, the XP is not for the faint of heart.

### Polaris SL750

Tugging the 500-pound beast off the beach for the first time, the test team thought the SL750 was a full-dress cruiser. But one flick of the throttle and the impression changed. The big Polaris is a true performance machine and surprisingly nimble.

The Polaris tied for second in top speed and was so close to the Sea-Doo on the performance course that we had





# BIKERS



YAMAHA PRO VXR



## WATER BIKERS



**POLARIS SL750**

perfection. The Xi pivots on the forward section of the hull and then whips the stern around. It's wet. It's fun. And you better hang on tight.

Overall, the Xi tied for second in top speed and was a close third on the performance course and in hole shot.

Powering the Xi is a twin-carb, 75-horse version of the 743cc introduced last year. It has a mechanical, 3-position jet nozzle. A feature of special note is a throttle limiter that's designed to reduce top end for young riders. The multifunction digital dash gauge is easy to read. The Kawi is easy to board from deep water and has above-average stability for 2-up riding. With versatility in spades, the Kawi provides performance excitement for every level of rider skill.

### Yamaha Pro VXR

Until recently, Yamaha sported a fairly conservative watercraft image,

to recheck the stopwatch.

A big reason for the SL750's performance is its 744cc 78-hp 3-cylinder 3-carb engine. Judging by the chart data, the engine likes the high end of the powerband best.

One reason for its outstanding slalom performance is its ability to turn on a dime without losing water to the pump. Also, the SL750 tracks with little sliding or skipping.

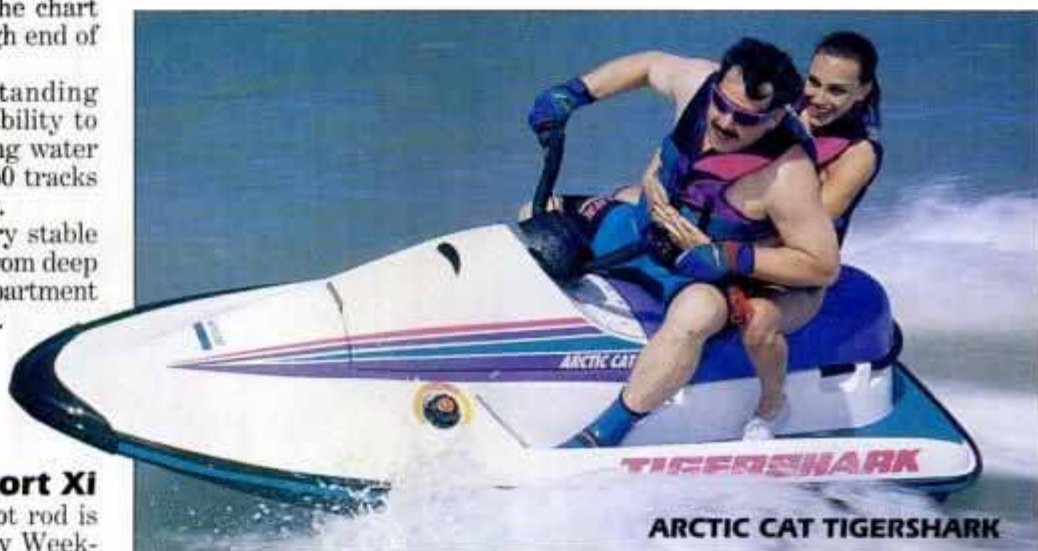
With its wide hull, it's very stable at rest and easy to reboard from deep water. The bow storage compartment has a lift-out tray and toolkit.

For a unique combination of solo performance and 2-up stability, the hot new Polaris is hard to beat.

### Kawasaki Super Sport Xi

The sweet-handling Kawi hot rod is designed to make even Wally Week-

ender look like a pro. This is one of the few craft where the rider relaxes in the seat and somehow carves to



**ARCTIC CAT TIGERSHARK**

### TEST PARAMETERS

Boats were tweaked and tuned by factory technicians. All models are showroom stock. Top-end, acceleration and performance-course data are averages of multiple runs. The performance course was marked by three buoys and required short bursts of speed to negotiate hard-left and hard-right turns, plus a 360°. Bold numbers in each line indicate ranking in fleet.



MODEL	ARCTIC CAT TIGERSHARK	KAWASAKI SUPER SPORT XI
Length/Beam/Weight/Fuel Capacity	111"/45"/390 lb./11 gal.	100"/41"/387 lb./8.7 gal.
Engine/Displacement/Horsepower	Arctco/650cc/NA	Kawasaki/743cc/75
Top-End Speed, Solo/Double	4. 43.5 mph/5. 41.5 mph	2. (tied) 47.5 mph/4. 44.5 mph
Acceleration 0-30 mph, Solo/Double	5. 4.23 sec./5. 5.07 sec.	3. 2.99 sec./3. 4.21 sec.
Performance Course, Solo/Double	5. 23.06 sec., hole shot holds it back	3. 18.91 sec., tack tight in turns
Overall Handling	4. Safe, easy, well behaved, no tricks	2. Superb manners, great all around
Stability	1. (tied) Like a rock in all conditions	2. (tied) Well balanced for one or two
Fun Factor	3. Spin-out champ, but not spritely	1. (tied) Kawi's best sit-down yet
Special Features	Adjustable handlebars and throttle	Mechanical trim, power limiter
Price	\$5399	\$6199
Address	600 Brooks Ave. S., Thief River Falls, MN 56701	9950 Jeronimo Rd., Irvine, CA 92718



but with the intro of the Pro VXR and a couple of other models, that image has been shattered. With plenty of low-end punch, the Pro VXR scored a close second in acceleration and placed a close third in top speed.

Handling is equally exciting. Like the Kawi, the Yamaha welcomes natural leaning in corners. Unlike the Kawi, it loves to be tossed about easily and spun out. Recovery is quick and forgiving. There's a slight tendency to cavitate in turns, but it's no big concern.

What's new about this model is the big 701cc engine, which has been installed in the existing VXR hull. The result is making a good machine even better. The engine, with its single carb, cranks out 63 horsepower.

Another notable addition to the Yamaha Pro VXR is a more comfortable seat. A tach is included, but few riders have the time and in-

clination to check rpm.

Bold graphics and bright yellow colors are departures for Yamaha, but so is this entry into the rarefied world of maxiperformance. This isn't your father's Yamaha PWC.

### Arctic Cat Tigershark

Don't feel too sorry for the Tigershark's performance rankings. In truth, the Arctic Cat Tigershark is more fast cruiser than race boat, and what's bad about that? It may not smoke the water or carve tack-tight turns, but it allows easy spin-outs, and its stability is unsurpassed.



KAWASAKI SUPER SPORT XI

The Tigershark is powered by a 650cc twin-cylinder single-carb engine that delivers a rumored 60 hp. (Arctic won't confirm.) The engine seems best dialed in for midrange and upper throttle settings.

Although the rock-solid craft is the widest and longest of the fleet, it has a low profile. Interestingly, the Tigershark has adjustable handlebars and throttle, which can be positioned as a thumb-squeeze or finger-pull trigger. About the only thing we didn't like was the low seat, but that was minor.

Reboarding from deep water is a simple exercise, even with two riders. Balancing is also a snap. Essentially, the Tigershark features an anyone-can-ride configuration that's amazingly similar to the popular original Yamaha WaveRunner, except it's much faster.

PM



SEA-DOO XP



#### POLARIS SL750

105.3"/45.9"/499 lb./9.8 gal.  
Polaris/744cc/78  
2. (tied) 47.5 mph/2. 46 mph  
4. 3.45 sec./4. 4.25 sec.  
2. 16.66 sec., eyeblink from leader  
1. (tied) Does everything right  
1. (tied) Firm footprint in water  
1. (tied) Delivers what it promises  
3-cylinder engine, toolkit, power trim  
\$6099  
1225 Hwy. 169 N.,  
Minneapolis, MN 55441

#### SEA-DOO XP

100"/41.5"/373 lb./9 gal.  
Rotax/650cc/70  
1. 51.5 mph/1. 48 mph  
1. 2.51 sec./1. 3.49 sec.  
1. 16.24 sec., all-around quickness  
1. (tied) Master blaster, but scary fast  
3. Slightly tippy, but who cares  
2. Plenty of thrills and chills  
Power trim, integrated mirrors  
\$6199  
6545 U.S. 1,  
Palm Bay, FL 32905

#### YAMAHA PRO VXR

109.1"/40.2"/408 lb./7.9 gal.  
Yamaha/701cc/63  
3. 46.5 mph/3. 45.5 mph  
2. 2.8 sec./2. 3.63 sec.  
4. 20.85 sec., loses some water to pump  
3. Great hole shot, lively performer  
2. (tied) Best at speed, but good overall  
1. (tied) A jammin' jet favorite  
Stainless-steel impeller, tach  
\$5999  
6555 Katella Ave.,  
Cypress, CA 90630

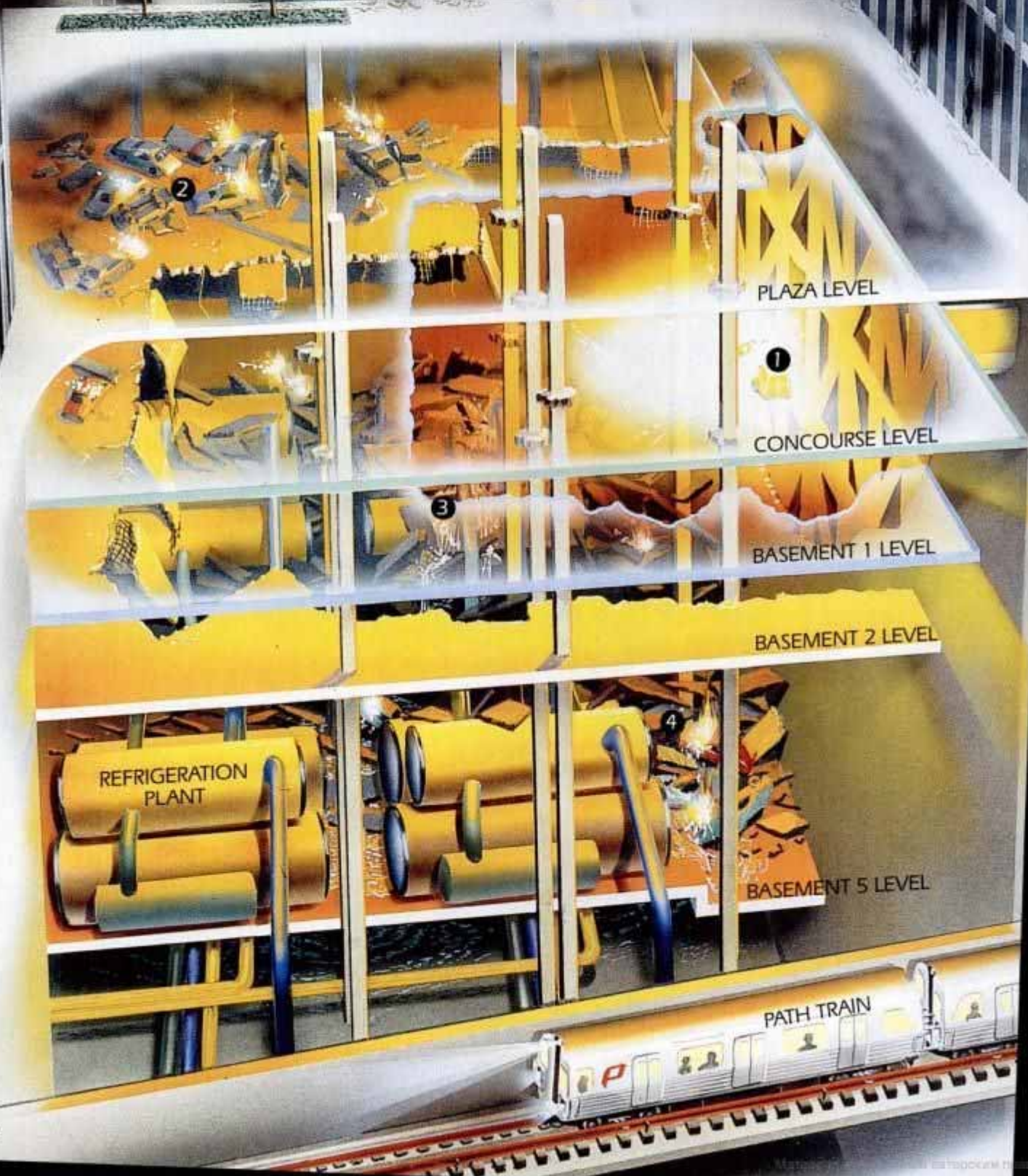
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# TECHNOLOGY

VISTA HOTEL

SOUTH TOWER







NORTH TOWER

# REBUILDING THE WORLD TRADE CENTER

The second-tallest building in the world still stands tall despite the heinous actions of terrorist fanatics. Here's what happened when the bomb went off and why the rebuilt twin towers will be stronger than ever.

BY HERBERT SHULDINER; PM Illustration by George Retseck

## What Happened

- 1 Van parks on Basement 2 (B2) level. Bomb detonates at 12:18 pm. Blast disintegrates concrete floors of B1 and B2. Crater extends to B5.
- 2 At least 200 cars are immolated, releasing oily black smoke.
- 3 Ruptured pipes cut off cooling water to backup generators, killing power for towers' public-address system, lights and smoke-purge fans.
- 4 Thousands of tons of rubble and water crush refrigeration plant for air-conditioning system.
- 5 Explosion shatters concrete wall, allowing smoke to penetrate tower. Blast breaches elevator-shaft wall.
- 6 Smoke races up shafts and spreads throughout towers.
- 7 Fire units begin arriving at scene.

● Charles Maikish was signing a lease when the bomb exploded. "It felt like there was a slight lifting of the tower, and there was a loud noise," recalls Maikish, director of the 7-building, 16-acre complex known as the World Trade Center. At 12:18 pm, on that raw February 26, Maikish was in his 35th-floor office in the North Tower. Right then, says the FBI, a 1500-pound explosive device, laced with hydrogen tanks as accelerants, detonated in the complex's subterranean parking garage.

The blast punched through five underground floors. More than 200 cars, including 50 Secret Service vehicles, were instantly ablaze, releas-

ing caustic, oily smoke. Shockwaves breached walls into the twin towers. The smoke, drawn up by a stack effect in elevator shafts, billowed throughout both 110-story buildings. More than 50,000 employees and thousands of visitors fled, many groping down dozens of flights in pitch-black stairwells, and a 12-hour rescue operation ensued.

The disaster went to 16 alarms—the most in New York City history—and summoned 66 fire engines, 52 trucks, five rescue companies and two fireboats. Total casualties: six dead, more than 1000 injured. Total damages: more than a half-billion dollars.



# REBUILDING THE WORLD TRADE CENTER

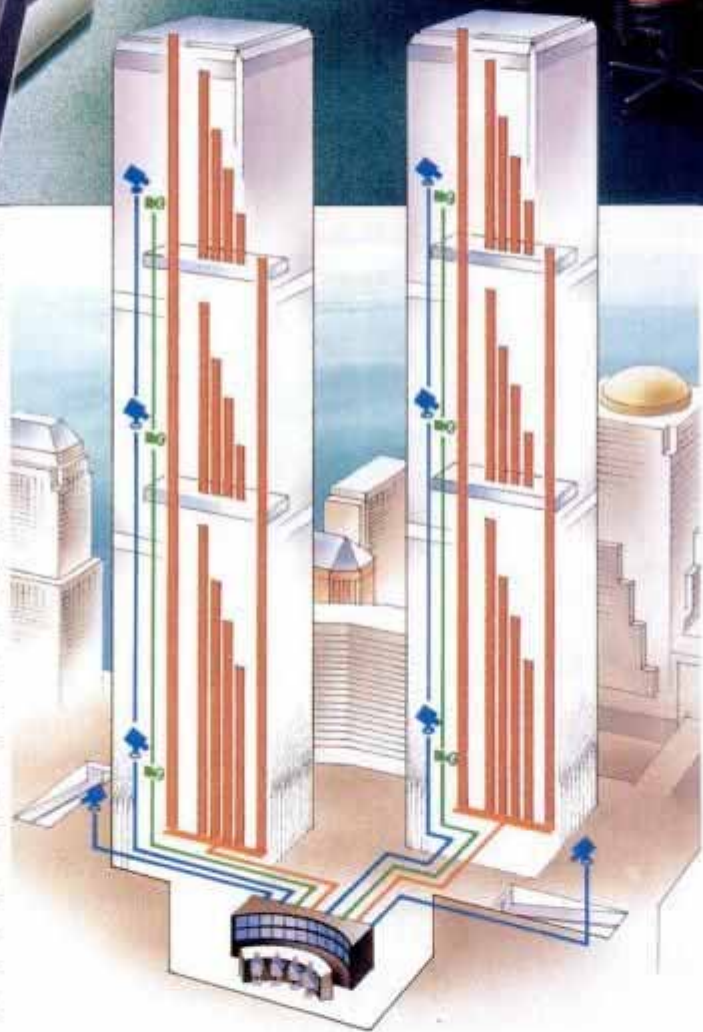


The twin skyscrapers—the centerpiece of lower Manhattan—shut their doors for more than a month. The explosion literally ripped the guts out of an American civil-engineering landmark.

And yet only six weeks later, the towers, which house more than 100 acres of office space, were fully reoccupied. Bringing the buildings back to life has taken an unprecedented effort, one that combined on-the-spot engineering know-how with sheer elbow grease and the determination to shake off a low blow.

The disaster may also lead architects and engineers to rethink the way they secure the inner workings of skyscrapers—especially the electrical, plumbing and mechanical networks that keep these mammoth structures safely humming with activity. For it was the ravaging of those systems that brought pandemonium to the World Trade Center.

Maikish himself reached the ground floor within 30 seconds of the blast, thanks to a fire-department key that unlocked a paralyzed elevator. Not so lucky was Eugene Fasullo, chief engineer for the Port Authority of New York and New Jersey, which owns the tower com-



The explosion damaged the original command center, located on level B1. A new highly automated operations-control center will feature 33 rear-projection screens that track elevators, show live video images from security cameras and update safety-system status.

plex. Trapped in an elevator 57 floors up, Fasullo and eight colleagues spent 3 hours chiseling through a sheetrock wall with a car key.

Raspy from smoke inhalation, Fasullo finally joined Maikish and a crew of Port Authority engineers at a makeshift command center in the

ballroom of the Vista Hotel, a 22-story building sandwiched between the towers. By then, reports were already filtering up from the basement levels. Within an hour of the blast—even before the fire was out—engineers had ventured in to start assessing the damage.

## Pillars of strength

The wreckage was greater than anyone could have imagined, Maikish recalls. But the World Trade Center was in no danger of collapsing. "No other structure, no complex would have withstood that kind of blast," claims Maikish.

After all, the giant buildings are designed to resist a once-in-a-century wind blast of 150 mph. Each tower can sway up to 3 ft. in heavy winds. The instruments that record this swaying registered nothing from the explosion. The structures were also engineered to soak up the impact of a Boeing 707, the biggest plane in the skies when the towers went up in the late 1960s.

This strength arises from the towers' unique steel curtain walls, the exterior frames designed by architect Minoru Yamasaki. Twenty-one steel columns, spaced 10 ft. apart and braced with horizontal spandrels,



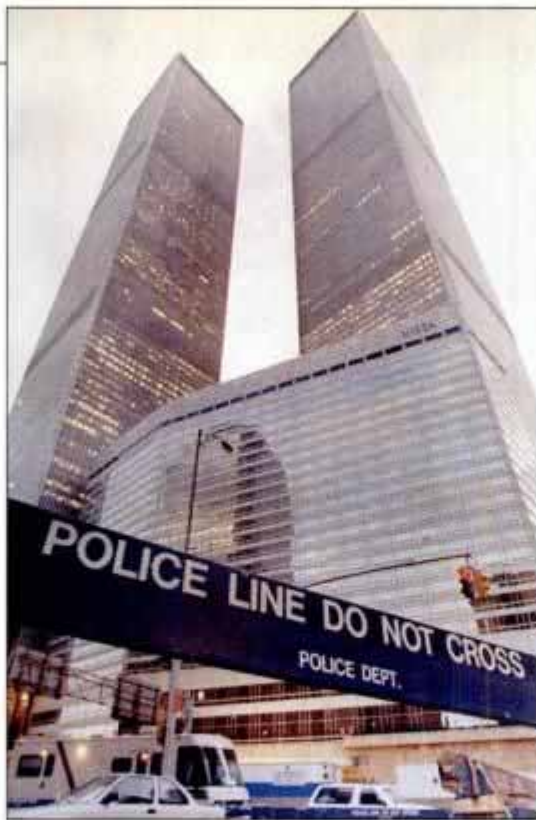
make up each facade of the towers. These are the main load-bearing components of the structures. True, the explosion did not occur within the footprint of either building, but even the loss of 10 columns in a tower could not have triggered a collapse, says Fasullo.

Instead, the bomb delivered its blow to the 12-in.-thick reinforced-concrete floor slabs in the 6-level basement that lies below both the Vista Hotel and the plaza between the towers. Centered on level B2, the explosion shattered that level's floor slab and gouged holes through the two floors above. The blast also ripped downward to level B5, a cavernous, 3-story-high machinery area that houses the towers' refrigeration plant.

Normally, these floor slabs shore up a massive concrete foundation wall—the so-called bathtub wall that keeps earth and groundwater out of the basement. They also buttress nine structural columns that support the northeast corner of the Vista Hotel. Yet, although the slabs were blown to smithereens, they acted as blast deflectors, absorbing the explosion's energy and confining the structural damage.

### Rubble trouble

Some 2500 tons of rubble crashed to level 5, which was rapidly filling with water from ruptured pipes. Mean-



A federal crime scene, the Trade Center stayed off-limits for days while agents went over the blast site.

while, gigantic chunks of concrete hung menacingly around the 11,500-sq.-ft. blast hole, keeping engineers and crime-scene investigators at bay.

By early evening, Fasullo and his engineers had gauged the danger level. Some of the structural columns that held up the hotel had been severely weakened. In demolishing the floor slabs, the explosion had left the

columns naked and unstable, with no lateral support for long vertical distances. The ruined slabs now lay three floors below in the 12-ft.-deep debris pile, which ironically lent some temporary lateral support for these columns.

But forensic investigators would still be at risk. And the agents were chafing to comb through the blast zone. "When they finally get in there, they're going to look like a colony of ants going after sugar," remarked James Fox, assistant director-in-charge of New York's FBI office.

The engineers worked out an ingenious seat-of-the-pants solution. A work crew anchored a spider platform (so named because it hangs from a ceiling) to steel scaffolding erected on the concourse level. Motorized cables lowered the platform into the crater through a hole opened in the Vista Hotel ballroom floor, to provide a short, mobile catwalk for two welders.

At the same time, a contractor showed up with a supply of 4-in.-square steel tubes, each 40 ft. long, to provide horizontal and diagonal bracing for the columns. The welders would ultimately interconnect the weakened columns with 180 of these braces to restore lateral stability, all over a period of three weeks.

Once this process got underway, federal agents could safely pick through every fragment of rubble



Above, new steel tubes brace vertical column, shorn of its supporting concrete floor slabs by the blast.

Right, to rebuild the floor of level B2, contractors are installing steel-beam framing between columns, laying a metal decking and topping it with reinforced concrete. The steel will support wooden scaffolding and forms for a replacement poured-concrete floor deck on B1.





## REBUILDING THE WORLD TRADE CENTER

(although they had already disregarded engineers' warnings and taken chemical samples inside the crater). Among the debris, agents found the evidence—a piece of van chassis with a vehicle ID number—that led them to their first suspect, Mohammed Salameh.

About 240 workers, split into two 10-hour shifts, pulled rubble from the pit with the aid of a crane. The debris emerged through a 30-sq.-ft. opening dug into the Trade Center plaza. Fausullo said it was like playing pick-up-sticks: "If you pick up the wrong stick, the whole thing collapses."

Once the wreckage was removed, contractors could begin rebuilding the B1 and B2 floor slabs. Normally, they would have followed the standard pour-in-place procedure: They'd assemble a wooden framework below the floor level, top it with a form mold for the new floor, then lay out a network of steel reinforcement bars and pour in a foot-deep layer of concrete. This would have taken too long, though, because beneath B2 yawned the 3-level opening to B5, where work crews were repairing the refrigeration plant.

Instead, a construction team rebuilt the floor as if it were an above-ground story in a high-rise. They spanned the existing columns with steel I-beams, attached a grid of infill beams, placed a corrugated steel deck on top and poured 7 in. of concrete over that. On this sturdy platform, a second crew could mount shoring for a pour-in-place replacement for the B1 floor above.

### Nervous breakdown

While the basement's ruined skeleton preoccupied the engineers, rescue personnel had to contend with the Trade Center's shattered nervous system.

The blast had shorted out five of eight high-voltage feeder lines from Manhattan's electrical grid, and the fire department ordered the rest turned off. Then a set of backup diesel generators overheated and shut down when the blast severed cooling-water lines. Communications, smoke-purge fans and lights went down within an hour of the blast.

One early priority was to restore power to certain elevators to aid the evacuation effort. Another was to return electricity to the subway tracks beneath the Trade Center.

The complex's electric power also feeds two telephone switches that serve lower Manhattan. Each switch

has two hours of backup battery power. While one handles 70,000 international lines, the other is a major switch for NYNEX, the Northeast's regional telephone network.

"Once that switch goes down," notes Maikish, "major portions of New York would have lost telephone service." Maikish pressed hard to restore power to the switches, because telecommunications for the regional air traffic control system also run through the NYNEX switch. Before the disaster could spread beyond the Trade Center, however, the three intact electrical feeders came back on line.



Ground zero, a month later. Debris still litters level B5 while new floors take shape to the right, above damaged refrigeration plant.

### Speed cleaning

Despite the daunting damage, restoration of the Trade Center has moved faster than anyone predicted.

Air conditioning, its refrigeration plant crushed under the rubble, remains the only system not fully revived. Maikish expected three of the seven 7000-ton chillers to be operational by the start of summer. Outside the towers, rented units on trucks are lending additional cooling.

Meanwhile, armies of workers performed the emergency surgery needed to resuscitate the twin towers.

Electricians bridged thousands of feet of severed wiring in the fire-alarm system. Other technicians restored the damaged high-voltage feeders. Twenty more electricians, working around the clock for a week, cleaned and tested the towers' 3000 smoke detectors, a job that normally takes six months.

Once pumps had drawn nearly 2 million gallons of water from the basement, plumbers moved in on thousands of standpipes and fire pumps. They also had to check and recharge 1.4 million feet of sprinkler-system pipe before tenants could move back in. In addition, the valving in 4000 sinks and toilets was checked and reset—a precaution against flood-

ing—before water pressure returned.

Workers repaired or replaced hundreds of stairway doors broken by firefighters or fleeing tenants. Within three days, glaziers had replaced hundreds of broken windows, including several 4-story glass windows in the lobby of the North Tower.

It took two weeks to restore all vital services. Then Maikish sent in 2700 workers to clean the towers. Seven days were needed to clean the South Tower, 10 days for the North Tower. Acres of stainless steel in the lobbies were polished clean of soot.

The Vista Hotel hasn't fared as well and won't re-open before August. The blast devastated the hotel's utilities, and contractors couldn't run new plumbing and electrical lines into the building until structural repair work at the blast site wound down.

### Fail-safe future

What can be done to prevent this type of disaster from recurring? "You can't bomb-proof against a 1500-pound explosive," says Robert DiChiaro, Maikish's deputy. Nevertheless, the Port Authority is taking steps to reorganize safety systems.

For one thing, an additional feeder from the electrical grid—low enough in voltage

not to threaten anyone knee-deep in flood water—will back up the smoke-purge systems. Battery-powered lights will illuminate the stairways. Workers will install new-generation smoke detectors that reveal their location when triggered.

In addition, a new radio-frequency phone system is in the works. The chaotic rescue effort demonstrated that walkie-talkies can't override the inevitable voice clutter that erupts during an emergency. By contrast, RF phones restrict themselves to one 2-way conversation per channel.

The Port Authority also plans to expedite the installation of a new state-of-the-art operations nerve center, with satellites in the lobby of each building. The \$18-million project will help coordinate procedures in the event of future disasters.

In the meantime, Port Authority officials take pride in the speedy return to business-as-usual at the World Trade Center. But when Charles Maikish could get back to his office, he found the lease he was signing covered with soot. Blowing off the grime, he saw that he had only signed the first letter of his last name when he dropped his pen to respond to the emergency. **PM**





# LIKE A ROCK

## FOR 75 YEARS



1993 S-10 Blazer Tahoe LT 4WD

**A**s it turned out, there was no contest. Advocates of the horse-drawn delivery wagon at about the turn of the century felt secure in their belief that no motor equipment could match—let alone surpass—the performance of their hoof-beating haulers. Back in those days, the 17 miles a day covered by a one-horse wagon was pretty respectable. Add another “horsepower,” and the extra giddyap was good for an additional three miles a day.

It may have been difficult to see the handwriting on the wall during the pre-dawn of the Roaring

*This special advertising section was produced by General Communication and did not involve the automotive editors of POPULAR MECHANICS. Some material provided by John Gunnell/Olds Cars and Robert Hensel/Vintage Chevrolet Club of America.*



Lotis Chevrolet

**Chevrolet trucks have been delivering the beef behind the bowtie since 1918.**



1918 Model T 1-Ton Eight-Post Curtain Top Express



# LIKE A ROCK



SPECIAL ADVERTISING SECTION



1938 Carryall Suburban

Twenties. After all, there were some 21-million horses clip-clopping around the country and only a few hundred trucks.

But change was in the wind. Louis Chevrolet was one wall-writer, and automobiles bearing his name first appeared in 1912. They were the initial salvo of what would eventually lead the Chevrolet Division of

Chevrolet introduced a closed-cab truck chassis. In 1935, the first Suburban "carry-all"—an 8-passenger all-steel wagon built on a truck chassis—was introduced. A new 4-main-bearing, 216.5-cu.-in. Six in 1937 produced as much horsepower as Ford's V8, but delivered better fuel economy.

World War II sucked up most of Chevy's truck production from '42



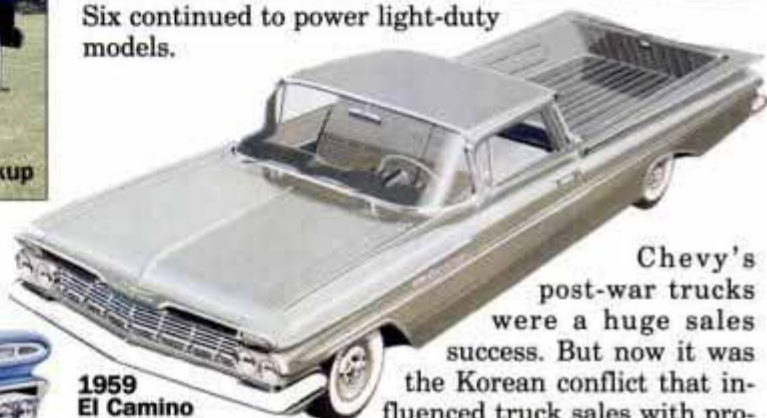
1947 Pickup

through '45, and 1946 models were essentially a continuation of pre-war 1941 designs. With the war behind it, Chevrolet set about re-designing the 1947 models. The new Advance-Design series featured larger and more comfortable "Uni-steel" cabs. The venerable 216.5-cu.-in. Thriftmaster Six continued to power light-duty models.



1957 Cameo Pickup

JIM KNIGHT/PHILIPS TV PANELS



1959 El Camino

Chevy's post-war trucks were a huge sales success. But now it was the Korean conflict that influenced truck sales with production controls coming on-stream in 1951 as the country again shifted to defense.



1960 Fleetside Pickup

General Motors to become one of the world's leading producers of cars and trucks.

Chevy's first trucks debuted in 1916, and weren't really trucks at all, but crude panel and canopy bodies installed on production passenger-car chassis. The first "real" trucks rolled out two years later, born of a World War I need. Bearing the "Model T" identification, these 1-ton capacity vehicles featured an overhead-valve 4-cylinder engine, worm-gear drive and artillery-type wheels with 12 hickory spokes.

Truck design as a separate field began in 1926 when



1961 Corvair Rampside



1967 Fleetside Pickup

1955 was a really interesting year. Chevrolet debuted an all-new passenger car and wanted a companion all-new truck, but they didn't make it in time. So they came out with a 1955 First Series (basically a '54 carryover) and a '55 Second Series. The latter featured a larger cab (the first with no running boards) that sported a more car-like interior, and 12-volt electrics. Under the hood, Chevy's first V8 appeared. It was the first application of what would be known as the small-block V8, at 265 cu. in.



An engine that would become a legend.

The Cameo model also debuted in '55 as the first smoothside, bolting on fiberglass panels to the stepside box.

Trucks from 1955-1959 were designated Task Force. One newcomer in the '59 lineup—the El Camino—was a passenger car-based pickup.

A facelift and a lower, roomier truck characterized the bowtie haulers in the 1960-'66 years. The independent front axle came on-stream in '60, and Corvair-based trucks joined the pickup fleet a year later. In 1965, the Sportvan series expanded the lineup.



1985 Fleetside Pickup



1992 Lumina APV

drive pickup and Blazer trim. An optional V6 helped add the "sport" to these sport trucks. And a new compact van—the Astro—came on board in '85.

The '80s saw important engine changes, including the new 6.2-liter diesel V8, fuel-injected V6 and V8 gas engines.

The biggest news, however, was the total redesign of the pickups in 1988. Sport-truck fans

Power-hungry buyers upped the sales of V8s to one out of every three Chevy trucks produced. The small-block V8 increased in displacement from 265 to 283 and 327 cu. in., and the Six had grown to 292 cubes. And, beginning in the '66 El Camino Super Sport models, you could get a big-block 396-cu.-in. V8 boasting horsepower up to 360.

Light-duty trucks were restyled once again in 1967, and included a new Custom Sport Truck concept. The K-5 Blazer hit the ground running in '69, debuting as a 4x4 only. Pickup sheetmetal changed again in 1973 with an all-new cab design. New models included a 4-door Crew cab and Big Dooley dual-rear-wheel Fleetside. Suburbans flexed new-found muscles with 454-cu.-in. big-block V8 power.

An all-new compact truck—the S-10—debuted for '83 in both 2-wheel- and 4-wheel-



1992 C1500 Suburban



1992 454 SS Pickup

weren't neglected and, in 1990, they had the hot 454 SS Limited Edition to play with.

For 1993, Chevrolet continues to offer a complete lineup of trucks, including full-size C/K pickups and Blazers, compact S-10 pickups and Blazers, full-size and compact vans (Sportvan and Astro), Suburban and Lumina APV. It's a 75-year-old tradition that's still going strong.



1992 C2500 Fleetside Silverado Pickup





**For a free product brochure call 1-800-950-2438.**

\*Included with Preferred Equipment Group #2. †See your Chevrolet dealer for terms of this limited warranty.

\*\*Based on full-line truck company registration data 1982-1991. Excludes other GM products. Chevrolet, the Chevrolet Emblem and S-10 are registered trademarks and Chevy is a trademark of the GM Corp.

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**PORTABLE BBQ IS A STOVE, TOO**

Versatile *Firelight II Cooker* snaps open to give you a barbecue grill on one side, a 2-burner stove on the other. Grill steaks, burgers, ribs and, at the same time, fry eggs, heat soup, cook vegetables, perk coffee — just like home! Separate controls for each side. A 1 lb. propane tank (available at hardware stores) powers everything. You get quick starts, even heat. Enjoy complete meals easily and conveniently at picnics, tailgate parties, the beach, camping, fishing, boating. Perfect for an apartment balcony. Removable grills are easy to clean, dishwasher safe. Rugged cast aluminum units fold to a trim 18" L x 13" W x 6" H. Easily portable (weighs about 20 lbs), easy to stow. Mfr.'s 1 yr. ltd. warranty. **\$149.95 #4800**.



**QUALITY AND VALUE — GUARANTEED**



So confident of the workmanship in this high-performance watch, *Xonix* offers a 5 yr. ltd. warranty — five times longer than warranties offered on watches costing thousands of dollars! Wear this stylish *Scuba Master Dress/Sport Watch* anywhere...office, sports, even 325 feet under water! It's made for divers, who demand accuracy, water resistance, reliability. Precision quartz movement. Magnifying-dome crystal for easy reading. Luminous hands. Rotating bezel gives elapsed time. Two-tone stainless-steel, adjustable-link band with safety clasp. **\$79.95**. Men's, with date window, **#4300**; Ladies', **#4310**.

**BREATHE EASIER**

Using technology developed for NASA, the powerful *Enviraicare® Air Purifier* lets you breathe the cleanest air possible by filtering out 99.97% of airborne contaminants and pollutants. Removes smoke, animal dander, bacteria, viruses, dust, fumes, pollen and mold spores. Can significantly reduce allergic and respiratory symptoms. Physicians often recommend it to asthma, hay fever and bronchitis patients. The unit's HEPA (High-Efficiency Particulate Air) filter captures and eliminates pollutants. A charcoal filter removes smoke and odors. Cleans the air in a 20' x 22' space every 10 minutes. Mfr.'s 2-yr. ltd. warranty. HEPA filter lasts up to 5 yrs; 1 yr. supply of charcoal filters included. **\$299.95 #3965**. *Enviraicare* for smaller areas (cleans the air in a 16' x 20' room every 10 minutes). Mfr.'s 1-yr. ltd. warranty. **\$249.95 #3960**.



**TO YOUR HEALTH**



Dating back 800 years, *Chinese Exercise Balls* have been used to induce well-being and serenity of the spirit. Rotating these polished chrome balls in the palm of each hand stimulates fingers and acupuncture points, improving the circulation throughout the body. Their soothing chime makes them effective for relaxation and meditation. Great muscle conditioners for sports enthusiasts, musicians, computer users, arthritis sufferers and health-conscious people. Silk brocade box. **\$29.95 #1702**; two sets for **\$49.95 #1705**.

**DEEP HEAT RELIEF**

Pain from inflamed joints and muscles can be excruciating. Heating pads and hot water bottles mainly warm the surface of the skin — heat does not penetrate deep into muscles and joints. Infrared heat goes deep beneath the skin to reach the site of inflammation and discomfort for safe, natural relief. The easy-to-use *Infralum* is contoured and angled to reach all parts of your body. Oversized heating surface. Hi/Low heat. Uses household outlet. UL listed. Includes case and extra bulb. **\$39.95 #3110**.



**CUSTOM BACK SUPPORT**

*Air Belts* help relieve and prevent back pain without restricting movement. Enjoy activities that were once off-limits — or simply sit in comfort. Squeeze the removable aspirator bulb to inflate belt for individualized lumbar support. A system of air chambers applies gentle pressure to help relax muscles and encourage proper alignment of your lower back. Contoured shape is flexible to allow a full range of movement. Adjustable, handwashable, lightweight. Soft, breathable material keeps you cool and dry. The *Air Belt®* is worn around your waist for support centered at the small of your back. Waist measurement: M (29"-35"), L (36"-41"), or XL (42"-50") **\$59.95 #3580**. For broader support and stability for your lower back, the *Lumbosacral Air Belt®* wraps around your hips. Additional air chambers and straps provide direct lumbosacral support. Hip measurement: M (29"-35"), L (36"-41"), XL (42"-46") **\$99.95 #3606**.



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# HOME&SHOP JOURNAL



## SHOP PROJECT

# TABLE FOR FOUR

A compact and elegant folding table and chair set

BY ROSARIO CAPOTOSTO, Contributing Editor

● This versatile gateleg table and chair set is a marvel of compactness. It seats four people comfortably yet, when folded, it needs a space only 14 in. wide × 34 in. long. And, that includes the four folding chairs stored underneath.

It's ideally suited for apartments and other confined quarters, but this handsome dining set will be an asset even if you have lots of space. Just

unfold the table and chairs when the company arrives. The chairs are solid mahogany, and the table has a mahogany base with a mahogany plywood top. We achieved a deep rich color with a mahogany stain topped by three coats of gloss polyurethane.

### The Chair

Rip and crosscut the pieces for the rails and stiles from 4/4 stock. Also

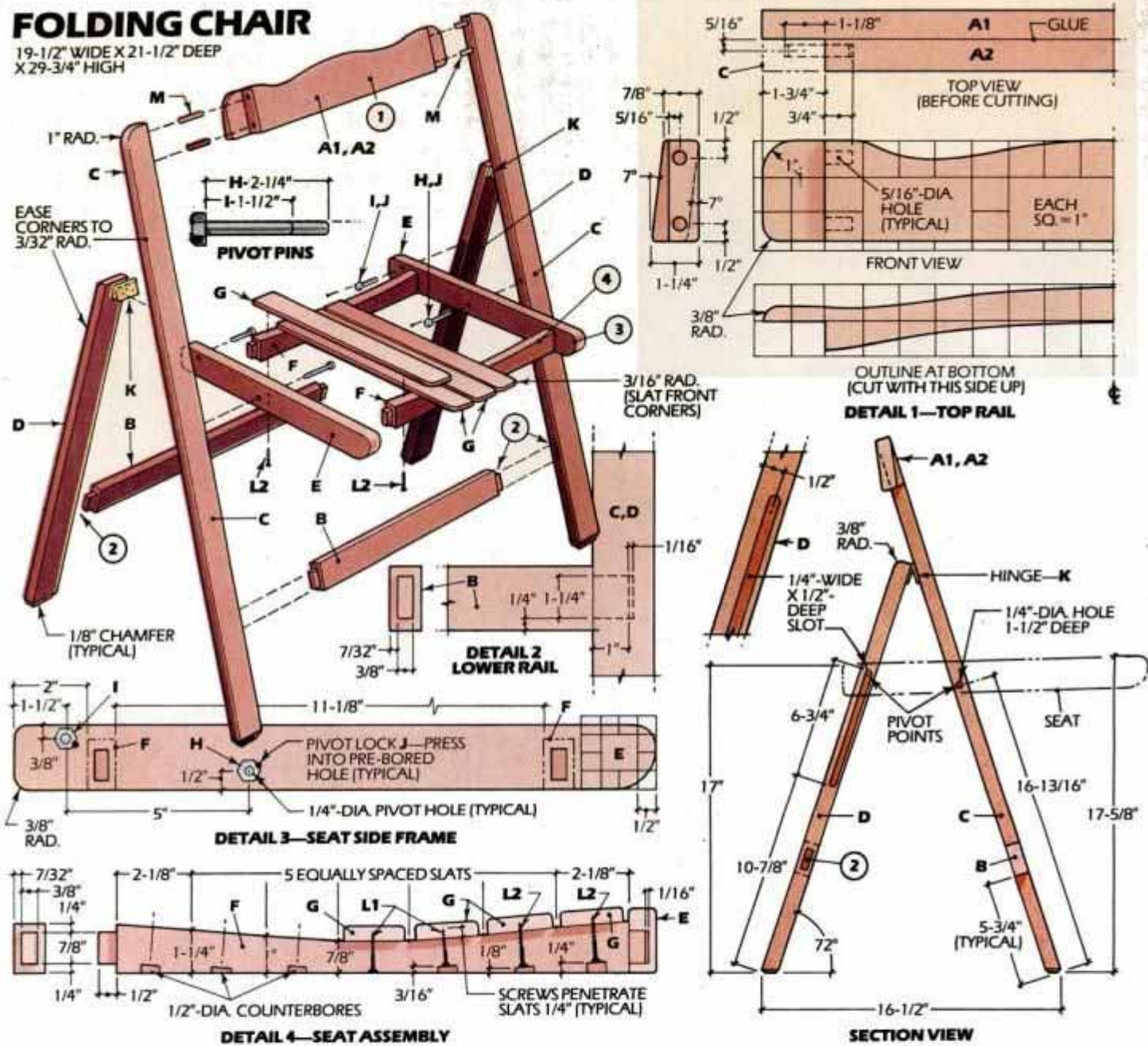


Color photo: J.R. Rost  
Black-and-white photos: Rosario Capotosto  
Technical art: Eugene Thompson  
Photo stylist: Gabe Herrick



## FOLDING CHAIR

19-1/2" WIDE X 21-1/2" DEEP  
X 29-3/4" HIGH



### MATERIALS LIST—FOLDING CHAIRS/TABLE

Key No.	Size description (use)	Quantity	Material
A1	1 3/8" x 2 3/4" x 19 1/2" mahogany (rail)	4	Mahogany
A2	1 3/8" x 2 3/4" x 16" mahogany (rail)	4	Mahogany
B	1 3/8" x 1 3/4" x 18" mahogany (rail)	8	Mahogany
C	1 3/8" x 1 3/4" x 31" mahogany (leg)	8	Mahogany
D	1 3/8" x 1 3/4" x 24" mahogany (leg)	8	Mahogany
E	1 3/8" x 1 3/4" x 17" mahogany (seat frame)	8	Mahogany
F	1 3/8" x 1 3/4" x 15 3/4" mahogany (seat frame)	8	Mahogany
G	3/8" x 1 3/4" x 14 3/4" mahogany (slat)	28	Mahogany
H	8 1/4"-dia. x 3 1/2" capscrow (pivot)	8	Capscrow
I	8 1/4"-dia. x 2 1/2" capscrow (pivot)	8	Capscrow
J	16 3/4" x 15-gn. escutcheon pin (pivot lock)	16	Escutcheon pin
K	8 1 1/2" x 2" Stanley CD5304 hinge (for legs)	8	Hinge
L1	24 1" No. 8 fh screw (for slats)	24	Screw
L2	32 1 1/4" No. 8 fh screw (for slats)	32	Screw
M	16 5/16"-dia. x 1 3/4" dowel	16	Dowel
N	4 1 3/4" x 1 3/4" x 26 1/4" mahogany (leg)	4	Mahogany
O	1 1 3/8" x 2 3/8" x 8" mahogany (apron)	1	Mahogany
P	1 1 3/8" x 3 1/2" x 8" mahogany (apron)	1	Mahogany
Q	2 1 3/8" x 3 1/2" x 30" mahogany (apron)	2	Mahogany
R	1 1 3/8" x 1 3/4" x 8" mahogany (apron)	1	Mahogany
S	1 1 3/8" x 2 1/2" x 8" mahogany (apron)	1	Mahogany
T	2 1 3/8" x 2 1/2" x 30" mahogany (apron)	2	Mahogany
U	2 1 3/8" x 1 1/2" x 28 5/8" mahogany (gateleg post)	2	Mahogany
V	2 1 3/8" x 1 1/2" x 21 1/4" mahogany (gateleg stile)	2	Mahogany

rip and crosscut two pieces of stock to be face glued for the top rail. The top rail uses a combination dowel and lap joint. Remember to bore the dowel holes in the front piece of the top rail before you glue and clamp it to the back piece.

Use a doweling jig to bore the dowel holes in the rail ends. If you have a self-centering jig, insert a wood spacer to position the dowel holes off-center (Photo 1).

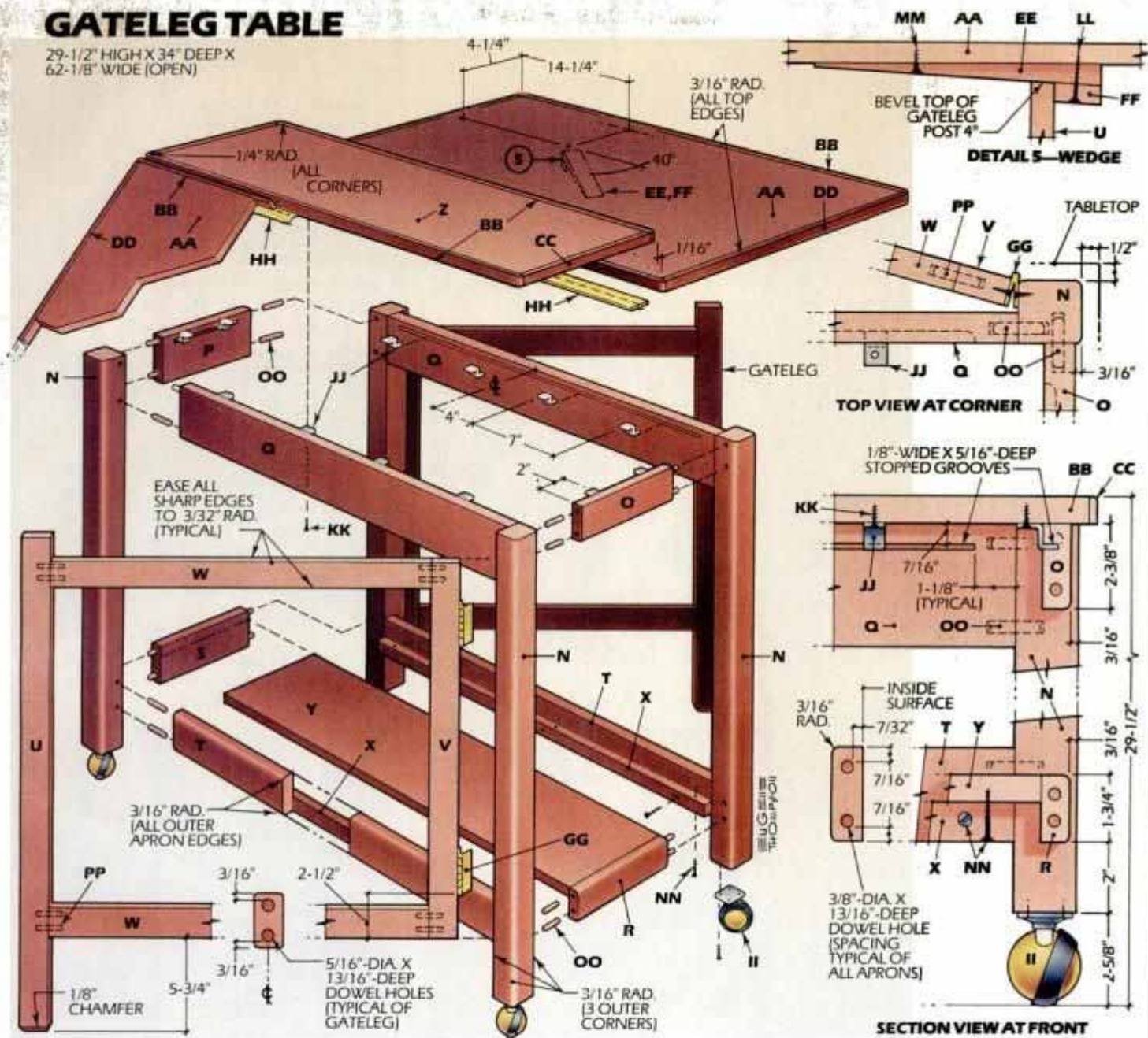
Next, center the front rail section over the rear section. Tape the two

pieces together and bore a pair of pilot holes for alignment nails near the ends of the back. Apply glue to the pieces, partially drive 1 1/2-in. finishing nails into the holes and clamp the assembly (Photo 2). When the glue is dry, pull out the nails.



## GATELEG TABLE

29-1/2" HIGH X 34" DEEP X  
62-1/8" WIDE (OPEN)



- W 4 1 3/16 x 1 1/2 x 20" mahogany (gateleg rail)
- X 2 1 1/16 x 1 x 30" mahogany (shelf cleat)
- Y 1 3/4 x 8 x 31 1/2" mahogany plywood (shelf)
- Z 1 3/4 x 12 x 34" mahogany plywood (top)
- AA 2 3/4 x 24 1/2 x 34" mahogany plywood (leaf)
- BB 6 1/4 x 1 1/16 x 34 1/2" mahogany (top/leaf trim)
- CC 2 1/4 x 1 1/16 x 12" mahogany (top trim)

- DD 4 1/4 x 1 3/16 x 24 1/2" mahogany (leaf trim)
- EE 2 3/4 x 1 3/4 x 10 3/4" mahogany (stop wedge)
- FF 2 3/4 x 1 3/4 x 1 3/4" mahogany (stopblock)
- GG 4 1 3/8 x 2" Stanley CD 5302 hinge (for gatelegs)
- HH 2 1 1/2 x 30" Stanley SC 311 continuous hinge (for top and leaves)
- II 4 2 1/4"-dia. Shepherd ball casters
- JJ 12 Tabletop fasteners
- KK 12 1/2" No. 8 rh screws
- LL 2 2" No. 10 fh screws

- MM 2 3/4" No. 6 fh screws
- NN 12 1 1/4" No. 8 fh screws
- OO 16 3/8"-dia. x 1 1/2" dowel
- PP 16 5/16"-dia. x 1 1/2" dowel

Misc.: Source for stain, retarder and cornering tool: Garrett Wade, 161 Avenue of the Americas, New York, NY 10013. Stain: Behlen's Solar-Lux Stain, Medium Red Mahogany No. B5033A116; Behlen's Solar-Lux Retarder No. B500-00A25; Minwax Clear Gloss Polyurethane.

Cut a thin cardboard template that matches the bottom outline of the rail. Trace the outline on each top, and put the pieces aside (Photo 3).

Mark the stiles and lower rails for mortises and tenons. Use a dado head on the table saw to cut the

tenons on the rails. To form the mortises, bore a series of overlapping holes then chisel the mortise sides parallel and the ends square. Next, insert dowel centers in the upper rail and press the rail and stiles together so the dowel centers make indents

(Photo 4). Bore dowel holes on the marks in the stile using a drill press.

Now cut the contour in the upper rail. Adjust the band saw for a 7° bevel and make the cuts with the bottom edge of the rail facing up (Photo 5). Be sure to save the cutoff pieces.



To sand out the saw marks, clamp a scrap board to the drill-press table so the table is propped up at 7°. This puts the face of the workpiece parallel to the sanding drum (Photo 6). Also, cut a 3/4-in.-dia. hole in the baseboard so the end of the drum is below the edge of the workpiece. This allows the drum to make full contact with the workpiece.

Use a 1/16-in.-rad. rounding-over bit in the router to round the edges on the top rail. Clamp the rail, front face down, onto the workbench with scrap blocks under the end laps while rounding the corners. Next, hold the rail in the vise with its bottom edge facing up. Use the curved cutoffs as clamping pads (Photo 7).

Next, tape the rear cutoffs to the rail to hold the workpiece level, and cut the front profile on the rail on the band saw.

Cut the tenons on the lower rail using a dado head in the table saw. Attach a fence and stopblock to the miter gauge. Butt the workpiece to the block and run it over the blade (Photo 8). Bore the mortises in the legs on the drill press, then pare their sides flat and their ends square with a chisel (Photo 9).

Tilt the blade on the table saw, and cut the angle on the bottom of the legs. Use a stopblock clamped to the miter-gauge fence to ensure consistency among all legs.

Rip and crosscut the stock for the rear frame and cut mortises and tenons where called for. Cut the seat pivot slot on the router table in three 1/4-in.-deep passes with a 1/4-in.-dia. straight bit. Clamp stopblocks on the router-table fence, and tilt the workpiece down onto the straight bit, then advance it to the stop (Photo 10). Hold the workpiece against the fence with a featherboard.

Round over the edges on the rear legs, but don't round the section where the leg and stile meet. We used a cornering tool to round the corners here (Photo 11). (See Misc. section of Materials List for a source for cornering tools.)

Next, glue and clamp the front frame. Attach the upper and lower rails to a leg and add the second leg. Clamp the assembly with two bar clamps and two C clamps (Photo 12). Don't use the router to round the top edge of the top rail, since the edge is curved in two planes. Instead, use the cornering tool. Finish sand the front and rear frames, then temporarily attach the hinges.

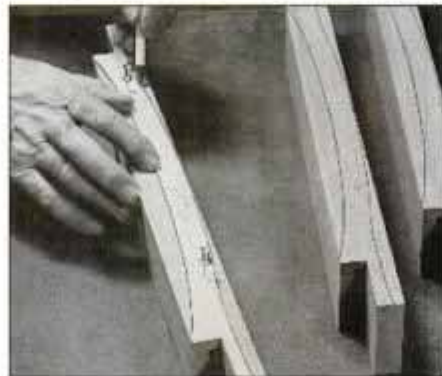
Next, rip and crosscut the stock



**1** Bore the dowel holes in the top rail. Offset a self-centering doweling jig using a thin piece of wood.



**2** Use alignment nails to prevent the two pieces of the top rail from sliding while you are gluing and clamping them.



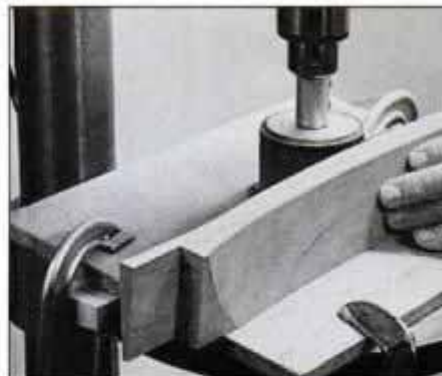
**3** Make a cardboard pattern of the top rail and pin it to the blanks. Carefully trace the pattern with a pen.



**4** To mark the dowel holes in the legs, insert dowel centers in the top rail and press the rail against the leg.



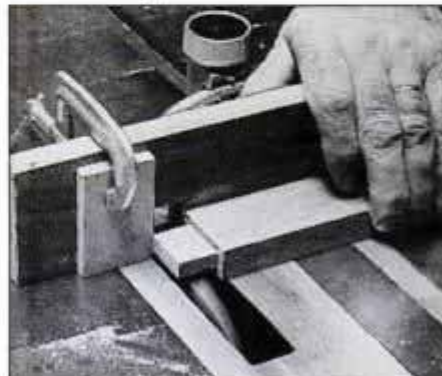
**5** Tip the band-saw table to 7°. Cut just to the waste side of the line and save the cutoff pieces.



**6** Clamp a panel to the drill-press table elevated at 7°. Use a drum sander to smooth the top rail.

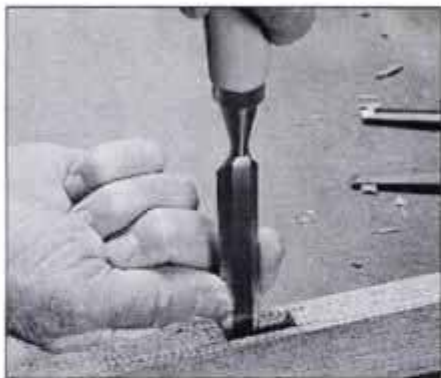


**7** Clamp the top rail in a vise using cutoffs as clamp pads. Round its front edge with a router and rounding-over bit.

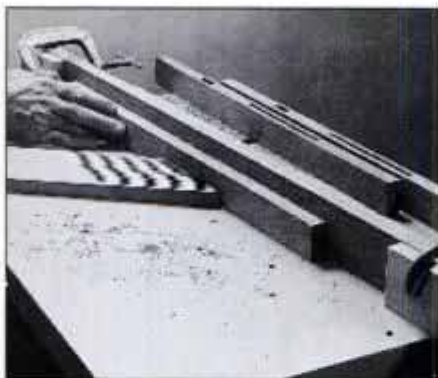


**8** Cut the tenons on the rails using a dado head in the table saw. Use an auxiliary fence and stopblock in this step.





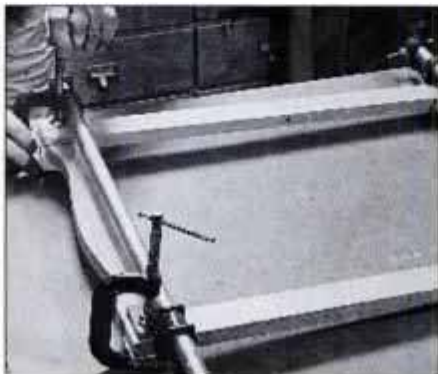
**9** Bore overlapping holes in a leg to form a mortise. Pare the mortise sides flat and parallel, and pare the ends square.



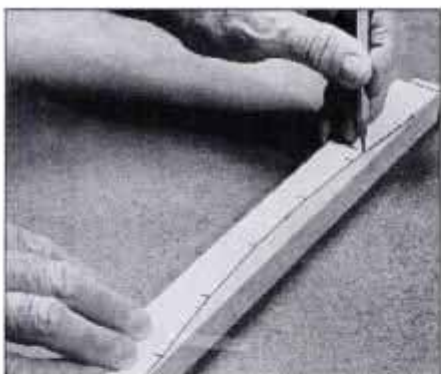
**10** Cut the slots in the legs with a straight bit in the router table. Cut the slot in three progressively deeper passes.



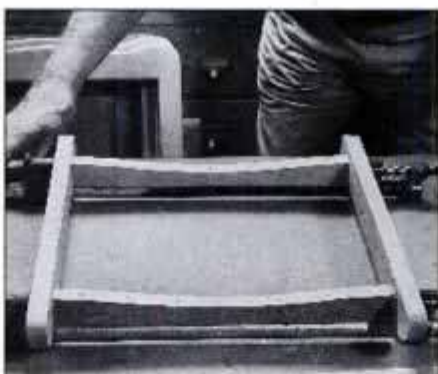
**11** Round the corners on the legs, except where they meet the rails. This is done quickly with a cornering tool.



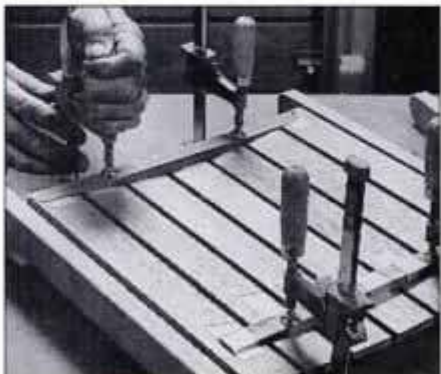
**12** Using two bar clamps and two C clamps, glue and clamp together a pair of legs spanned by a top rail and a lower rail.



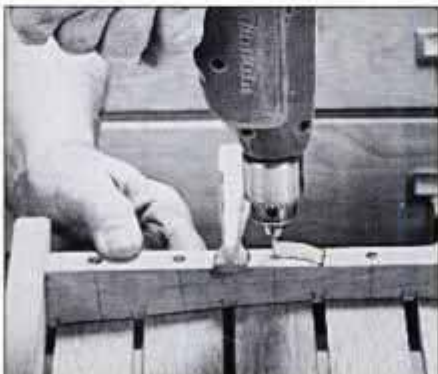
**13** After you cut the tenons, make a cardboard pattern of the seat crossmember and trace it onto the workpiece.



**14** Bore the pilot holes in the crossmembers, then glue and clamp them to the seat sides.



**15** Hold the seat slats to the seat frame using the curved cutoffs from the crossmembers and clamps.



**16** Bore pilot holes into the seat slats. Use a piece of tape wrapped around the drill bit as a depth guide.

for the seat sides and crossmembers. Mark the pivot pinholes in the side members, then bore the holes. Next, mark and cut the mortise and tenons in the seat sides and crossmembers.

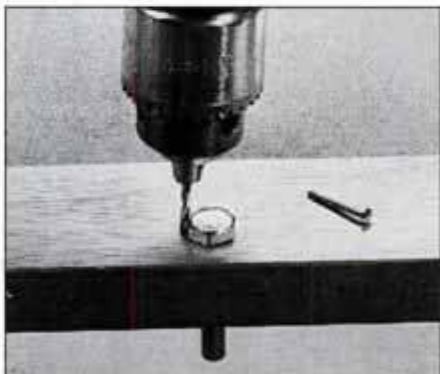
The top edge of the crossmembers is a series of flats. Cut a cardboard template of the shape and trace the outline onto each piece (Photo 13). Cut the facets on the band saw, then clean up the saw cuts with files.

The seat slats are screwed to the crossmember, and the screws are driven perpendicular to the face of each facet. Mark layout lines perpendicular to each facet for the pilot holes and use the lines as a guide while boring the pilot holes with a  $\frac{3}{32}$ -in.-dia. bit. Next, counterbore each hole with a  $\frac{1}{2}$ -in.-dia. bit then glue and clamp the seat frames together (Photo 14).

Make the  $\frac{3}{8}$ -in.-thick seat slat stock by resawing  $\frac{5}{4}$  stock on the band saw or table saw. Crosscut the slats to length and rip them to width. Clamp them to the crossmembers using the shaped cutoffs from the crossmembers. Bore the pilot holes into the slats with a  $\frac{3}{32}$ -in. bit (Photos 15 and 16). Use a piece of tape on the drill bit to serve as a depth indicator, and code each slat to avoid mix-ups during later reassembly.

The pivot pins are hexhead capscrews with the threaded section cut off. Cut these to length from  $\frac{1}{4}$ -in.-dia.  $\times$   $2\frac{1}{2}$ -in. and  $3\frac{1}{2}$ -in.-long capscrews. Bore  $\frac{1}{4}$ -in.-dia. holes in the seat frames and chair legs to accept the pivot pins.

Drive oval-head nails (escutcheon pins) next to the capscrew heads to serve as retainer pins to hold the screws in place. To bore the hole for the retainer pin, insert the capscrew then position a  $\frac{1}{16}$ -in.-dia. drill bit against the flat of the hexhead (Photo 17). The nail should fit the hole snugly, and its head will prevent the



**17** Bore a hole for the escutcheon nail that fastens the hinge pin. Position the drill bit against the hinge pin.



capscrew from creeping out. Just make sure to bore these holes before installing the slats.

### The Table

Rip and crosscut the upper and lower aprons and the components for the gatelegs. Glue up the stock for the legs, then rip, crosscut and joint the legs to shape and dimension.

Use the doweling jig to bore dowel holes in the ends of the aprons. Place two thin pieces of stock under the apron to align it correctly with the legs, and use guide blocks clamped to the legs to locate the apron position on the leg. Insert dowel centers in the dowel holes, and press the parts together to mark the location of the dowel joints (Photo 18). Bore matching holes in the legs.

Next, cut the stopped grooves in the aprons. To do this, tape markers on the table-saw fence and the workpiece to guide the length of the cuts. Then make the cuts (Photo 19).

Use a router to round over the corners of the aprons and legs, then sand the aprons and legs. Glue and clamp the long aprons to the legs. Then glue and clamp these subassemblies to the short aprons (Photo 20).

Temporarily attach the casters to the legs, then glue and clamp the gateleg assemblies and attach the hinges to them. Mark the hinge locations on the table legs so the bottom of the gateleg coincides with the bottom of the casters (Photo 21).

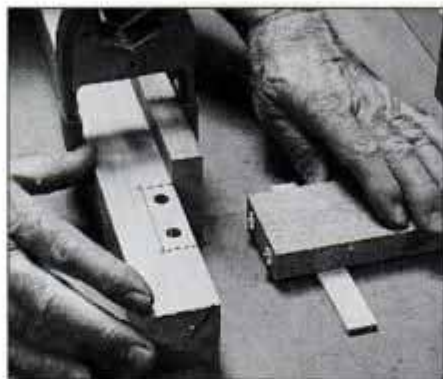
Next, attach the cleats to the lower aprons. Cut a plywood panel to fit, and glue and screw it to the cleats.

Cut the plywood panels for the top to rough dimension. Then attach a strip of wood to each panel that fits snugly in the miter-gauge slot in the saw table. Mark the desired cutting line on the back of the panel, then tack nail the strip to it. Offset the strip on the panel by the distance from the inside edge of the blade to the inside edge of the table groove (Photo 22).

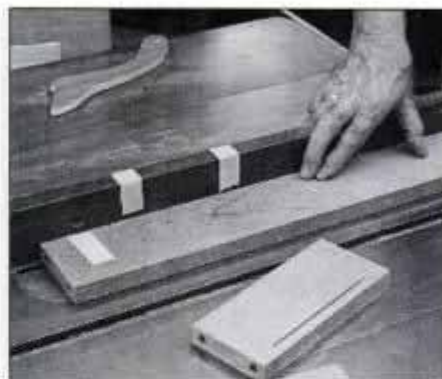
Rip  $\frac{1}{4}$ -in.-thick  $\times$   $\frac{13}{16}$ -in.-wide strips and glue them to two opposite edges in two stages. When the glue has set, plane the banding flush to the surface (Photo 23).

Lay the three tabletop panels on the workbench, bottom face up. Insert  $\frac{1}{16}$ -in. shims between them for edge clearance. Mark the hinge screwhole centers along the drop leaves and the center top piece (Photo 24). Screw the hinges in place.

Secure the table base to the top with the tabletop fasteners installed



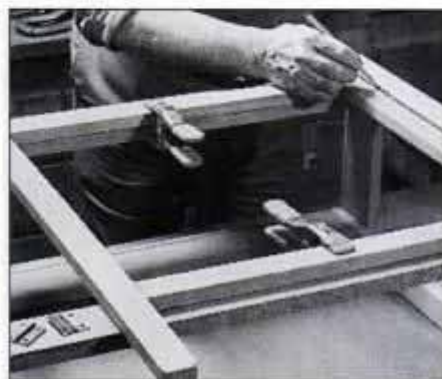
**18** Bore the dowel holes in the aprons, and mark hole positions on the legs using dowel centers and guide blocks.



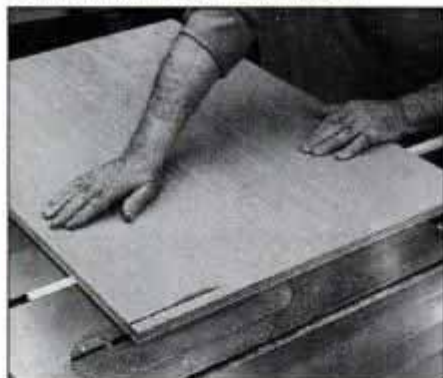
**19** Saw the slots in the aprons. Put tape on the fence and workpiece to mark where the cut starts and stops.



**20** Glue and clamp the legs to the long aprons. Then glue and clamp these subassemblies to the short aprons.



**21** Clamp the gatelegs to the table base and mark their hinge locations. Remember to install casters for this step.



**22** Cut the top on the table saw. Guide the workpiece with a strip tacked to the panel's back.



**23** Glue edge banding to the plywood. Banding is slightly thicker than plywood and is planed flush after glue sets.

in the apron grooves. Cut and install the gateleg stop wedges. Then, partially disassemble the chairs and the table.

Stain the chair and table components. We used Behlen's Solar-Lux Stain, Medium Red Mahogany, altered with 1 part Solar-Lux Retarder to 6 parts stain. This non-grain-raising stain is very fast-drying and must be retarded to avoid leaving lap marks.

Finish the project by applying three coats of polyurethane. We used Minwax's Clear Gloss Polyurethane. Sand lightly between coats with 220-grit sandpaper.



**24** Invert the top and base on the workbench. Attach the center top to the aprons and mark the hinge screwholes.



**LAWN & GARDEN**  
**NATURAL  
 LAWN CARE**

BY MERLE HENKENIUS  
 PM Illustrations by  
 Eugene Thompson

● If you've been using synthetic chemicals—and chemicals alone—to improve your lawn, you're missing alternative strategies that will not only help you reach your goal, but are kinder to the environment, as well. While synthetic chemicals can be effective, most sources agree that we've been relying on them too heavily. It may take a season or two, and setbacks are to be expected, but a less-toxic approach is workable. Alternate methods abound, though adopting the right combination of measures takes some education.

To help focus our thinking, and to correct our perspective, let's look at what we know to be true. We know that prior to the wide use of chemicals, beginning in the 1960s, people had reasonably attractive and functional lawns. Were they the vast, manicured stretches of blue-green perfection occasionally glimpsed today? Not at all. They were a little spotty in places and generally included a mixture of turf grasses, low-growing clover and, yes, a few weeds. In other words, they were a lot like many chemically treated lawns we see today.

Which brings us to an important element in enlightened lawn care—altered expectations. As it turns out, perfection is a costly concept, both environmentally and financially. By slightly diminishing your expectations, your lawn can become a self-sustaining pleasure, and not a hole into which you pour your money and energy.

One problem with chemical pesticides and herbicides is that they offer only a temporary solution. Over the long term, weeds, diseases and insects still enjoy the upper hand. For example, if you apply a selective crabgrass herbicide, with luck, you'll kill the current stand of crabgrass. The problem is that thousands of crabgrass seeds lie ready to start the cycle anew. A similar conundrum exists with insects. Insects are best controlled by other insects. This has been the case for millions of years.



But when we kill the nuisance bugs, we also kill their natural enemies. And, a new batch will soon drift over from your neighbor's lawn.

Another problem is that many of us have never figured out exactly which chemicals to use, or how and when to apply them effectively. We might apply a pesticide for the grubs we find in June, for example, not knowing that grubs don't feed until about the third week in July. All we end up killing are beneficial insects and birds.

**Old grasses**

Here's the most important thing to know about lawns: If you establish a disease- and drought-resistant grass, many of your lawn problems will go away. In fact, often the best way to reduce water and chemical usage is to till up that beloved, old-generation bluegrass.

The problem is that traditional bluegrass has a very shallow root structure, with nearly all of its roots

within 5 in. of the surface. When surface moisture is depleted quickly, as it is in many parts of the country, the grass becomes distressed and susceptible to disease. The more constant subsoil moisture that rests only a few inches farther down remains out of reach. Lacking sufficient moisture, traditional bluegrass will also revert to its thinned-out, conservation mode, which is an open invitation to deep-rooted weeds to fill the gaps. Add to this the fact that traditional bluegrass has little shade tolerance, becomes thatch bound annually and is genetically vulnerable to several kinds of blight and a host of insects, and pretty soon other grass varieties begin to have real appeal.

Let's consider an equally traditional, though hardier, competitor: tall fescue, or K-31 fescue. Its roots are long enough to reach the more constant subsoil moisture. What this means to you is a tremendous water savings. It is also genetically more resistant to fungal and bacterial leaf



blight, and grubs find its roots much less appealing than bluegrass roots. When well established, it can actually choke out some weeds, and as a clump grass, it won't invade the neighbor's yard or your flower garden. And finally, it won't commit suicide with a dense layer of thatch.

## Improved turf grasses

If tall fescue (with its coarse leaves and rapid top growth) is not for you, then you might consider red fescue, or one of the new, fine-blade dwarf fescues. How good are the new wonder-grasses? Some varieties, such as those offered through the Gardens Alive catalog (5100 Schenley Pl., Lawrenceburg, IN 47025), have roots that reach down a foot or more and are poisonous to some insects.

Certain grasses have always harbored microorganisms (fungi) called endophytes, which produce alkaloids that are poisonous to sod webworms, cutworms, aphids and chinch bugs. The new blends contain enough of these toxins to make a difference. Add to this characteristic deep roots and slow top growth, and you start getting your weekends back.

If you can't bear to part with bluegrass, you might try overseeding with one of the newer, hardier blue-

grass varieties. Overseeding is understandably slower than starting from scratch, but several years of overseeding with an improved variety will greatly improve your lawn. In three to five years, the new variety should overtake the old.

Overseeding can be done in the spring or fall, though fall is better. When overseeding bluegrass, it's best to use another bluegrass variety. Assuming an autumn seeding, start by dethatching and removing the debris. Then overseed and rake it in so that the seeds are partially covered. Finally, water deeply, then wet the soil daily for several weeks.

Traditional warm-season grasses, common in the Southeast, also have been improved. The newer zoysiagrasses (such as Meyer Z-52) are less cold-sensitive and therefore stay green longer and can be successful farther north. To further green-up your zoysiagrass, you might overseed with a fescue. In fact, many turfs can benefit from a judicious overseeding with complementary varieties. Perennial ryegrasses are popular overseeding choices.

Because no single grass is right for all situations, a blend of grasses will often prove more durable. Most lawn centers can custom blend grass-

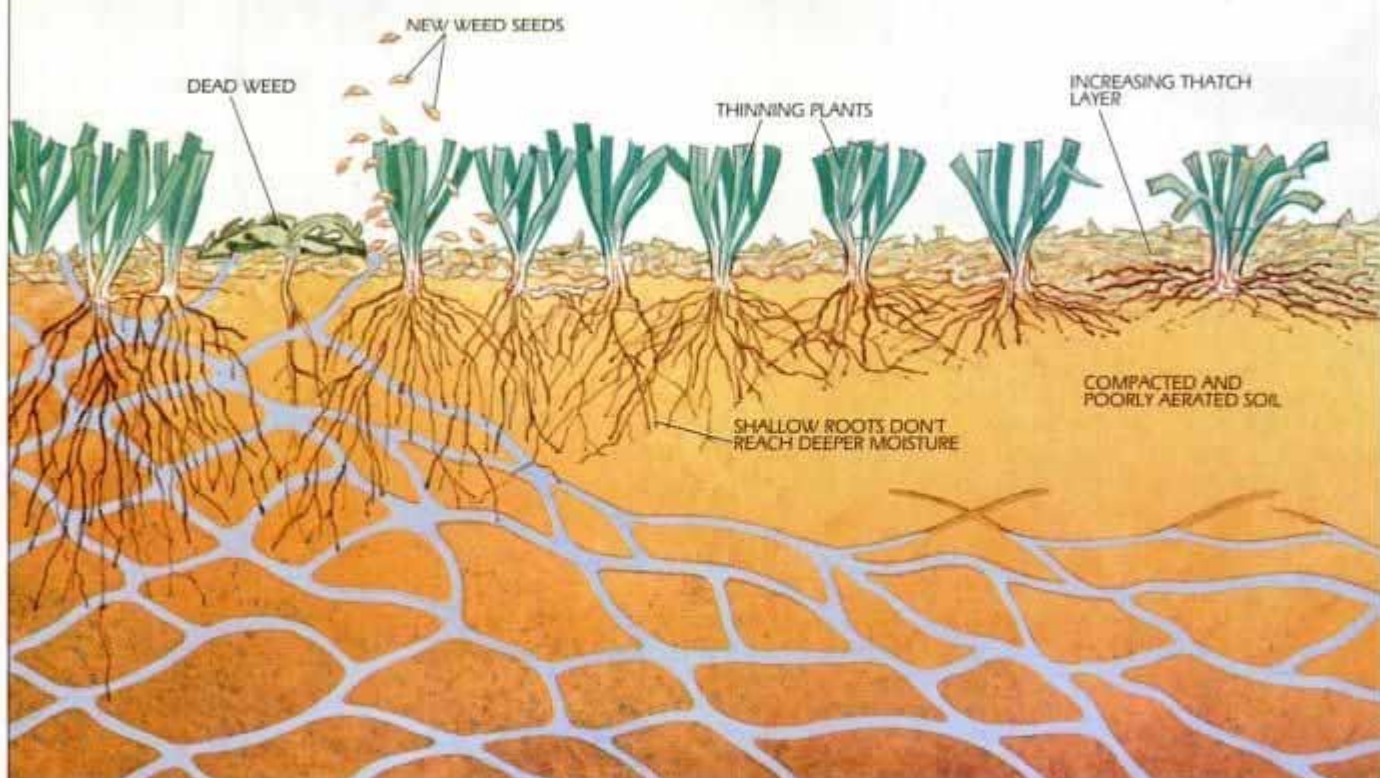
es to your specifications. Check with your county extension agent for the best mixes for your area.

## Turf management

Thatch accumulation is an almost universal trouble source which is encouraged by heavy doses of fertilizer. Thatch is a dense matting of plant matter that accumulates at ground level. Where thatch is dense, grass populations thin out. Thatch harbors and encourages insects and shields the root structure from moisture and nutrients. It also renders the chemical treatment of subsurface pests ineffective. Virtually all Southern grasses, plus bluegrass, ryegrass and the fine-leaf fescues need mechanical dethatching at least once a year.

A condition most problem lawns have in common is compacted soil. Turf grasses need an aerated soil to thrive, while most weeds favor compacted soil. Soil-aeration machines cut plugs from the top layer of soil, leaving holes that help alleviate compaction. The plugs then break down and are assimilated into the topsoil layer. While you should aerate each spring, the best natural aerators are earthworms and ants, which ironically, are the first victims of pesticides and quick-release fertilizers.

## CHEMICALLY TREATED BLUEGRASS LAWN



As surface moisture moves deeper, shallow bluegrass root structure can't reach water. Pesticides eliminate earthworms, which creates nonaerated compacted soil. Thinning and shallower roots follow. Heavy thatch encases roots and promotes insect infestation. Herbicide treatments kill weeds while new airborne weed seeds start growth again.



In fact, without these two aerators, and the millions of microorganisms that follow, it's doubtful that any lawn could be sustained in good condition for long. The thousands of tunnels they create keep the soil loose and provide direct downward pathways for moisture and nutrients.

As an added bonus, earthworms consume thatch and convert it to plant food. The earthen castings left by earthworms, for example, are up to seven times richer in nitrogen than normal soil. As for microbes, they are indispensable, as they render nitrogen extracted from a wide range of organic substances. They are what separates active soil from inert dirt.

In addition to dethatching and aerating, use a mulching mower with a sharp blade to return nutrients to the soil. Contrary to popular belief, grass clippings do not contribute to thatch buildup—the clippings are 90% water and they decompose quickly.

## Synthetic fertilizers

While you might not want to eliminate synthetic fertilizers entirely, you often can cut back to fertilizing once a season, or less, by keeping your turf aerated and dethatched and by using a mulching mower.

Choose a slow-release fertilizer and water it in deeply. Too much applied too often merely burns the grass, reduces the earthworm population (and nitrogen-converting microorganisms), stimulates top-growth and encourages thatch accumulations. The best time to fertilize cool-season grasses is after the peak growing period, in late fall. Warm-season grasses should be fertilized before the peak growing season.

## Natural fertilizers

Natural fertilizers, made of bone meal, blood meal, feathers, seaweed, fish byproducts, bat droppings, ash from sunflower-seed hulls and a variety of other substances are becoming increasingly popular. Most of these packaged fertilizers also include nitrogen-converting microbes. The primary difference between conventional, inorganic fertilizers and organic fertilizers is that inorganics exist in a ready nitrate state. The moment you add water, the nutrients can be absorbed by plant roots.

Organic fertilizer, in contrast, first must be converted by microbes in the soil from an organic to an inorganic state. The microbes actually produce the nitrates. As this process takes place deeper in the soil, the ni-

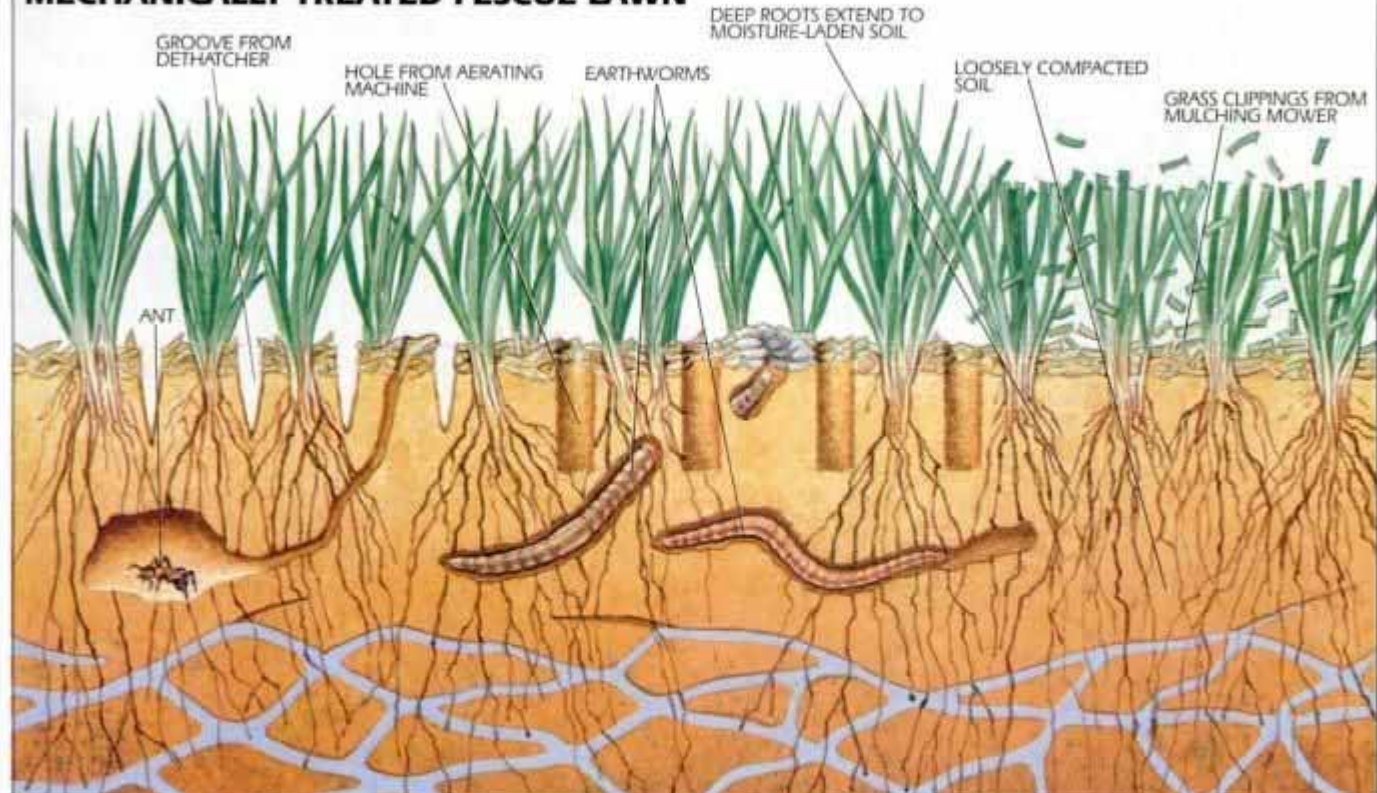
trates are not as exposed to surface runoff. This is not to say that nitrates from organic material cannot be eroded from the soil, or leached downward through sandy soil, but that the problem is a lesser one. Because nutrients are released slowly, organics can be applied any time throughout the year.

The one disadvantage is that organics are generally more expensive. You may be able to beat the system, however, by buying the ingredients in bulk (less microbes) and mixing your own. Look to blood meal for nitrogen, bone meal for phosphorus, and sunflower-seed ash for potassium. (If this option is available at your local gardening supply outlet, it should be able to suggest a proper mix for your area.)

## Improving soil structure and pH

Don't automatically assume that a thin, pale turf needs fertilizing. It well may, but often the soil structure or soil pH is the problem. Grasses grow best in at least 6 in. of topsoil. By digging down a foot or so, you'll be able to see how much topsoil you have, as evidenced by its darker color. Composted manure, which is odorless, can also be added to the

## MECHANICALLY TREATED FESCUE LAWN



Deep-rooted fescue variety reaches moisture up to 10 in. deep. Earthworms and ants aerate soil through tunneling, and earthworms contribute nutrients. Thatch layer is kept in check through dethatching and a mechanical aerator further loosens soil. Grass clippings from frequent cutting with a mulching mower decompose and provide nutrients.



surface a little at a time, as can peat moss and gypsum pellets.

Another option is to treat your lawn with an enzyme-activated soil conditioner, such as Nitron Formula A-35 (Nitron Industries, P.O. Box 1447, Fayetteville, AR 72702). Research indicates that by increasing certain enzymes in the soil, water-tension factors are altered and the soil is made more water permeable and absorbent. As such, water-borne nutrients are more easily accessed by plant roots and soil compaction is reduced. Nitron Industries' product costs about \$8 per 2500 sq. ft. of lawn.

The only way to check for proper pH is with a soil test. You can call a professional or take a soil sample into your local lab, extension office or university. Home testing kits are also available through catalogs and garden centers. An alkaline soil will need an application of sulfur or gypsum, while acidic soils will benefit from a sprinkling of lime. Turf grasses do best within a pH range of 5.6 to 7, and your extension agent or dealer will know which plan is best for your lawn.

As for watering, it's always best to water more deeply and less often. To hold down fungi-related leaf blight, water in the morning so that the grass dries quickly. Avoid evening waterings.

## Weed, pest and disease control

When it comes to weed control, a healthy, well aerated, dethatched

and nutrient-rich turf will choke out all but the most stubborn invaders. The rest can often be managed by hand weeding and mowing.

Pest management, on the other hand, is really a matter of numbers. A few pests won't make that big a difference, and may even signal a healthy lawn. When your lawn is naturally disease and insect resistant, and is kept healthy using the methods discussed above, the degree of damage is often acceptable.

The natural approach pays the biggest dividends in the area of insect and blight control. Natural insect control takes two primary forms. You can use natural substances that attack the body of the insect directly or release disease-causing microorganisms (fungi, nematodes), which burrow into the target insect, killing it in the process.

We'll take a brief look at those products with the best record of success. These products are offered by a variety of firms, the Ringer Corp. (9959 Valley View Rd., Eden Prairie, MN 55364) being the most prominent. Ringer also markets the Safer line. A word of caution is in order, however. Insecticides, of any kind, should be used sparingly and only as a last resort. Some beneficial insects will be killed in the process, no matter what you use.

One of the most effective, broad-spectrum insecticides is extracted from the seeds of African and Southeast-Asian neem trees. The active in-

gredient, azadirachtin, is a growth regulator, which is to say that it causes death. The Ringer/Safer Corp. markets this extract under the BioNeem trademark. It's effective on a variety of pests, including aphids, gypsy moths and webworms. Though BioNeem has very low toxicity, it does have a 2-to-7-day residual period, during which it remains effective. Because of this, its use in a vegetable garden is certainly inappropriate.

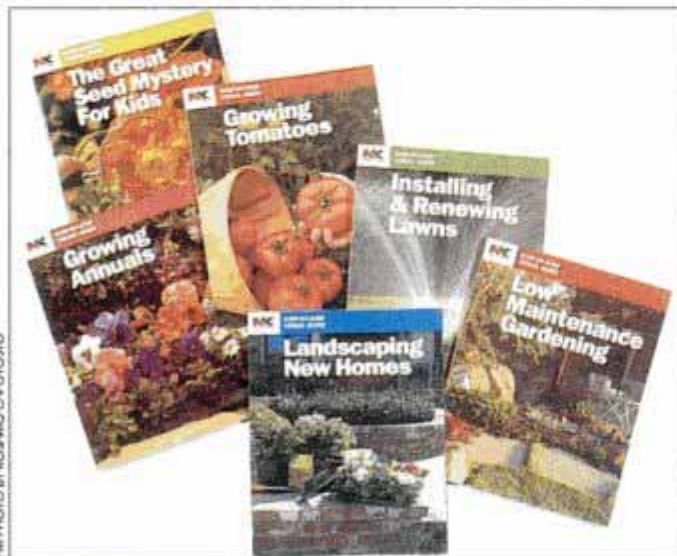
Insecticidal soap is another proven insect killer. It's made from fatty-acid salts derived from animal fat and plant oils. When sprayed on soft-bodied insects, it kills them by breaking down their cell-wall membranes. Insecticidal soap works well on sod webworms.

For effective control of hard-bodied insects, such as june bugs and Japanese beetles, pyrethrum, an extract from the chrysanthemum flower, works well. To treat infestations of subsurface grubs, you might try mail-order nematodes, which kill grubs from within, or milky-spore disease (*Bacillus popilliae*), which is a fungus that attacks grubs and other soft-bodied subsurface pests. Once established, milky-spore disease remains effective for years.

For treatment of bill-bug larvae, diatomaceous earth works. Diatomaceous earth is a sediment taken from the seafloor and is made up of millions of dead, single-cell creatures that dehydrate soft-bodied insects on contact. **PM**

## BOOK REVIEW

# NK LAWN AND GARDEN BOOKS



● If you're a homeowner with a thumb that's less than green, you can always solve your lawn and garden problems with several yards of concrete. However, if that hard, gray vista doesn't appeal to you, it may be time to look to the experts for some advice. One excellent source is a series of books published by NK Lawn & Garden Co.

If tomatoes are your passion, NK's *Growing Tomatoes* tells you their history, where and how to grow different varieties and how to control pests. Interested in flower gardening? There's a book devoted to growing annuals, which includes information on all your favorites, from African daisies to zinnias.

For those who simply desire a green lawn, NK offers *Installing & Renewing Lawns*—a comprehensive look at what it takes for healthy turf. And, if you'd like a garden, but are less than enamored with the work it takes, you'd probably benefit from *Low Maintenance Gardening*—a book devoted to choosing plants, shrubs and ground covers that are as easy to take care of as they are to look at. Finally, there's a book on landscaping and, for the kids, one that explains how plants grow.

Each book is illustrated with drawings and photos, and features step-by-step guides for doing the work yourself. The books cost \$7.95 each at garden supply retailers and home centers. Contact NK Lawn & Garden Co., Box 59282, Minneapolis, MN 55459. —Tom Klench



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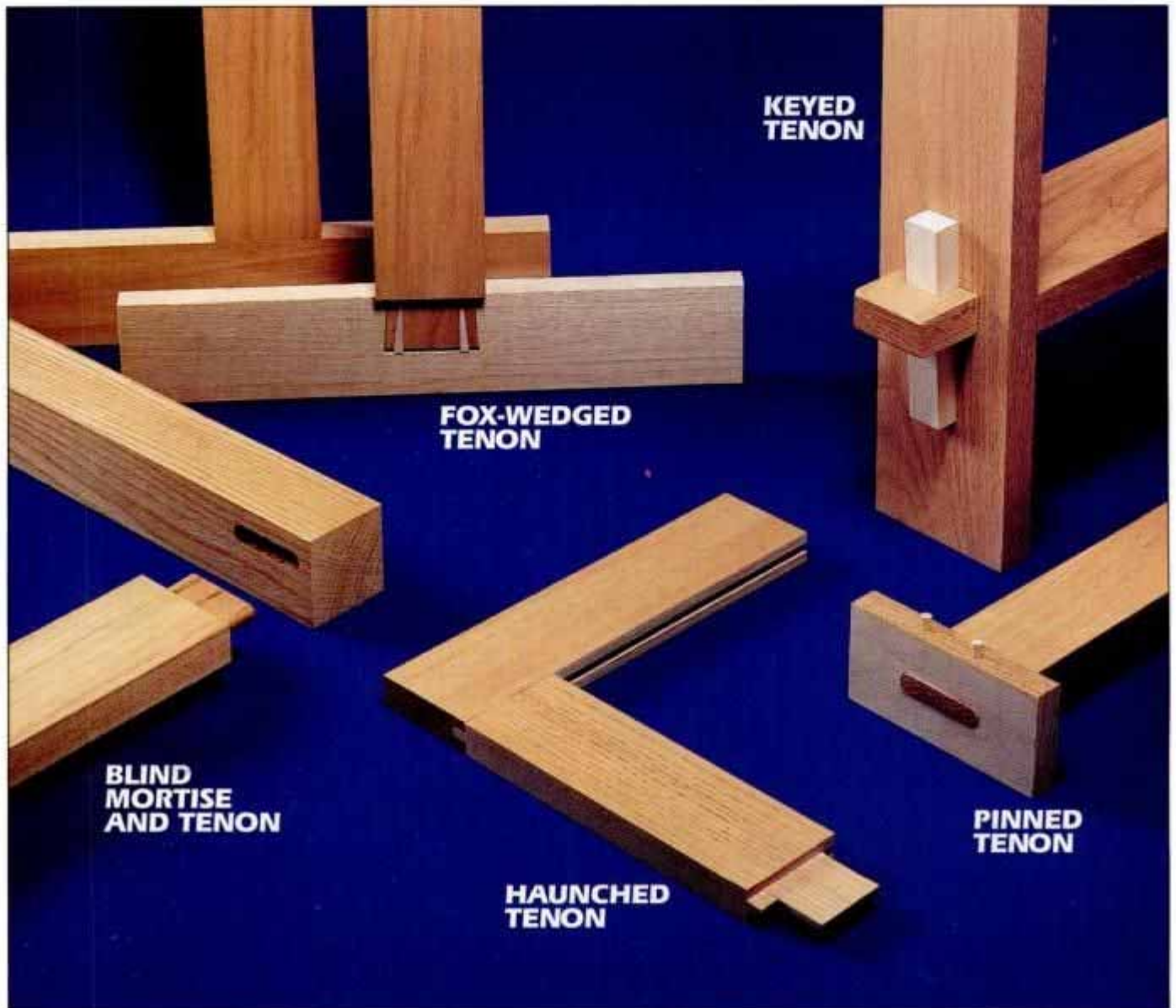
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**SHOP  
 TECHNIQUES**

**MORTISE-  
 AND-TENON  
 JOINTS**

TEXT AND PHOTOS BY  
 ROSARIO CAPOTOSTO,  
 Contributing Editor

● Long before plate joiners and doweling jigs—in fact, long before screws were invented—woodworkers relied on simple, strong joints that could be made with basic tools. And of all the joints used, the mortise-and-tenon joint was clearly the most widely employed when it came to joining wood at right angles. To-

day, the joint remains the undisputed leader for strength and durability and sets the standard by which modern joining techniques are judged.

As its name implies, the joint is comprised of a mortise, or cavity, cut into one piece, and a mating tenon shaped on the other. In addition to the simple mechanical strength of this union, the joint provides excellent long-grain contact for gluing. The ability of the joint to resist racking and twisting makes it the choice for chair and table rail-to-leg joints as well as top-quality door and cabinet face-frame assemblies.

The basic mortise-and-tenon joint is either a blind or a through joint. In a through mortise-and-tenon joint, the mortise extends completely through the stock and the end of the tenon is visible. In a blind joint, the mortise stops short of the opposite face. Other variations include the

haunched, wedged and fox-wedged and keyed mortise-and-tenon joints.

A haunched joint is commonly used for corner joints in frame construction. The small hip on this tenon serves to fill the panel groove in door stiles and is also used when there is no groove to resist twisting. The fox-wedged joint is a blind mortise and tenon with internal, hidden wedges that produce a blind dovetail-type joint as the tenon is driven into place. Through wedged tenons have the wedges driven in from the opposite face. Keyed mortise-and-tenon joints are reserved for nonglued assemblies and knockdown furniture. Here, the tenon projects well beyond the mortised member and is itself mortised to accept a tapered, locking key. In addition to being functional, the keyed mortise-and-tenon joint adds some visual interest to the finished piece.



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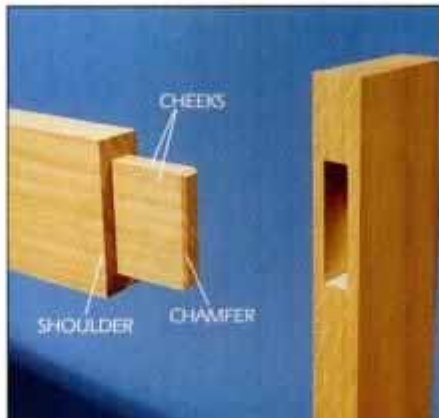
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## Joint Layout

The design of a basic tenon is important as it affects the joint's strength. The wide surface cheeks of a tenon provide gluing area, and the shoulders, when pressed tightly against the adjoining piece, mechanically resist racking. The shoulders also hide the actual mortise. The ends of the tenon are chamfered (Photo 1).

When planning a joint, make the tenon thickness about one-third of the stock's thickness. You can increase this to about one-half if the mortise stock is thicker than the tenon stock. Use a marking gauge to lay out both the tenon cheeks and the mortise outline (Photo 2). Special marking gauges with double pins are available for laying out both sides of a joint at once. Use a square and a marking knife to lay out the tenon shoulders and mortise ends. The scored lines from the marking gauge and knife will serve to guide your chisel cuts as you fit the joint.



**1** Typical tenon is one-third the width of the stock. Cut shoulders square and trim cheeks for snug fit. Chamfer tenon ends.

The length of the tenon in a blind mortise-and-tenon joint is slightly less than the depth of the mortise. This allows a cavity for excess glue and ensures that the shoulders will seat against the adjoining piece. For a through mortise and tenon, cut the tenon slightly oversize in length—



**2** Use a marking gauge to lay out the tenon cheeks and sides of the mortise. Scribe shoulders with a knife and square.

the protruding end will be trimmed flush after assembly.

Always try to cut the mortise before cutting the tenon. It's generally easier to fit the tenon to the mortise than vice versa, particularly if the mortise is formed with bored holes or by routing.

## Cutting A Mortise

In the old days, a mortise would be cut with a chisel and a mallet. And, although you can still get the job done with these simple tools, it makes sense to use modern power equipment to remove most, if not all, of the waste.

One of the most expedient methods is to use a drill to bore overlapping holes within the mortise outline, and then trim the mortise sides to the line with a chisel. A drill press is ideal for this purpose, but a portable drill with a doweling jig to align the holes works nearly as well.

Set the doweling jig for boring holes centered in the mortise outline. Then, use a brad point drill bit to bore overlapping holes to the required depth (Photo 3). After the bulk of the waste is removed with the

drill, use a sharp chisel to trim the mortise sides flat and parallel to the layout lines (Photo 4).

Routing the mortise is probably the quickest solution for small shops and is ideally suited for small production runs such as might be required in chair, table or cabinet-door and face-frame construction. Here, the plunge router is the best tool for the job. Equipped with a straight bit of the right size, a plunge router can cut a mortise that requires no trimming by hand. In addition, many plunge routers handle 1/2-in. shank bits. These heavy bits are available in longer lengths than ordinary 1/4-in.-shank bits and therefore are suited to routing the deeper mortises that most furniture projects require.

After laying out the mortise, set the plunge-router edge guide so the

bit is aligned with the sides of the mortise. If the mortise width is larger than the bit, align the bit with one side of the mortise. This way, you can complete a centered mortise by making two passes—each referenced against an opposite face.

Next, tack stops to the workpiece in order to limit the travel of the router to the length of the mortise. If your workpiece is narrow, clamp the stock between two boards to provide a broad base on which the router can ride. To determine the placement of the stops, measure the distance from the cutting edge of the bit to the edge of the base. Then, place each stop that distance from the ends of the mortise.

To make the cut, first adjust the depth-of-cut stop on the router and place the tool in position on the work.



**3** If you don't have a drill press, use a doweling jig and brad point bit to remove most of the mortise waste.



**4** Trim roughed-out mortise to guidelines with a sharp chisel. Keep the sides parallel and square to the stock face.



**5** Set plunge router fence to align the bit and use stops to limit router travel. Make several passes to remove waste.



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Push the edge guide firmly against the workface, turn on the power and slowly plunge the router while making a pass from stop to stop (Photo 5). Don't try to achieve the full depth in one pass. Instead, make several shallow passes until the desired depth is reached.

## Cutting A Tenon

While a tenon is easier to make than a mortise, you have to take extra care in layout and cutting to ensure that it will fit snugly in the mortise. The simplest way to make a tenon is to cut away the waste with either a handsaw or a radial-arm or table saw. You can also use a handheld router or one mounted in a router table to remove the waste.

To cut a tenon with a handsaw, first lay out the shoulders with a square and a marking knife and the guidelines for the shoulders with a marking gauge. Then, make the shoulder cuts on the waste side of the line. A V cut made with a chisel on the inside of the shoulder lines will help guide the saw.

Next, position the workpiece vertically in your vise and make the narrow cheek cuts, followed by the broad cheek cuts (Photo 6). Then, use a sharp chisel to trim the shoulders exactly to the lines. Finally, test fit the tenon with the mortise and, if necessary, pare the cheeks for a snug fit. If you're making a tenon to fit a round-end routed mortise, use a chisel and rasp to round the tenon sides.

The most popular tool for making tenons is the table saw. On this machine, tenons can be cut with either a regular blade and a tenoning jig or a dado blade.

To cut a 4-shouldered tenon with a regular blade, begin by making the shoulder cuts. Clamp a stopblock to the miter-gauge fence to position the

Once the mortise is cut, use a chisel to square the rounded ends. If you cut a mortise the same size as the bit, you can leave the ends round and shape the tenon cheeks to fit with a chisel and rasp.

You can also rout mortises with a standard nonplunging router. In this

case, set up a high fence to guide the router in a straight line. Then, set the bit depth for a shallow cut, turn on the power and lean down the bit into the work. After the first pass, increase the bit depth, make a second pass and repeat the process until the desired depth is reached.

stock, and then set the blade height for the desired tenon thickness. Make the shoulder cuts on the faces of the workpiece first (Photo 7). Then, adjust the blade height and repeat the cuts with the work on edge to finish the shoulders.

A tenoning jig holds the work vertically for making the cheek cuts. Tenoning jigs are available from woodworking suppliers or you can make your own. The one shown here rides on the rip fence and uses a clamp to hold the work in place (Photo 8).

After cutting the shoulders, clamp the stock in the jig and position the jig so the blade cuts on the waste side of the cheek that faces away from the fence. Make sure the waste falls on the free side of the blade.

Cut the narrow cheeks by making

partial rip cuts with the blade set high and the stock held flat on the table. Clamp a stopblock to the fence so that the cut stops short of the shoulder (Photo 9). Then, use a chisel to trim away the waste pieces. You could also use a band saw to cut the narrow shoulders.

To cut a tenon with a dado blade, clamp a stopblock to the miter-gauge fence so the shoulder guideline lines up with the dado blade. Then adjust the height of the blade to suit the mortise thickness. After making the first pass, shift the stock over and remove the remaining waste with successive passes. When the broad cheeks are done, cut the narrow cheeks in the same way, readjusting blade height if necessary. Using a dado blade in this way is a fast way to cut haunched tenons (Photo 10).



**6** To cut a tenon by hand, first cut the shoulders. Then cut to cheek lines and trim shoulders square with a sharp chisel.



**7** With a standard blade in table saw, first cut tenon shoulders. A stop on auxiliary miter-gauge fence positions the work.



**8** Use a table saw tenoning jig to cut broad tenon cheeks. Align the work so waste falls away from the saw blade.



**9** Cut narrow cheeks by ripping toward the shoulder. Stop the kerf short of the shoulder and remove waste with a chisel.



**10** Use a stop clamped to an auxiliary fence to position tenon for cuts with dado blade. Here, a haunched tenon is cut.



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## Mortise-And-Tenon Variations

Once you've mastered the basic techniques for making mortises and tenons, you're ready to try a few of the many variations of this joint.

To provide extra strength to a mortise-and-tenon joint, drive pins through it to lock the tenon in place. This technique is common to traditional door and frame-and-panel construction and has applications in other situations, as well. A shallow mortise, for example, gains extra strength through pinning (Photo 11).

After cutting and fitting the joint, bore the dowel-pin holes through the mortised stock first. Then, temporarily assemble the joint and mark the hole locations on the tenon. Disassemble the joint and bore the holes through the tenon slightly closer to the shoulders than the marks indicate. The offset holes will draw the shoulders of the tenon tightly against the adjoining piece. Reassemble the joint and drive chamfered dowel pins through the holes, and then trim the pins flush to the surfaces with a sharp chisel, and sand.

Haunched mortise-and-tenon



**11** Use dowel pins to lock the tenon in place. Bore holes in the tenon slightly closer to shoulder to draw the joint tight.



**14** Make a pin to fit tapered mortise and tap it in place with a mallet. Here, joint secures trestle table leg to stretcher.

joint are well suited to traditional door construction. Make the mortises after the panel grooves are cut. Use each groove as a guide for the mortise sides, remove most of the waste by boring holes and clean up with a sharp chisel (Photo 12). When you cut the tenons, dimension the hip on the tenon to fit the short groove that extends past the mortise to the end of the stile.

The mortise and tenon for a keyed joint are cut the same way as a basic joint. First, lay out the main mortise and remove most of the waste with a drill. Bore small holes at the corners to simplify squaring the hole. Then, cut the tenon with a dado blade—in our example, the tenon has only two shoulders. To cut the mortise for the tapered key, first lay out guidelines and cut the mortise square. Then, use an angled guide block clamped to the workpiece to guide your chisel (Photo 13). Make the slope of the guide block about 1/8 in. over 1 in. After the tapered mortise is done, cut a tapered key to fit. Assemble the joint and tap the key in place with a mallet (Photo 14).

Wedged tenon joints offer great



**12** When cutting mortises in grooved stiles, use groove as a guide. Haunched tenon fills the gap left by the groove.



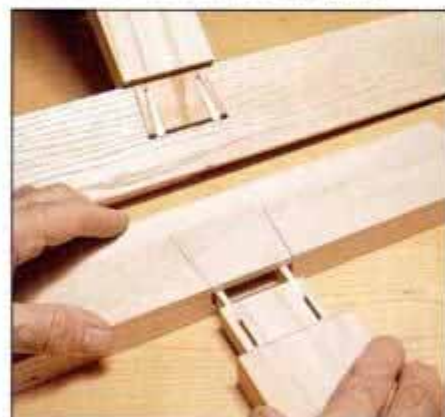
**15** Cut a tapered mortise of a fox-wedged joint with a chisel and guide block. Make mortise 1/8 in. deeper than the tenon.

mechanical strength because the wedges spread the tenon to create a dovetail-type locking effect. To make an ordinary wedged tenon joint, begin by cutting and fitting a through mortise-and-tenon joint. Then, taper the mortise sides using an angled guide block clamped to the stock, and cut slots in the tenon for the wedges. Assemble the joint and drive wedges into the slots to lock the tenon in place.

Fox-wedged joints are the blind counterpart to wedged-tenon joints. First, cut and fit a blind mortise-and-tenon joint, making the mortise at least 1/8 in. deeper than the tenon. Use a guide block to slightly undercut the mortise sides so they slope about 1/8 in. over 1 in. (Photo 15). Saw two kerfs in the tenon that stop about 1/8 in. from the shoulder. Then cut two narrow wedges to the length of the tenon. Make their narrow ends slightly less than the width of the kerf and taper them slightly less than the mortise taper. Finally, apply glue, insert the wedges in the kerfs and assemble the joint (Photo 16). Use a clamp to draw the joint tight and spread the tenon.



**13** To make a tapered mortise for a keyed tenon, use an angled block to guide the chisel after mortise is first cut square.

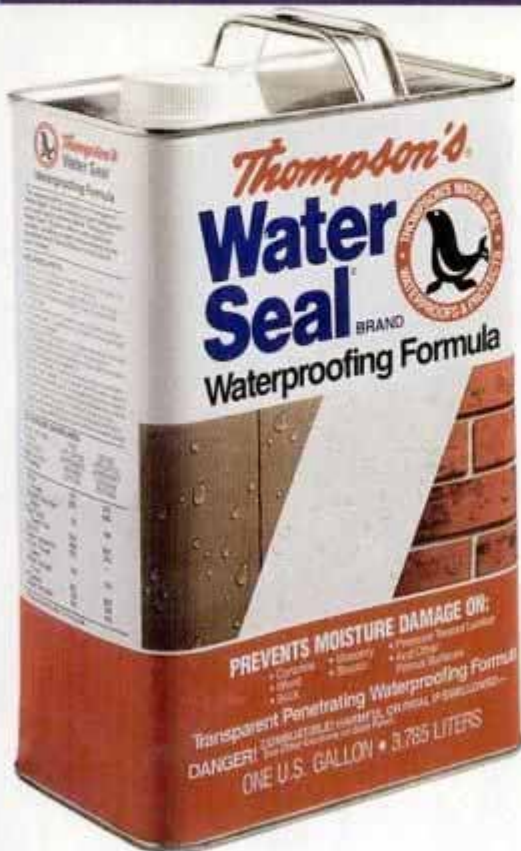


**16** Insert wedges in tenon kerfs. Tenon spreads when installed. Cutaway at top shows the locking dovetail effect.



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**NEW PRODUCTS**

**MADE IN THE SHADE**

BY ROY BERENDSOHN, Assistant Home Improvement Editor



**The Best Of Both**

The Char-Broil water smoker combines the best features of a smoker and a barbecue. You put charcoal and chunks of wood in the bottom of the appliance. Above the charcoal pan is the steam pan. Fill the pan with water (add wine, fruit juice or soda, if you like). Two cooking racks hold up to 50 pounds of food. One rack is at midheight, the other is just below the lid. The manufacturer says

this device acts like a large outdoor crock pot, slowly cooking food over a period of 4 to 7 hours. The food comes out moist and tender, Char-Broil says, because it has been steamed. The deluxe water smoker shown (about \$80), can also be converted to a barbecue. It's sold at home centers and department stores. For more information, write Char-Broil, 200 Brookstone Centre Pkwy., Suite 321-CW, Columbus, GA 31904.



**You Can Take It With You**

Firelight II is a portable propane barbecue and campstove. Unfold the appliance and you have two stoveburners inside its lid in addition to the base, which is a barbecue with nearly 200 sq. in. of cooking surface. Fold it together once it has cooled for storage and transport (a carrying case is optional, about \$15). It has a smoker plate so there aren't any lava rocks to roll around and cause a mess. Other nice features include a tabletop heat buffer and drip tray and independent heat control on both sides of the appliance. The appliance's lid and base are made from cast aluminum. It costs about \$120 to \$140 at LP gas suppliers, camping supply stores and cookware catalogs. For more information, write Firelight Division, Ducane Co., 800 Dutch Sq., Columbia, SC 29210.

**Big Light, Small Package**

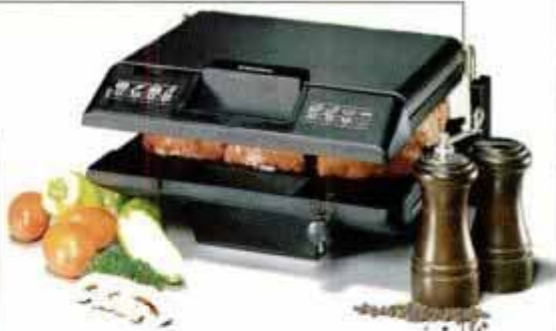
Lanterns are great, but often they require a fuel that you don't have handy, like kerosene or propane. This appliance solves that problem—it uses either unleaded gasoline or Coleman Fuel. What's more, the lantern is downright petite. At just 30 ounces and 9½ in. high, it's perfect to set on the picnic table when the cookout stretches into the evening. The single-mantle lantern burns for 3½ hours, and its light output is adjustable. Coleman estimates that it costs 2 cents per hour to operate on high. It costs about \$30 at sporting goods and hardware stores. Write The Coleman Co. Inc., P.O. Box 2931, Wichita, KS 67201.





### Rainy-Day Barbecue

The Rain-Er-Shine is a convertible barbecue. You can use it as a standard charcoal grill outside, or inside without charcoal on your electric or gas range. Because it's designed to reduce the amount of smoke produced when grilling food, you can barbecue indoors or out with a minimum of mess and less grease deposited on the food from the smoke. The 14½-in.-dia. barbecue is made from porcelainized steel with a twist-lock lid and a carrying handle. It costs about \$70 at department stores and in kitchenware catalogs. Write Talisman Marketing, 4120 Cameron Park Dr., Suite 401, Cameron Park, CA 95682.



### Indoor Cookout

Put the barbecue away when it rains, but not those nice juicy T-bone steaks. This electric grill cooks both sides of a steak, chop or fish simultaneously. Its manufacturer says you don't need to use cooking oil with it either. It can handle barbecue fare up to 2 in. thick. The 1600-watt appliance sears the food, sealing in its juices, says its manufacturer, while melted fat is channeled away from the food. The Express Health Grill costs about \$110 at department stores. For more information, write T-Fal Corp., 208 Passaic Ave., Fairfield, NJ 07004.

### We Have Ignition

Bar-B-Q Box solves two problems associated with charcoal grilling: You don't have to handle the charcoal to barbecue, and you don't need to use lighter fluid. To use it, place the box in your grill, pull open the top tapes and push in its bottom vent. Then put a match to the tab on the box, and the charcoal is ready in 8 to 10 minutes. The box has a petroleum-free igniter, which starts the charcoal. (You can also buy the igniter on its own, in packs of four, for about \$1.80.) Each box has 2½ pounds of hickory charcoal and provides 1½ hours of cooking time. It costs about \$2.20 at hardware stores and home centers. Write Camp's Fire, 2115 W. Park Dr., Lorain, OH 44053; or call (800) 237-7399.



### In The Swim

Building a swimming pool is not generally considered a do-it-yourself project, yet that's exactly what

this pool is designed for. It consists of two half-round sections that can be enlarged to create any length pool you want by adding pairs of 7-ft.-long extensions. The pieces bolt together with a gasket sealing the joints (stainless-steel bolts are provided). The pools are made from eight layers of fiberglass and have a turned corner along the top edge. The 4-ft.-deep pools can be installed in or above the ground, as shown. A 15-ft.-dia. pool costs about \$3400 (a pair of extensions costs about \$1520), and the mechanical system (heater, filter pump, plastic pipe and pipe fittings) is extra. The pools are sold by pool dealers and through Gemini Fiberglass Products Inc., 14224 W. First Dr., Golden, CO 80401.







**Take It Or Leave It**

With 255 sq. in. of cooking surface, this is a substantial, but portable, electric grill. The hood and burner box are made from cast aluminum, while the cooking surface is stainless steel. The grill costs about \$200 at appliance and home-and-garden stores. For more information, write Ducane Co., 800 Dutch Square Blvd., Suite 200, Columbia, SC 29210.

**Sunny Disposition**

The Solar Sun Shed is a versatile prefabricated shed that you can get with or without a photoelectric power kit (about \$800 extra). The shed has a pressure-treated lumber floor, 8-ft.-wide x 10-ft.-long ultraviolet-protected polycarbonate greenhouse windows, a dutch door and an openable side window with mullioned panes. A pretty nice structure, we think, for about \$1700. Except for batteries, the optional 48-watt solar panel is ready to install because it comes with a prewired control board, hardware, controller



and an owner's manual. The shed is sold through Real Goods Trading Corp., 966 Mazzoni St., Ukiah, CA 95482 and Gardener's Supply Co., 128 Intervale Rd., Burlington, VT 05401.

**Stay Sharp**

This carving knife holds an edge 10 times longer than competing kitchen knives, its manufacturer says. The entire knife (blade and tang) is forged from a proprietary metal that has more carbon and stainless steel than competing brands. Yet the knife is not difficult to sharpen, as are many high-carbon stainless knives, its manufacturer says. Also, the knife handle is molded on the tang to seal out the bacteria that forms from meat juices collecting between the tang and handle. Several sizes and types of knives are available in the Chef's Choice Trizor cutlery line,

including a bread knife and knives for boning, slicing and paring. The 6-in.-long utility knife has an edge that is shaped to provide a smooth rocking motion. It costs about \$60 through catalogs and gourmet shops. Write Edgecraft Corp., Limestone and Southwood Roads, P.O. Box 3000, Avondale, PA 19311-0915; or call (800) 342-3255.



**How Much Cooking Is Left In The Tank?**

This liquid-crystal device indicates the amount of propane left in the tank. The indicator has several vertical bars that indicate gas level. The bars on the lefthand side work in colder temperatures and the ones on the righthand side work in warmer



weather. The multiple bars are required to cover a wide range of outside temperatures because each bar covers a fairly narrow segment. At any given temperature, a single bar illuminates the gas level. The indicators cost about \$6 for an adhesive-back model to \$8 and \$12 for magnetic-back models. They are sold at hardware stores and propane dealers. For more information, write Clark R&D Ltd., 1918 Eastwood Dr., Arlington Heights, IL 60004. **PM**

**Light With Gas, Cook With Charcoal**

Weber has added propane-gas ignition to its Performer line of charcoal barbecues. The appliance has a pushbutton igniter switch. The barbecue has a long list of other nice

features, such as: a holder for the lid, the ability to grill with the lid off or to cook with the lid on

like a convection oven, a hinged cooking grate, a hinged-lid storage bin that can hold 20 pounds of spare charcoal, and a pivoting ash catcher. The model shown costs about \$350 at hardware stores and home centers. For more information, write Weber-Stephen Products Co., 200 S. Hicks Rd., Palatine, IL 60067; or call (800) 446-1071.





## HOME IMPROVEMENT

# BASIC DECK CARE

BY NEAL BARRETT  
PM Illustrations by  
George Retseck

● If you're like many homeowners, the backyard deck is the focal point for warm-weather activities. Whether used as a gathering place for dining and socializing, or as a quiet spot to read the newspaper or catch a nap, the deck extends your living space to the outdoors and enhances your leisure hours.

As with most parts of your home, however, a certain amount of routine maintenance is required to keep your deck structurally sound, safe and looking its best. And, if your deck is several years old, it's time to evaluate its condition, fix trouble spots that need immediate attention and employ a little preventive maintenance to ensure that your deck will continue to perform its role in years to come.

The design and construction of a deck can vary considerably, from a simple square or rectangle resting right on the ground to an elaborate, multilevel polygon supported on posts or piers. While it would be impossible to cover every particular condition that might need attention, the following tips and techniques will apply to most situations.

Chances are your deck is built of either cedar, redwood or pressure-treated yellow pine. These are the most commonly used materials because they are resistant to rot and insect damage. When exposed to the elements, however, any wood will show signs of weathering. Even if the deck was originally treated with a stain or preservative, this treatment eventually needs to be renewed.

### Surface treatments

First, inspect the surfaces of the deck and railing for excessive splintering. If splintering is a problem, sanding the surface is the simplest solution. Use a belt sander to smooth the boards on the deck surface. Sand only in the direction of the grain, and keep the sander moving evenly to avoid gouging (Fig. 1). On the railings, hand sand with a sanding block or use an orbital pad sander to remove



Decks and other exterior structures need regular maintenance to keep looking new. Periodic applications of deck sealer will help keep weathering to a minimum.

roughness and hazardous splinters.

You'll find many stains and sealers designed specifically for your deck. Several manufacturers offer products called deck brighteners (actually bleaches), which remove stains and weathering from the wood surfaces. Apply these products according to the manufacturer's directions, usually with a stiff-bristle brush, and rinse off the deck thoroughly before applying any top coat (Fig. 2). Be sure to wear gloves and eye protection.

Sealers protect your deck from moisture and are available in clear or tinted, which acts as a stain. Sealers need to be renewed periodically to of-

fer continuous protection. Stains are offered in a range of opacities for either completely hiding the grain or allowing it to show. When it comes to choosing a stain and sealer for your deck, check that both products are compatible and suitable for the type of wood your deck is made from.

After a new deck has been exposed to the elements for a year or so, shrinkage of the lumber can cause nails to pop up above the deck surface. If the boards are still flat, reset the nails slightly below the deck surface using a nailset or punch that matches the size of the nailheads (Fig. 3). If the deck boards have



cupped due to drying, there are several ways to approach the problem. If the cupping is not too severe, first remove the nails with a pry bar (Fig. 4). Then, install galvanized decking screws to pull the board flat (Fig. 5). If the board is too severely cupped to do this, use a pry bar to remove the board. Then use a circular saw to make a series of relief cuts along the back, convex surface of the board, equal in depth to about one-third of the board's thickness (Fig. 6). Replace the board and fasten it with galvanized decking screws. If this technique fails to bring the board flat, install a new board in its place.

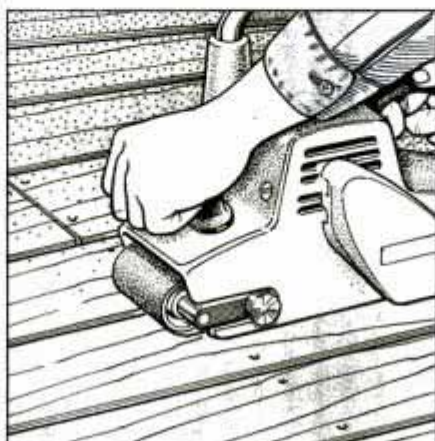
Once in awhile a deck board will develop a serious crack or break, either from an accident or as the result of an original structural flaw in the lumber. To fix this problem, first use a jigsaw to cut through the board near the crack (Fig. 7). Then pry up the pieces on either side of the cut (Fig. 8). Drive the nails back through the boards and remove them with a pry bar. Then, mark the boards and cut them to break in the middle of the

joists to either side of the damaged area. Replace the board sections, cut a new piece to fit in the gap and nail or screw it in place. Remember to always use galvanized nails or screws when working on a deck.

## Structural fixes

Next, check your deck for structural problems. Crawl under the deck and

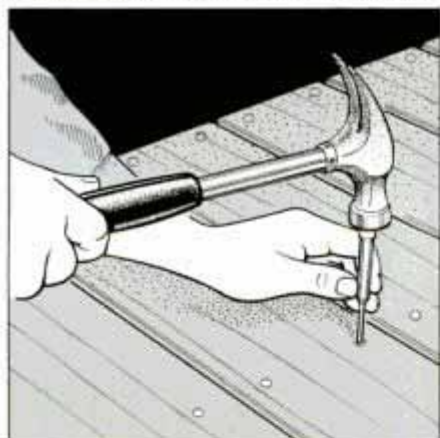
examine the joints between the floor joists and the deck rim joists. Although joist hangers usually are used, they may not be. If there are joist hangers, check to be sure they are properly nailed. If there are no joist hangers, drive two or three toenails into a loose joist to reinforce its attachment (Fig. 9). For extra security, install joist hangers on all the joists.



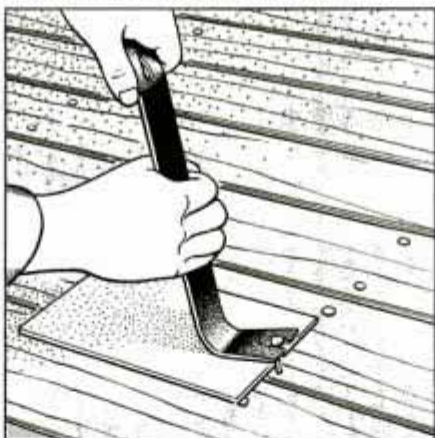
**1** Use a belt sander to remove roughness and splintering from a weathered deck. Smooth rails with a sanding block.



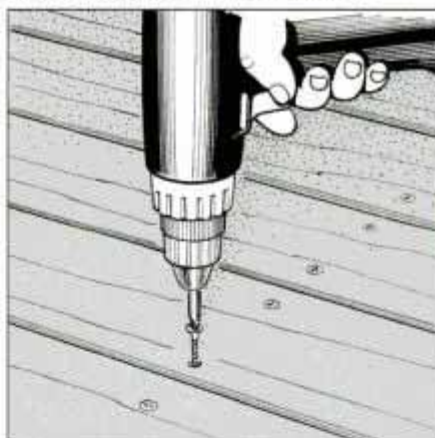
**2** Apply a deck brightener with a stiff brush to remove stains and weathering. Follow manufacturer's instructions.



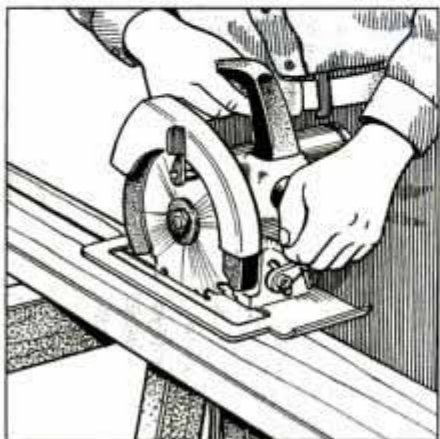
**3** If decking nails have popped above the surface due to wood shrinkage, use a nail set or punch to drive them back in place.



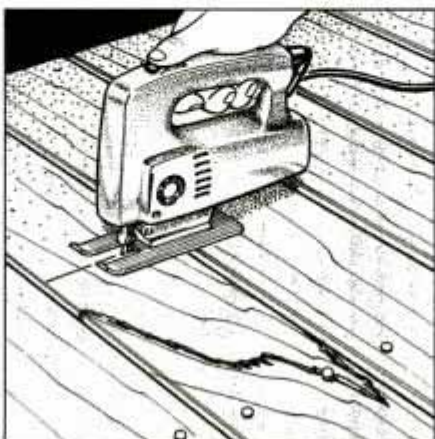
**4** To repair slightly cupped boards, first pull nails with a pry bar. Use a thin piece of plywood to protect deck from marring.



**5** Install galvanized decking screws to draw cupped board flat. Use a power screwdriver to simplify the job.



**6** Flatten severely cupped boards by sawing a series of parallel kerfs on the underside. Then, screw the board in place.



**7** If a deck board shows signs of cracking, remove it by first using a sabre saw to cut across the board near the crack.

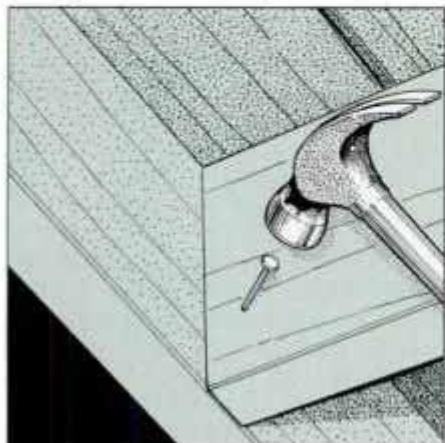


**8** Then, use a pry bar to remove both pieces. Cut each at the joist positions and reinstall. Then install a filler piece.

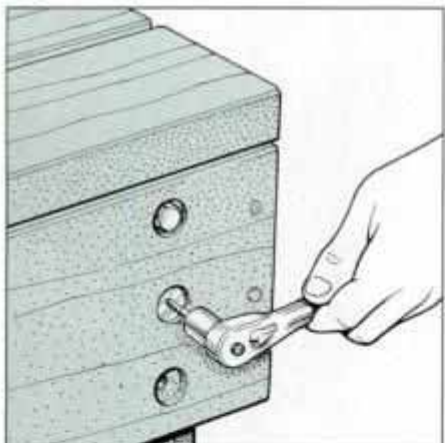


Keep in mind that while minor problems can easily be handled with simple tools and a free weekend, serious structural fixes such as post replacement may require a building permit and approval from your local inspector. Check your building code to be sure.

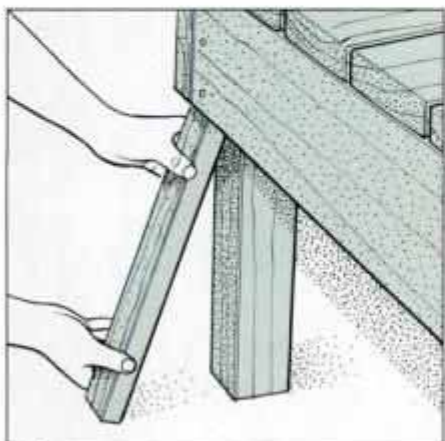
If the rim joists on your deck are simply nailed to the posts, check to



**9** Crawl under the deck to inspect joist fastenings. Install toenails to strengthen joint and add hangers, if necessary.



**10** Reinforce rim joist-to-post joint with lagbolts. Counterbore lagbolt holes for washers and bolt heads.



**11** For added strength, install a support under the rim joists at the posts. Secure support with galvanized nails or screws.

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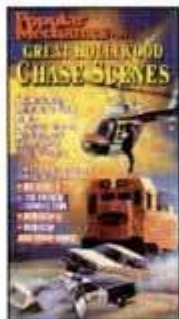
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see that the joints are secure. While nailing may have been adequate when the deck was built, cupping of the joists or vibration of the deck may have loosened the nails. The remedy is to install lagbolts through the rim joists into the supporting posts. Drill pilot holes and counterbore for the lagbolt head and washer. Use a socket wrench to install the bolts—usually two or three per joist end are adequate (Fig. 10). To further support the structure, install a 2 x 4 support underneath the rim joist and nail or screw it to the supporting post (Fig. 11).

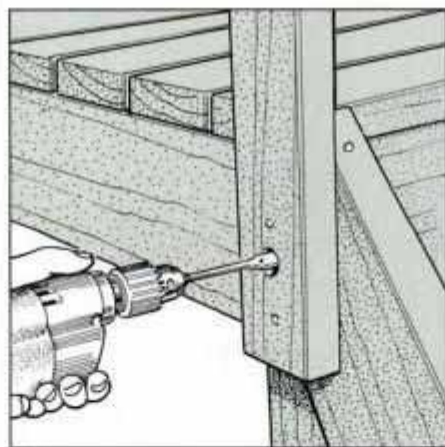
Likewise, the supports for the deck railing can come loose if they're only nailed in place. To stabilize the rail supports, bore and counterbore holes for lagbolts (Fig. 12), and install the new fastenings.

The steps that lead from your deck to the ground can also become the site of needed maintenance. Through frost heaving or settling, the earth or pad that supports the bottom of the stairs can move. This loosens the attachment of the stair to

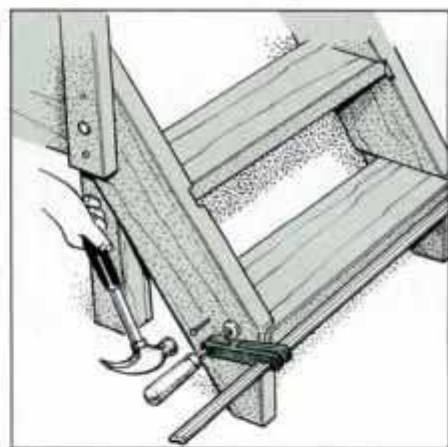
the deck. The first course of action is to readjust the bottom support of the stair. If your steps sit directly on the earth, shim the stringers with flat rocks or shovel new earth in place. If your steps rest on a masonry pad, you have to lift and shim the pad. Then, reinforce the attachments at the top of the stairs by driving toenails through the stringer into the rim joist.

Through use, the nails that hold the stringers to the stair treads can become loose. Use a long clamp to draw the stringers tight to the tread and drive new nails to hold the assembly together (Fig. 13).

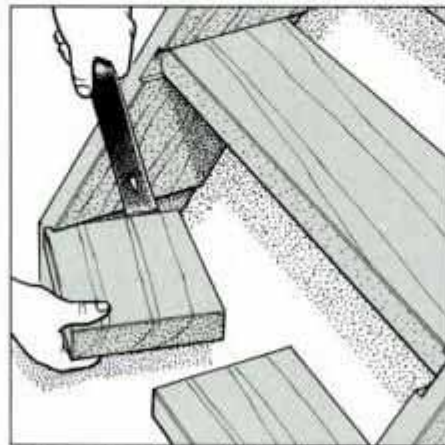
When a tread develops a crack, which might later prove to be a hazard, it's best to replace it before the problem gets worse. Cut the tread in half with a handsaw and pry the two halves from their housings in the stringers (Fig. 14). Use a hammer to drive the nails back through the stringers and remove them with a pry bar. Cut a new tread and slide it into position, fastening it in place with new galvanized nails (Fig. 15). **PM**



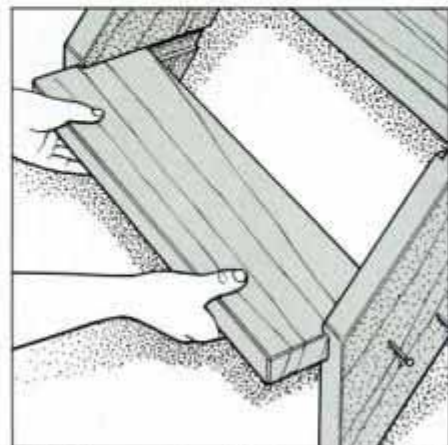
**12** To stiffen loose railing supports, bore and counterbore lagbolt holes and install lagbolts and washers.



**13** If step stringers have moved away from the treads, draw the joint tight with a long clamp. Then, secure with nails.



**14** To remove a cracked or weak step, first saw the step in two with a handsaw. Then, remove each half with a pry bar.



**15** Cut a new tread to fit, and slide it in place in the stringer slots. Then, secure with galvanized nails or screws.



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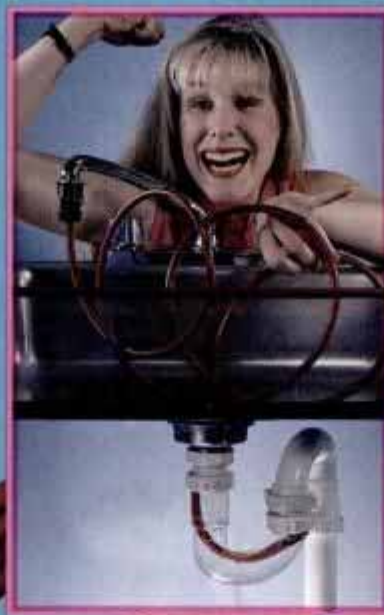


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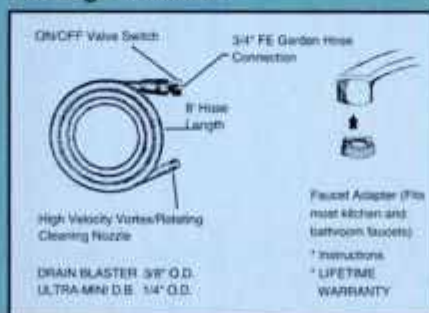
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# HOMEOWNERS CLINIC

BY NORMAN BECKER, P.E., Contributing Editor

## Tub Refinishing

I would like your assistance on a problem with a bathtub. The porcelain has worn off about half of the tub. The remaining porcelain is very rough and porous.

I cannot replace the tub, but I think that a good paint and primer system would improve its appearance. Do you have any suggestions?

TERRY HINES  
 KEOKUK, IA

*I would definitely not recommend painting the tub. This is considered a temporary solution. I have seen tubs where the finish has peeled, cracked, chipped and discolored in just a few years. It would be better to replace the tub or to cover it with a Re-Bath Liner. Re-Bath manufactures high-impact acrylic liners with a nonporous surface. It has more than 400 models of liners.*

*This is not a do-it-yourself project, however. Prior to ordering, a factory-trained dealer will check dimensions of your existing tub so that the installed liner will fit.*

*The installation does not disturb the existing walls or floor around the tub. It also will not disturb the*

*plumbing, except for the tub drain and overflow to the liner. A typical tub installation costs about \$550. Tub surrounds are also available.*

*For more information, contact Re-Bath at (800) 426-4573.*

## Condensate Pump Source

I read your article in the July '92 issue about the use of condensate lift pumps. I have never heard of this particular piece of equipment and neither have my local hardware dealers. I would greatly appreciate information on where I could purchase the pump.

LEN WEISS  
 FREEHOLD, NJ

*Frankly, I'm surprised that the hardware dealers in your area have never heard of a condensate lift pump (also called a condensate pump). This pump is used throughout the United States to remove condensate from central air-conditioning systems and dehumidifiers. It is used where gravity drainage is not possible.*

*One manufacturer of automatic condensate pumps is Little Giant Pump Co. Its pumps are sold at*

*plumbing and heating supply stores and hardware stores.*

*The company makes several models for home use with prices from \$65 to \$90. Write to the manufacturer at P.O. Box 12010, Oklahoma City, OK 73157.*

## Paint Peels Off Clapboard Siding

I cannot get paint to stay on the exterior clapboard siding of my house. It constantly peels. I have followed the directions on the paint can and after a few years, the paint peels off.

I even tried high-pressure water blasting to clean the siding, and this didn't help. Any suggestions would be helpful.

ROBERT W. BUNTIN JR.  
 SHERBORN, MA

*It sounds like the problem is not the surface preparation or the application of the paint, but excessive moisture in the house that is migrating through the exterior walls. The moisture vapor moves from inside the house, through the walls, to the outside. The paint, which forms a barrier to the moisture migration, is lifted off the wall in the process.*

*To correct this, you must control the moisture buildup and stop the moisture migration.*

*The migration can be reduced by painting the inside of the exterior walls with a moisture-resistant paint. Two coats of aluminum paint plus two coats of decorative paint are best for a sand-finished wall. On a smooth wall, apply a primer-sealer and at least one coat of alkyd semigloss paint.*

*You can control the moisture buildup in your house by ensuring that the attic and crawlspace are adequately insulated and ventilated. The ground in a crawlspace should be covered with a vapor barrier, such as a 6-mil polyethylene sheet.*

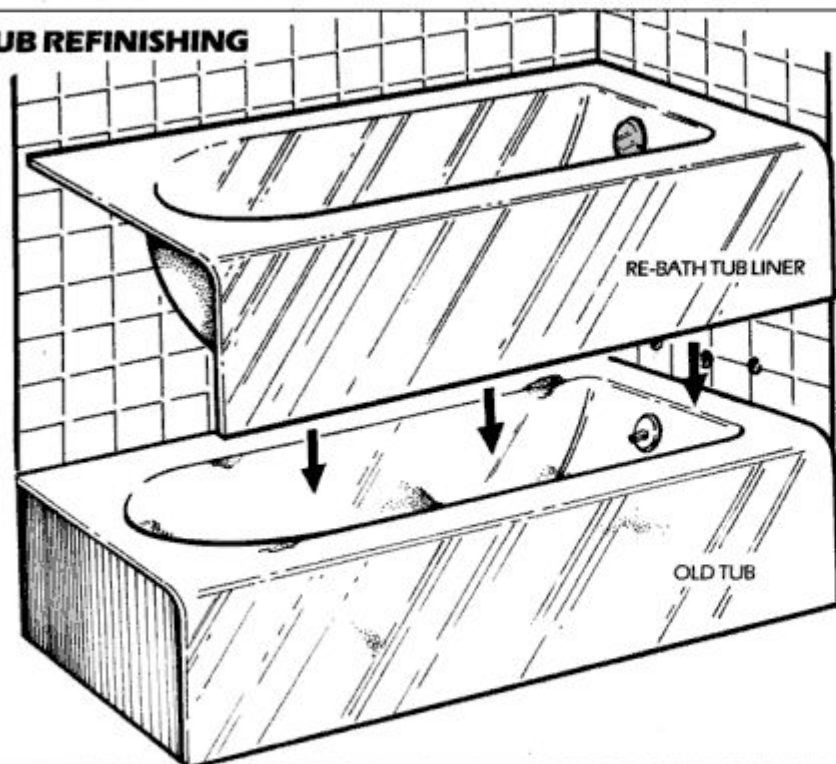
*Clothes-dryer vents and exhaust fans from bathrooms and kitchens should all be vented to the outside. Roof gutters and downspouts must be maintained to prevent overflow and to direct the downspout effluent away from the house. Otherwise, water will accumulate around the foundation and seep into the basement or crawlspace.*

PM

## DO YOU HAVE A HOME-MAINTENANCE OR REPAIR PROBLEM?

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

### TUB REFINISHING



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**TOOL TEST**  
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**ULTRA**  
**SHAPER**  
**TOOLS**

TEXT AND PHOTOS BY  
 THOMAS KLENCK,  
 Associate Home  
 Improvement Editor

● When it comes to cutting wood fast, most of us think of power saws, routers, planers and a host of other intricate and expensive machines. However, if you get a chance to try out these new Ultra Shaper Forming Tools from General, you might begin to think otherwise. The new line is comprised of five rasp-type cutters, which handle a full range of wood-shaping chores, and a saw blade with a new design.

There are several features that set these tools apart from the competition. First, each tempered stainless-steel cutter is sharpened by an acid-etch sharpening system. This produces incredibly sharp edges on a thin (.015 in.) lightweight cutter body.

Three of the rasp designs and the saw blade are designed to fit in an ordinary 12-in.-capacity hacksaw frame. One of these is convex (No. 872, about \$9) for handling hollowing chores and contouring, the second is flat and flexible (No. 874, about \$8) for shaping convex surfaces and the third is flat but shaped into a shallow channel (No. 870, about \$9) to create a rigid blade that cuts straight surfaces. All three hacksaw rasps are about 1 1/4 in. wide.

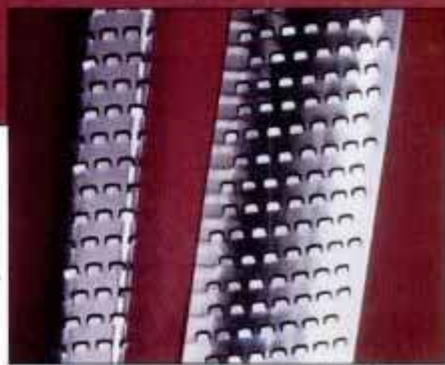
In addition to these three rasps, General offers a double-edge, fine-kerf saw blade (No. 865, about \$8) that also fits in a hacksaw frame. The saw blade is curved for aggressive cutting, with one edge coarse and the other fine. The last two tools that round out the line are handled rasps—one 1/2 in. square (No. 876) and the other round, about 3/8 in. in diameter (No. 875). Both have 8-in.-long cutters, are 13 in. long overall and cost about \$11.50.

We tested these cutters on a variety of contouring, shaping and notching chores and found them fast and effective. For example, using the square-handled rasp on 3/4-in.-thick pine, I was able to cut a notch 1 in.



deep with only 16 strokes, working from the end of the board. The wider cutters are equally effective, and there's none of the clogging that's associated with traditional rasps.

General Ultra Shaper Forming Tools are available through woodworking mail-order catalogs and hardware stores. Contact General Hardware Mfg. Co. Inc., 80 White St., New York, NY 10013. **PM**



These tools feature acid-etch sharpened edges. Two rasps have handles, and the other tools fit in a hacksaw frame.



The convex rasp rapidly removes stock to create hollows. The cutting edges on all the rasps are nonclogging.



The flat, flexible rasp excels at shaping convex curves in wood. A second flat rasp is rigid for handling straight cuts.



The double-edge, thin-kerf saw blade has a curved profile for fast cutting. One edge is coarse and the other, fine.



Handled rasps are either round or square. Aggressive cutting removes stock at the rate of 1/4 in. on each pass.



# APPLIANCE CLINIC

BY STEVE TOTH,  
 Contributing Editor

## Whistling Whirlpool

I have a Whirlpool refrigerator model No. EET171EKDR4, serial No. E84826816, Type 17ATR78. The problem is a high-pitched scream or whistle whenever the unit runs. It sounds like a slipping belt or a dry bearing. What is causing the noise?

JOHN SCHOEPPNER  
 ACCORD, NY

The noise is probably coming from the evaporator or condenser fan motor. If the sound is in the area of the compressor, underneath the refrigerator, the condenser fan motor may be the culprit. If the noise is coming from inside the refrigerator, look for a bad evaporator fan motor.

The whistle is usually caused by a motor that has either dry or worn bearings. The evaporator fan motor is Whirlpool part No. 482731, and the condenser fan motor is part No. 833697. Each costs about \$35.

To replace either motor, first unplug the refrigerator. For the condenser fan motor, pull the refrigerator away from the wall and remove the compartment cover at the bottom rear of the refrigerator.

At the right rear of the refrigerator are the fan motor and blade. Follow the motor leads to the junction box. Remove the screw holding the box to the cabinet and remove the box. Then, remove the two fan motor wires from their terminals and label where each goes on the box.

Next, using a 1/4-in. socket wrench, remove the three screws holding the motor and bracket to the air baffle. Hold the fan blade with one hand and, using pliers, remove the speed nut, turning it counterclockwise on the motor shaft. Remove the blade.

Now use a socket wrench to remove the three screws holding the motor to the bracket. Reverse the procedure to install the new motor.

To replace the evaporator fan motor, first remove the food and shelves from the freezer compartment. Then remove the Phillips-head screw and shelf stud on the left wall. Now remove the screws holding the evaporator cover (the large cover at the rear of the com-

partment). Then remove the cover.

Remove the fan scroll by backing out the screws holding it to the freezer liner. Remove the screws holding the evaporator fan motor to the back of the freezer liner. Pull the motor forward enough to remove the spade connector from the motor, being sure to note onto which terminal the green ground wire is attached. Remove the motor.

Using a small screwdriver, remove the two screws that hold the fan blade to the fan motor. Install the blade on the new fan motor and reverse this procedure to install the new motor.

## Timer For GE Pot Scrubber

We have a bad timer on our GE Pot Scrubber 900 dishwasher. The appliance is model No. GSD 900D-02, serial No. GM 25708B. Where can I get a replacement timer?

PAUL REDLINGER  
 SCOTT, OH

A new timer is still available from General Electric for your 1983 dishwasher. You can order the part from the GE/Hotpoint National Parts Center at (800) 626-2002, or contact your local GE parts center. The timer is GE part No. WD21X517, and costs about \$130.

Another option is to send the timer to be rebuilt. Send it to: T&E Timer Inc., 53 E. 10 Mile Rd., Madison Heights, MI 48071; (800) 521-0258. It takes about a week to rebuild the timer, and it will cost about \$62, plus shipping.

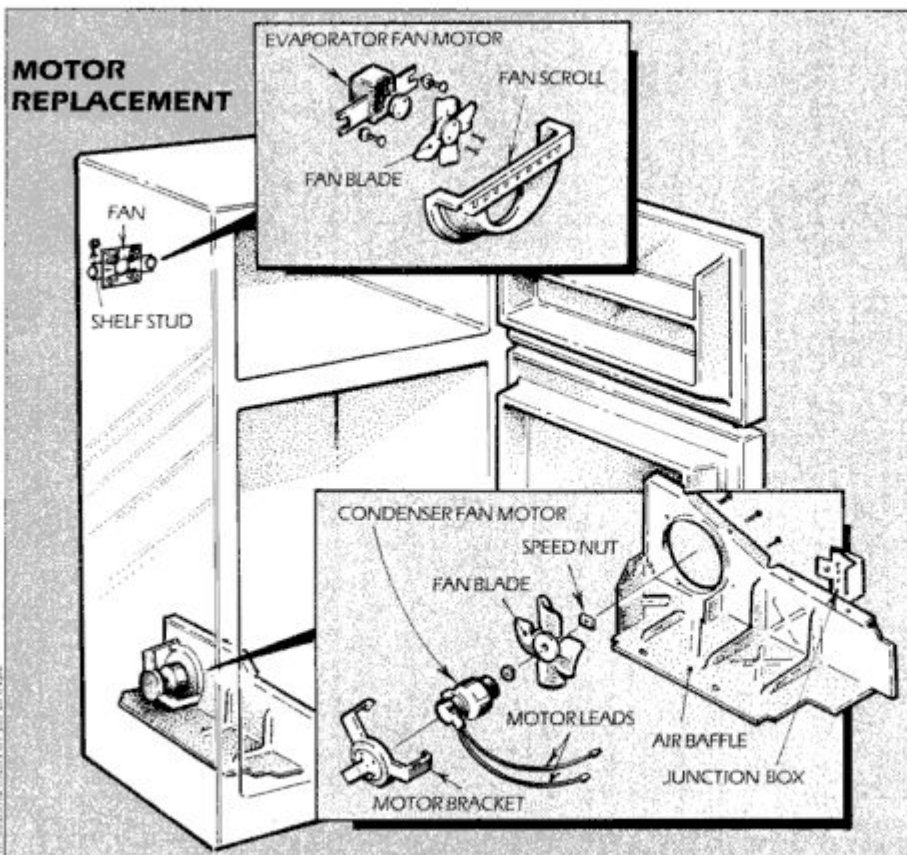
## Evaporator Stops

I have a Frigidaire 20.6-cu.-ft., model FPCI-206T-8, frost-free refrigerator. The freezer/evaporator fan stops periodically due to ice below the fan blades. The defrost cycle works properly. I've replaced the seal on the fan cowling, but that didn't stop the freeze-up. Any suggestions?

MATT BATHKE  
 EL CAJON, CA

Frigidaire had a problem years ago with ice forming in the fan housing of some refrigerators. To correct this, the company made a heater kit that is installed in the liner under the fan housing to prevent this ice buildup. The heater kit (about \$30) is Frigidaire part No. 09957071.

To locate a Frigidaire parts distributor in your area that can order this kit, call (800) 327-2440. **FM**



The evaporator fan motor is accessible from inside the freezer compartment, while the condenser fan motor is accessible from the back of the appliance.





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# CAR CARE

## CAR CLINIC

BY MIKE ALLEN,  
Associate Automotive Editor

### And Herein Lies A Tail...

The transmission output shaft on my pickup leaks ATF whenever the truck is parked. You can drive the thing 1000 miles and not lose more than a few drops—but park it overnight, and it drops a quart or more on the driveway. I've replaced the seal twice, but it doesn't help. Also, there's a low-frequency rumble at some speeds since I put it back together.

Since the day this truck was new, almost 125,000 miles ago, there's been a huge clunk when shifting into gear from PARK. The dealer said it's normal—I was wondering if it's related, because it seemed to go away for a while after I reinstalled the driveshaft.

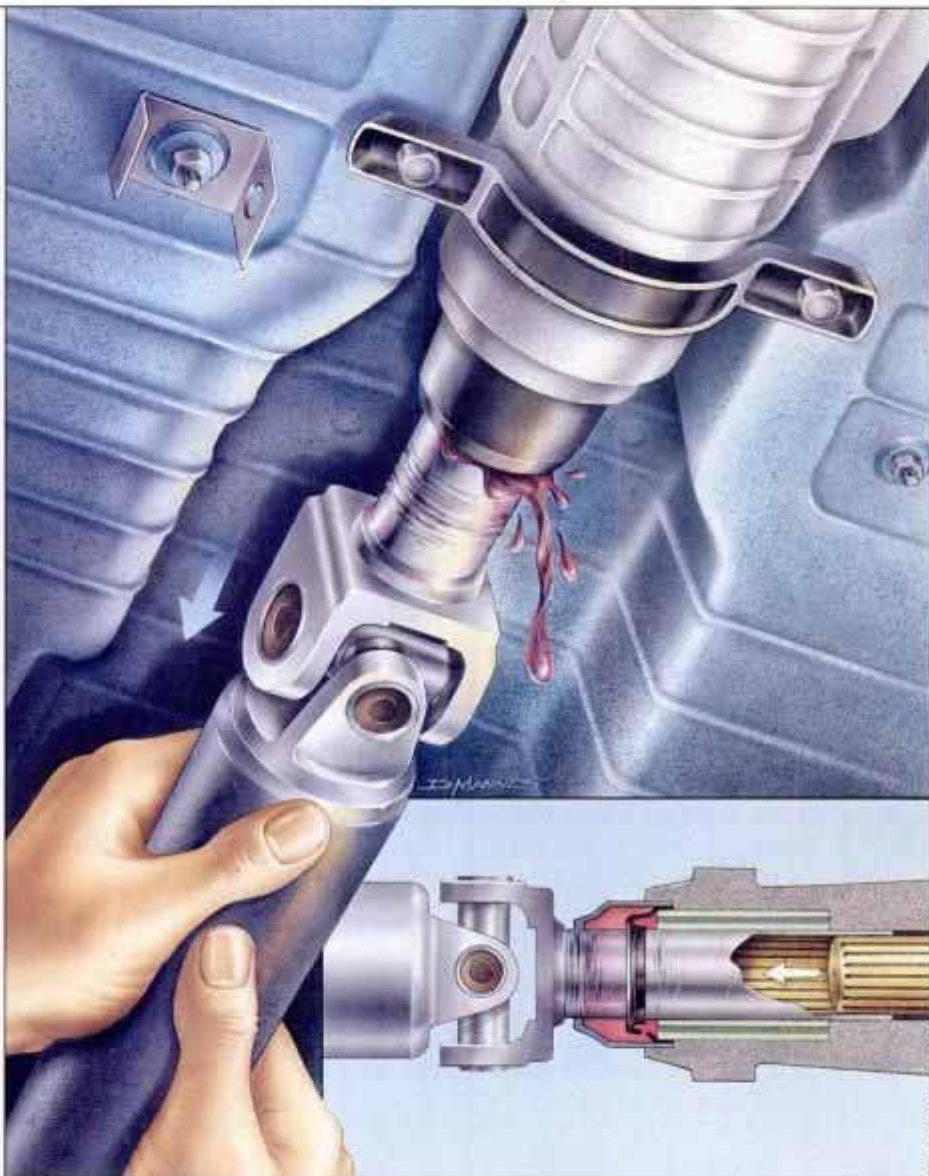
JOHN ABRAN  
UTICA, NY

*The low-frequency rumble is an out-of-balance condition caused by reinstalling the driveshaft out of index with its original position. Always mark all of the parts so you can reinstall them in their original relationship.*

*There's a bushing inside the transmission output housing to support the tranny's final driveshaft. Eventually, this wears out. Then the shaft can move around enough to make the seal ineffective. You have several options—the bushing can be replaced with the tranny in the car by using a special tool from Ford. See your dealer or a well-equipped independent repair shop, or borrow/rent the tool. Or, you could pull off the transmission tailpiece and take it someplace to get a new bushing installed.*

*Regardless, replace the output yoke. The yoke's outer surface is undoubtedly worn or scuffed along not only the area where it mates with the bushing, but also where it contacts the seal.*

*The clunking noise is lash between the yoke's internal splines and the transmission output shaft's*



*external splines. This is probably the single most common complaint I hear about pickups and vans—so the dealer is correct when he says it's normal. Annoying, isn't it?*

*The clunk went away when you replaced the seal because you probably greased the splines just before reinstalling the driveshaft. The grease cushioned the slam of metal-to-metal, at least until the grease melted in the hot ATF bathing everything inside there.*

### Blow Me Away

After I turn off the ignition and walk away from my van on hot days, I can

hear a hissing or running fan noise from the engine compartment. This noise continues for 10 minutes or so. What is it, and should I be concerned?

HERBERT VEDA  
CLAREMONT, NH

*It could be one of several things:*

1. An auxiliary fan is keeping the radiator from boiling over as heat from the engine soaks into the cooling system. There's plenty of heat left after the engine shuts down—but no airflow through the radiator or water pump to circulate coolant.

2. Steam is boiling out of the radiator and into the coolant recovery



# CAR CARE

tank, there to condense and be sucked back into the radiator as the engine cools. (See above for why.)

3. Freon is venting internally inside the a/c system.

All three things are normal.

## Cool Problem

What can I do next fall to prevent the parking-brake cable on my Nissan Pathfinder from freezing up overnight? I have to crawl under the truck and free it up by hand when the temperature drops below freezing overnight.

MIKE REVI  
CROTON-ON-HUDSON, NY

*There's water freezing up inside the handbrake cable's jacket. Start by making sure the cable is completely dry—blow compressed air into the annulus between the cable and the sheath until there's no water left. Did I mention you should remove the cable (or cables, if both sides are sticking) to accomplish this?*

*Use some spray-can lubricant and force it into the cable by pinching the cable and the snorkel from the spray can in a rag. Spray in plenty of lube, until it starts to drip out of the other end. Don't use spray-can grease—it'll freeze up almost as hard as the water does on really cold days.*

*When you reinstall the cable(s), replace the rubber boots at the ends. This is where the water is getting in in the first place.*

## Electroshock Therapy

I have a new Japanese car with those fancy electronically controlled shock absorbers. The service manager at the dealership tells me that, if they ever go bad, the replacement cost is almost \$3000—and I can only get them from the dealer. First off, is it true these things are so expensive? And isn't there some aftermarket brand that I can get installed somewhere for less?

RON HUANG  
TORRANCE, CA

*I couldn't get the price of replacing the shocks on your particular vehicle up over \$2000 no matter how I wrote the estimate, including a complete 4-wheel alignment and new tie-rod ends and balljoints. So the dealer's statement is suspect.*

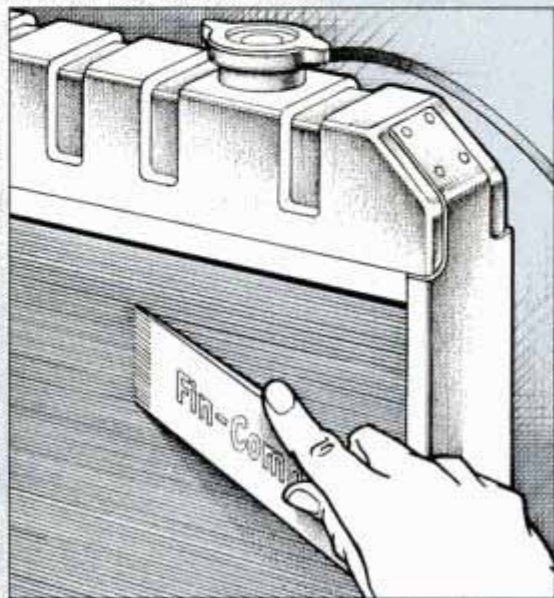
*On the other hand, two grand is still a bunch of money. There are a few OEM replacement shocks that are a drop-in replacement for some vehicles, and more are being added constantly by several manufactur-*

## Radiating Good Grooming

I found a good used radiator in a junkyard last week. (Excuse me, we call 'em Auto Parts Recycling Centers in these politically correct times.) And I got a terrific deal on it too, because somebody apparently had spent a considerable amount of time carefully folding over the fins with a smooth piece of wood or even their fingers. This had the effect of blocking most of the airflow through the radiator.

I could have used a tongue depressor and a lot of patience to straighten the fins, but I inherited a bunch of tools from my uncle, who was a refrigeration mechanic. He had this set of combs with short little teeth intended to straighten out fins on any kind of a/c or refrigeration system.

You can pick up a similar tool at most auto parts stores.



*ers. When it's time to replace yours, check local auto parts suppliers.*

*Many of these vehicles also can be fitted with conventional, nonelectronic shocks. This obviates the advantages of the onboard computer—but after a few years, it's simply not economically feasible to spend that kind of cash, if the vehicle's resale value won't justify it.*

## Remote Possibilities

I just got around to doing the first oil change on my new Dakota—only to find that the oil filter is impossible to access. What's your opinion of the remote oil filter relocation kit in the JC Whitney catalog?

JOHN BOYD  
PHILOMATH, OR

*I'm in favor of almost anything that will get you to change the oil regularly. The kit sold in the Whitney catalog is as good as any. Be sure to mount the remote filter mount so the filter is upright and threads-up. That way you can unscrew the filter and remove it without making a mess. And prefill the new filter with oil before you install it.*

*If you need to replace the hoses*

## 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.*



*between the filter adapter and the mount, be sure to use hose rated for oil-line service. Radiator hose looks the same, but will last about 10 miles.*

FM

## SERVICE TIPS

● Some 1991-'92 Hydra-Matic 4L60 automatic transmissions used in Roadmasters may have problems Buick characterizes as "stuck in First gear" or "no upshift." Seems that the output-shaft retaining ring may become unseated. In fact, some transmissions seem to have been assembled with no ring at all.

● Some 1990 and '91 Subaru Loyales may have misadjusted shift linkages, causing the automatic transmission to pop out of Park, potentially allowing the car to roll forward. If you haven't already received the recall notification on this one, see the dealer for a simple 20-minute adjustment.

● 1992 Dodge trucks and vans with either 3.9- or 5.2-liter engines that experience an oil leak that's difficult to trace may have a leaky distributor, rather than a leaky valve cover or intake manifold. Look for oil inside the distributor. If you find it, there's a new distributor with an internal seal.



# CAR CARE

## MAINTENANCE BASICS

### SAFETY INSPECTION

BY DON CHAIKIN,  
Contributing Editor

• In an effort to keep unsafe automobiles off the road, most states conduct annual safety tests. However, it's a good idea to perform your own safety inspection in your driveway and not wait for that annual test.

If replacing the bulb does not cure the problem, check the socket and the wiring connector.

• With the back of the car against the garage door or wall, step on the brake pedal and look in the rearview mirror. You should see the glow of the brake lights.

• Turn on the ignition and check the directional signals. Also check the 4-way hazard flashers. If they do not work, replace their relay.

• Press the horn button. If the horn is weak or nonsounding, check the wiring under the hood.

• While you're still in the driver's seat, check the steering without the benefit of the power assist. Gently

free play in the steering wheel.

If the steering wheel feels sloppy, check the components under the car.

• With the engine running, but the car not moving, tromp the brake pedal.

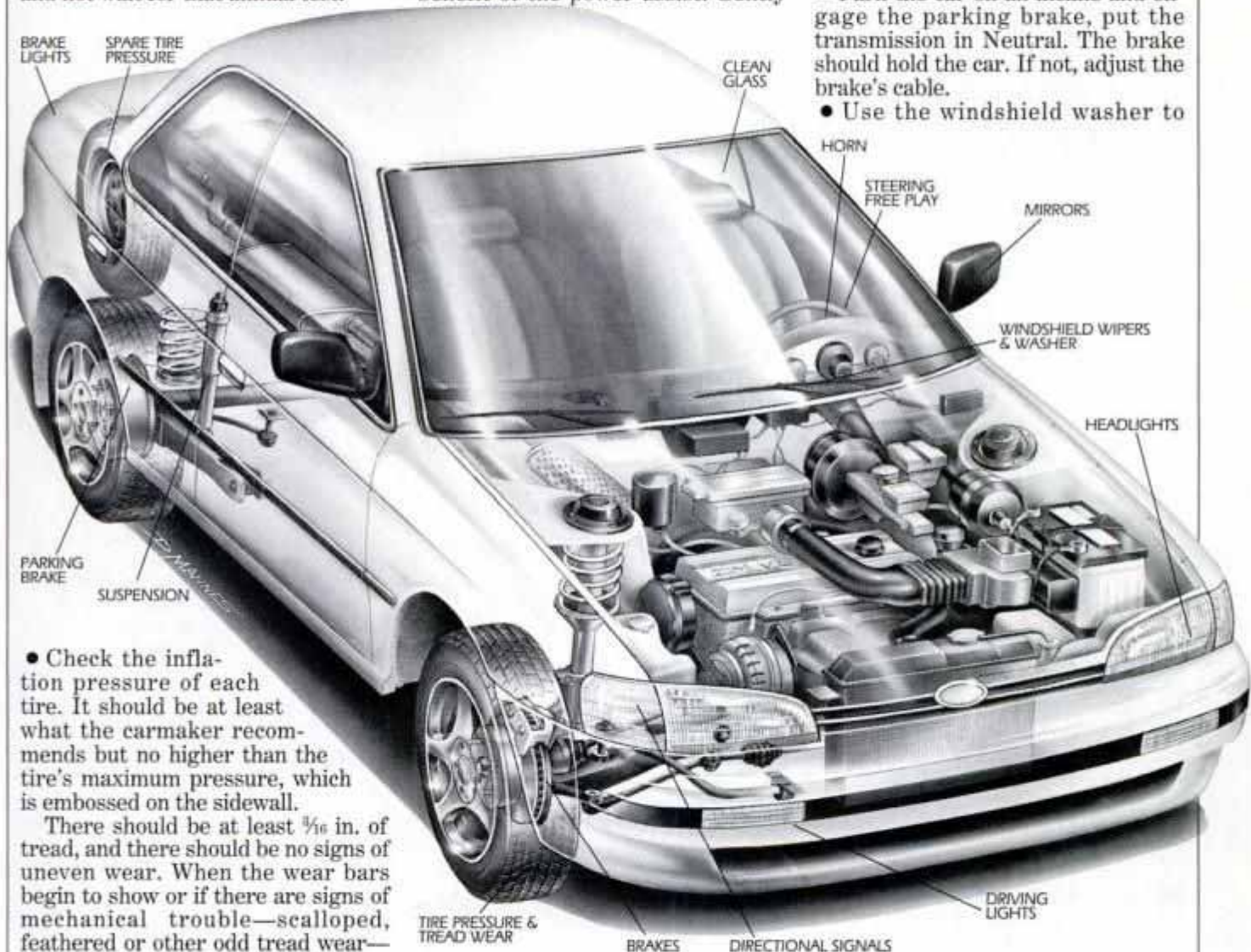
The pedal should be firm under foot and should not continue to sink as you press on it.

• Put the car in gear and accelerate quickly. Again, stomp the brake.

The car should stop short, without veering left or right, with most of its weight transferring to the nose. If the car pulls, or one brake locks, check for a sticking caliper, warped rotor or improperly adjusted drum brake.

• Park the car on an incline and engage the parking brake, put the transmission in Neutral. The brake should hold the car. If not, adjust the brake's cable.

• Use the windshield washer to



• Check the inflation pressure of each tire. It should be at least what the carmaker recommends but no higher than the tire's maximum pressure, which is embossed on the sidewall.

There should be at least  $\frac{3}{16}$  in. of tread, and there should be no signs of uneven wear. When the wear bars begin to show or if there are signs of mechanical trouble—scalped, feathered or other odd tread wear—replace the tire.

• Pop the trunk and check the spare, the jack, its handle and the lug wrench.

• Turn on the lights and walk around the car. Check the headlights, on both high and low beam, and all marker lights and taillights.

Replace any burnt-out, dim or flaring bulbs.

turn the steering wheel left and right, feeling for free play.

In rack-and-pinion systems, there should be virtually no movement of the steering wheel that does not move the front wheels.

With other systems, there should be no more than about 1 to 2 in. of

clean the windshield. The spray should be full and powerful, covering the glass. The wipers should clean the glass without streaks. Replace the rubber inserts if they do not do the job. Top up the reservoir.

• Clean and check all windows and mirrors for nicks, chips or cracks. **PM**



## HOW IT WORKS

# ANTILOCK BRAKES

BY DON CHAIKIN,  
Contributing Editor

● Make no mistake about it, antilock brakes may be the most important development in automotive technology of the past quarter-century.

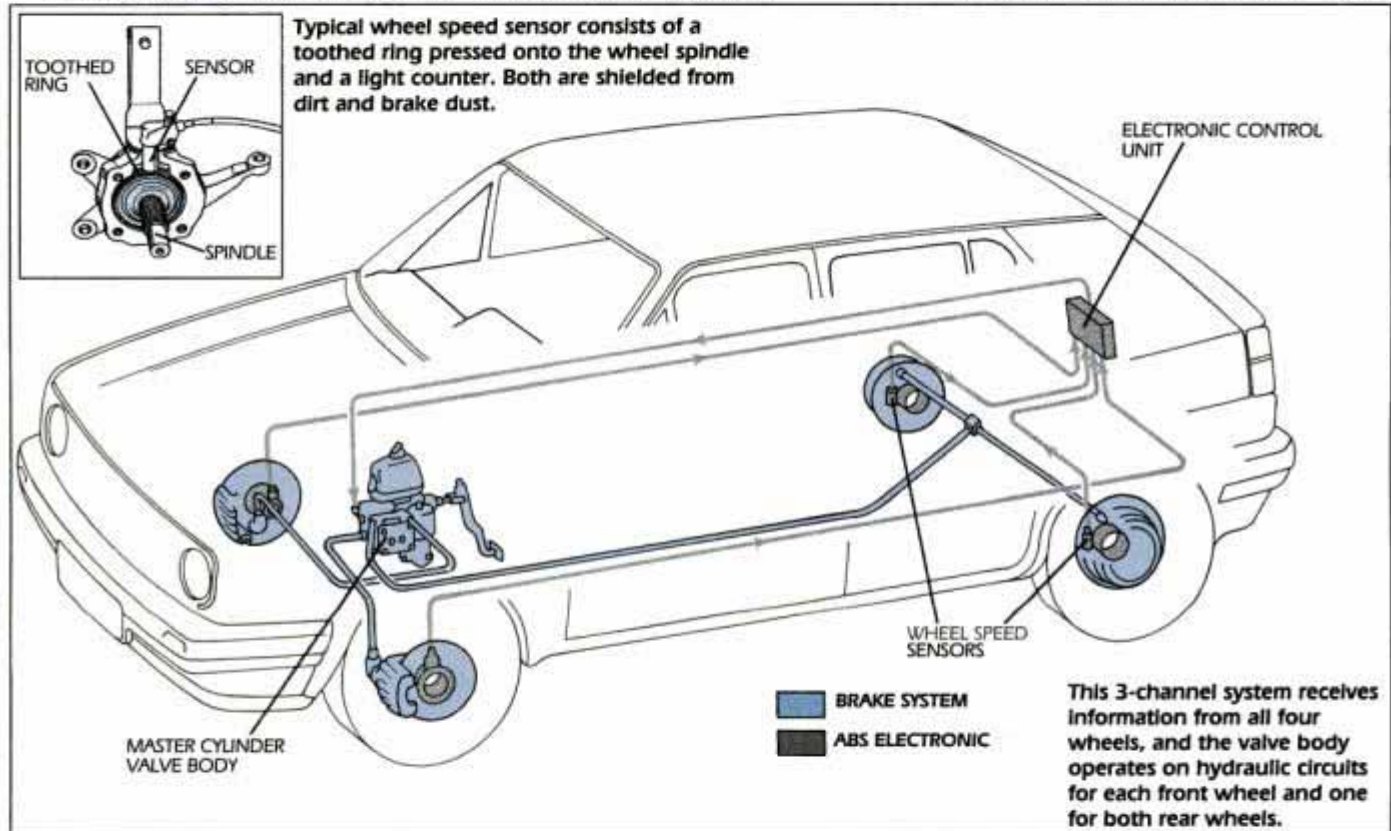
Whether they admit it or not, most

tains solenoid valves for each brake.

The wheel speed sensors typically consist of a toothed ring, which spins along with each wheel, or in some systems along with the rear-drive axle, and a counter. The counter keeps the computer apprised of the passing of each tooth on the ring. By counting the pulses from each sensor, the computer calculates and constantly compares the speed of each wheel. If, under braking, the computer determines that one or more of the wheels is slowing more quickly than the others, it concludes that this wheel is about to lock up.

pulsating open and closed—in effect modulating that one brake's pressure—until the wheel's deceleration is in line with what the computer determines it should be. This rapid—dozens of times a second—opening and closing of one brake's solenoid is felt as a pulsating or vibrating in the brake pedal. This is a signal to the driver that the ABS is working.

Some cars are equipped with separate speed sensors, electronics and hydraulic circuitry for each wheel. On other cars, the rear brakes may be controlled as one, since the object is to prevent the front wheels—which



drivers react to a sudden emergency by slamming on the brakes in a blind panic, hoping to stop before crashing. Unfortunately, in many cases the result is that the brakes lock—especially on wet roads—causing the car to skid right into whatever is in its way. Skidding tires will not steer.

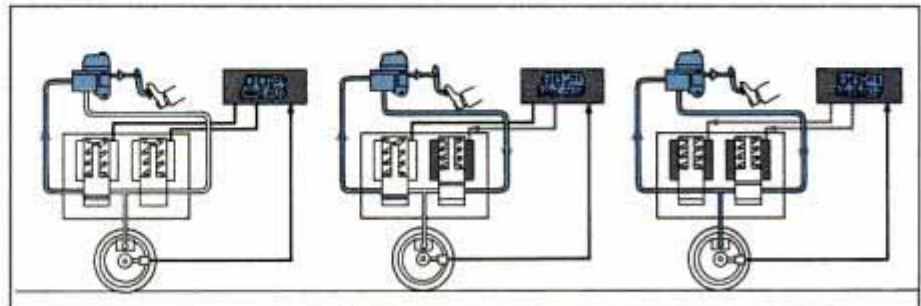
### Slow before you stop

With an antilock-brake system, commonly referred to as simply ABS, computerized electronics work together with sophisticated hydraulic controls to maintain maximum braking pressure to all the wheels without allowing any of the wheels to lock up.

Essentially, the typical system is comprised of a computer, or electronic control unit, wheel speed sensors and a special valve body which con-

The computer then instructs the locking brake's solenoid valve to briefly relieve and then quickly re-apply hydraulic pressure—despite the fact the driver is jamming the brake pedal through the floor. The computer keeps the valve rapidly

do the majority of the braking and the steering—from locking. Systems with totally separate sensors and circuitry for each wheel are referred to as 4-channel. Those in which both rear wheels are modulated together are called 3-channel systems. **PM**



ECU first allows pressure to build in the system (left). If brakes are about to lock up, the valve body maintains maximum pressure to the individual brakes (middle). If ECU determines sudden deceleration at a wheel, it relieves pressure to locking wheel (right).



# CAR CARE

## NEW PRODUCTS

### IMPROVE YOUR CAR

#### Retro Steering Wheel

One of the most effective ways to personalize your car or truck is with a custom steering wheel, like the Banjo from Lecarra, U.S.A. This stainless-steel wheel strongly evokes a look and driving feel from decades long gone. The 14-in.-dia. wheel, available with one of eight different hand-stitched leather covers, features brightly polished, string-like spokes between the rim and the polished horn button. The \$369 wheel requires the correct adapter hub (about \$45) to be mounted to your steering column. From Lecarra, U.S.A., 15850 W. Sixth Ave., Golden, CO 80401; (303) 279-5181.



#### Chevy Valve Covers

Center holddown bolts may do a better job of sealing valve-cover oil leaks than flange bolts, but they also render useless any polished valve covers designed for flange bolts. B&B Performance Sales now has a line of polished, die-cast aluminum valve covers to fit all 1987 and newer Chevrolet small-block V8 cylinder heads. These covers are 1/16-in. taller than stock and have bolt towers which clear roller rockers. Prices range from about \$98 to \$150 per pair. From B&B Performance Sales, 29752 Avenida De Las Banderas, Rancho Santa Margarita, CA 92688; (714) 589-5956.



#### D-I-Y Wood Dash

From Rolls-Royce to Cadillac, the presence of real wood on the dashboard says luxury, effectively and quietly. You now can add a real wood veneer to the dashboard of your car, truck or sport/utility with a kit from Sport Shades. Various types of quality wood, like rosewood, are used, finished to a high sheen and pro-

ected by a layer of epoxy resin. The wood veneer is laminated to an aluminum layer, which helps the wood follow the contour of your dash. An adhesive backing on the wood attaches it to your dash—no fasteners needed. Prices range from about \$250 to \$700. From Sport Shades, 360 Highland Ave., Passaic, NJ 07055; (800) 772-7662.

#### Add-On Center Console

Regardless of what type of vehicle you own, "stuff" tends to accumulate and ultimately gets lost around the interior. Steel Horse Automotive offers one solution with its line of 2000 Concept Consoles.

These are available in a variety of colors and feature cup holders, a note pad, compact-disc and cassette-tape holders and various other pockets and compartments. The padded center armrest offers some additional driving comfort. The 2000 Concept line has consoles to fit most vehicles for both floor mounting as well as for bench seats. Prices are \$64.95 to \$119.95. From Steel Horse Automotive, 1200 W. Walnut St., Compton, CA 90220; (310) 537-0837.



#### Plug Thread Repair Kit

If you strip the threads of a spark-plug hole—all too easy with an aluminum cylinder head—you can repair them without removing the head. All you need is a special kit, like this one from Thread Kits Co. The kit (about \$29) contains an insert which you thread into the spark-plug hole. A reamer/tap cleans the hole and threads it for the insert, and a special expanding tool installs the insert. The inserts are serrated at the top so the expanding tool locks them into the cylinder head. For short-, long- and normal-reach tapered seat- and gasket-type plugs. From Thread Kits Co., 2530 W. 237th St., Torrance, CA 90505; (800) 372-4477. **PM**





## SATURDAY MECHANIC

# REPAIRING THE WINDSHIELD WIPER SYSTEM

BY DON CHAIKIN, Contributing Editor

• The already ominous sky ahead is growing darker by the second and the traffic coming at you is all wet. Now you can clearly see that cars and trucks coming from where you're going all have their windshield wipers on—full tilt. Suddenly you know why, as you drive into a wall of water at 50 mph. "No problem," you say to yourself as you flick the lever

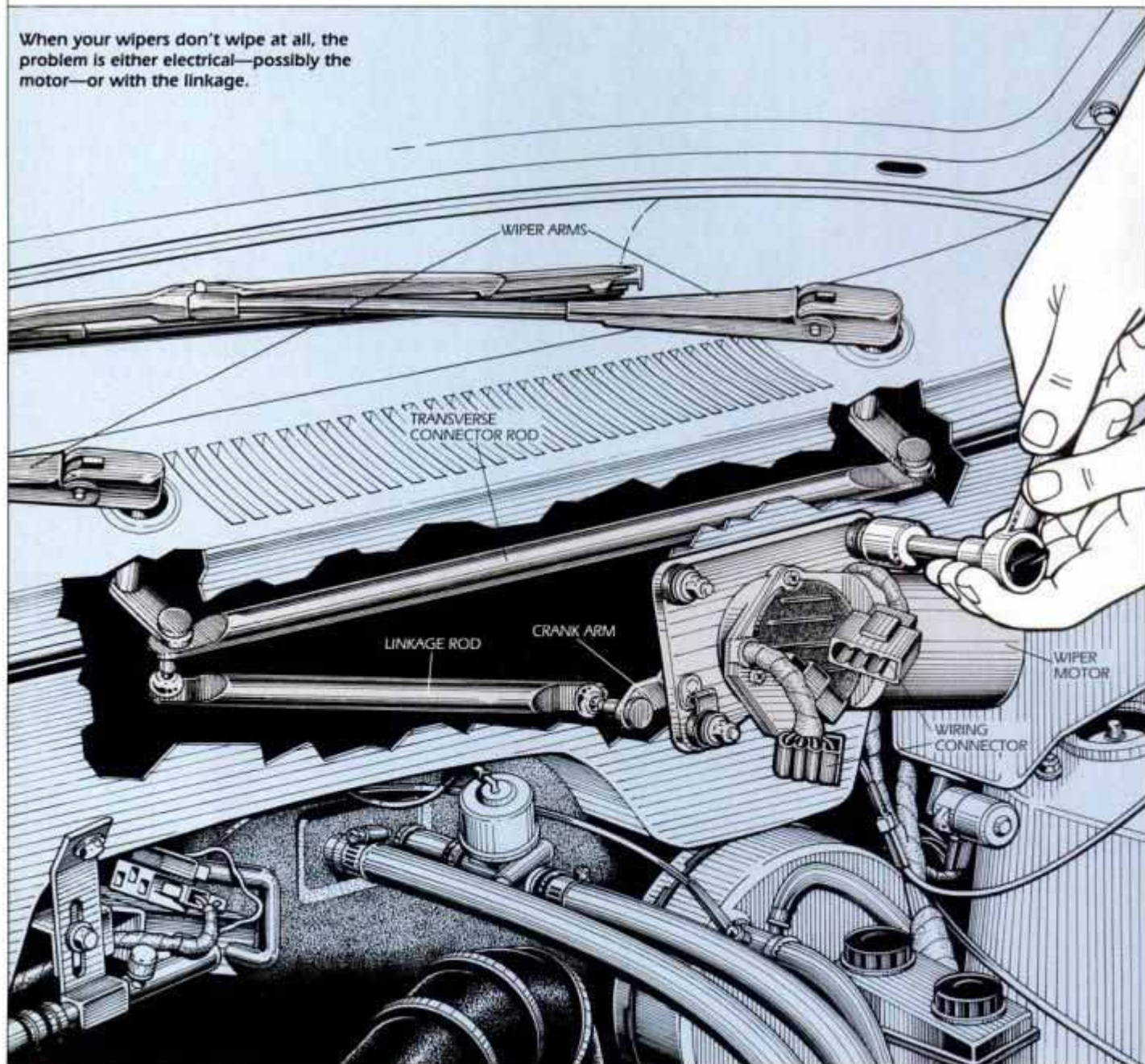
to turn on your wipers. Wrong. You've got a big problem—the wipers do not budge from their perch no matter what you do.

Or, while it may be less dramatic, it is no less dangerous when you turn on the wipers to clear the annoying muddy mist thrown up by traffic ahead of you after a rain, but all your wipers can do is chatter, bounce and

groan their way across the glass. And they do this despite the fact that you replaced the rubber squeegees no more than a couple of weeks ago.

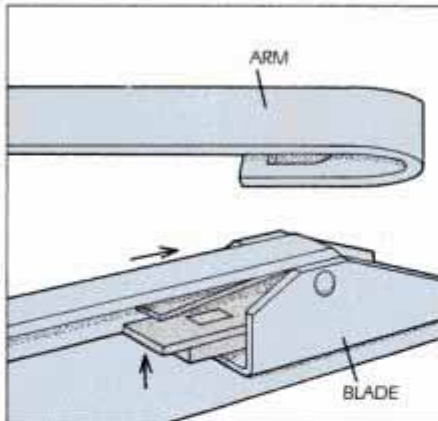
In both cases, you simply cannot see where you are driving. And, in both cases, you didn't even know you had a problem until you were face to face with it on the other side of your windshield.

When your wipers don't wipe at all, the problem is either electrical—possibly the motor—or with the linkage.

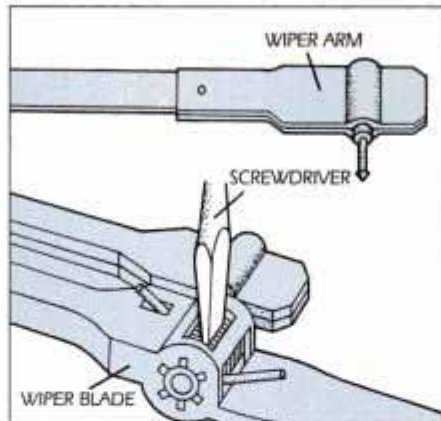




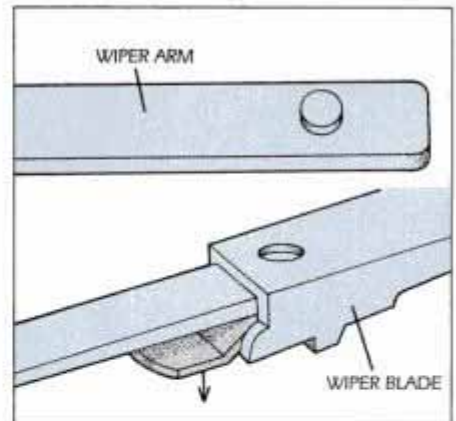
# CAR CARE



Remove blade from hook-type wiper arm by unlocking tab, slipping arm over pin.



Remove blade from pin-type wiper arm by releasing catch, pulling blade away.



Remove blade from bayonet-type arm by lifting locking tab, pulling blade out.

## Don't appreciate the water...

Your car or truck's windshield wipers have been designed to perform one function, and it's a function that you may not utilize very often. Part of the trouble is, if you don't use your wipers, you won't know that there is a problem—until it rains.

And like the roof that stops leaking as soon as the rain stops, you may tend to put off repair and maintenance of the wipers when it's not raining.

However, once you discover a problem with the windshield wipers, and the system that operates them, pinpointing and repairing the trouble is simple and inexpensive.

## The hip bone's connected to...

The windshield wiper system actually has several components, many of which may be hidden behind your vehicle's cowl. The pieces that actually wipe the water from the glass are called the squeegees or rubber inserts. These are held by the wiper blade, which is the plastic or metal frame that is the same length as the squeegees. The blades are attached to the wiper arms, which sweep them back and forth across the glass. The wiper arms are spring-loaded to tension the blade and squeegee down on the glass even at highway speeds.

The wiper arms are attached to drive spindles. Typically, the spindles and the bases of the wiper arms are splined and have matching tapers for a press fit. In addition, the tips of many drive spindles are threaded to

take a locknut and washer. Others may have a hidden retaining clip or spring. A cover may hide the locknut.

The spindles rotate as a transverse connecting rod moves back and forth across the base of the windshield. Small links between the spindles and the connecting rod force the spindles to rotate in one direction and then the other as the connecting rod moves back and forth.

The connecting rod is attached to a linkage rod, which is connected to a

blades can continue through the remainder of their arc and park at the base of the windshield. In addition, a fuse or circuit breaker protects the electric motor from overload—such as when the wiper blades are frozen to the windshield or buried beneath heavy snow. And a relay allows for intermittent action.

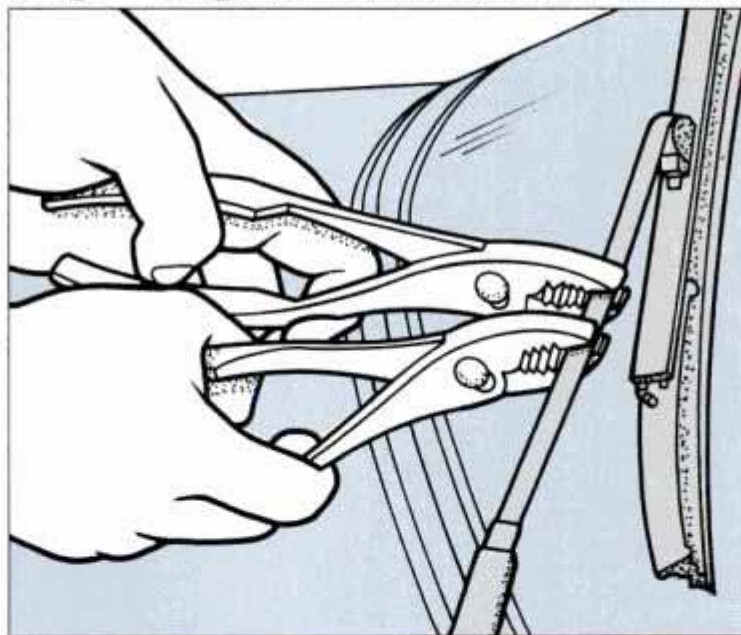
## A smear job

Even if the wiper motor, its wiring and its various linkage rods work perfectly for the life of your car, the rubber squeegees will have to be replaced periodically. Dirt, grit and various airborne contaminants all work to destroy the squeegees. Even the ammonia in household window cleaner, along with various other environmental elements, will deteriorate natural rubber squeegees.

If the wipers streak, smear or otherwise wipe unevenly, replace them. Naturally, if an inspection reveals tears, cracks or chunks missing from the squeegee, it should be replaced.

While squeegees are available at auto parts stores and discount chains, you may have to replace the wiper blade

as well as the squeegee if your car's original blade design does not take a replaceable insert. However, you may also choose to save money next time by replacing your original wiper blade/squeegee combination with an aftermarket blade designed to take replaceable rubber inserts. In addition, various carmakers and wiper manufacturers have different systems



Cure chattering wipers by straightening a twisted wiper arm using two pairs of pliers. Arm must be parallel to the surface of the windshield.

crank arm driven by an electric motor. As the shaft inside the electric wiper motor spins, it rotates the crank arm. As the crank arm spins, it pulls the linkage rod over center, converting the pulling motion into a pushing one, then back again.

A switch inside the motor allows the motor to continue running after you have shut off the wipers so the



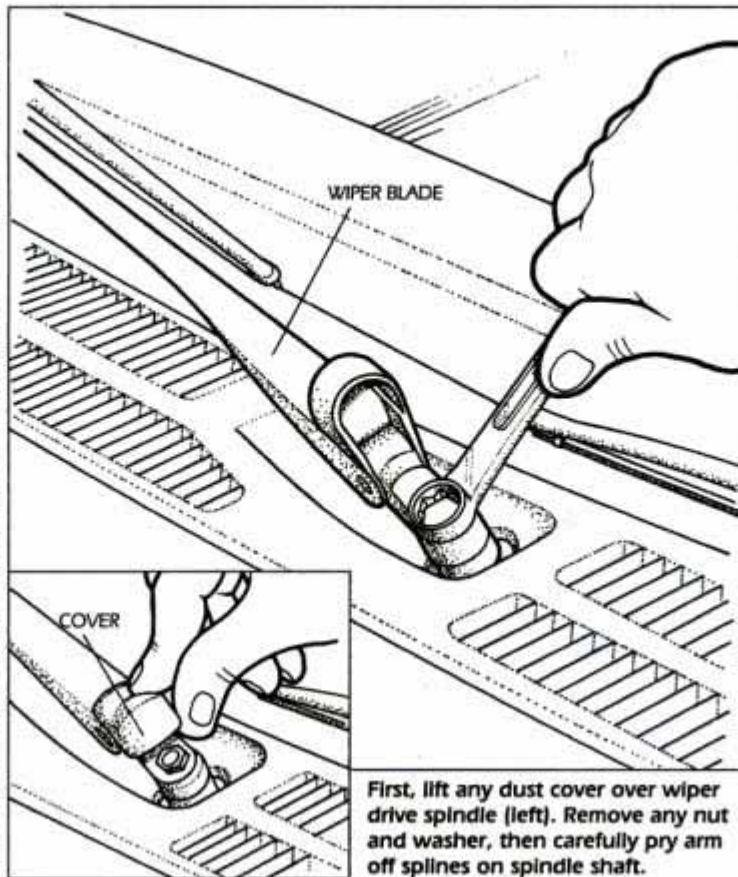
## CAR CARE

for securing the wiper blade to the wiper arm. All, however, allow the blade to be removed from the arm for replacement.

The most common attachment systems are the hook, locking pin and bayonet. Naturally, there are variations on these themes.

Hook-type wiper arms have a 180° bend at the end, which attaches to the wiper blade. This hook wraps over a pin or tab at the center of the blade. Release the lock on the pin or tab, slip the hook off the pin and thread the blade off the arm. Some of these blades must be flipped upside down in order to be removed.

Locking-pin wiper arms have a small pin connecting the tip of the blade. The perpendicular pin keeps the wiper arm parallel to the center of the wiper blade. Disengage the lock that holds the pin and pull the blade away from the wiper arm. The lock and the pin may be located



First, lift any dust cover over wiper drive spindle (left). Remove any nut and washer, then carefully pry arm off splines on spindle shaft.

on either the blade or the wiper arm. On a simple bayonet mount, the tip

of the blade. With the other, you must unlock one of the links of the

of the wiper arm slides into a sheath on the center of the wiper blade. Release a locking tab and pull off the blade.

If you are replacing the blade and the squeegee as a unit, reverse the process and you're done. If you are replacing the wiper blade with one from the aftermarket, select the appropriate adapter from the assortment packaged with the blade. First install the adapter on the blade, then install the blade on the arm.

If you are changing the rubber insert only, you must remove the squeegee from the wiper blade. There are essentially two ways that the rubber insert attaches to the wiper blade. In one system, you must squeeze or pry open locking tabs and slide the squeegee out

PH ILLUSTRATIONS BY BOB CARBON

ADVERTISEMENT

# Small Company's New Golf Ball Flies Too Far; Could Obsolete Many Golf Courses

Pro Hits 400-Yard Tee Shots During Test Round

Want To Shoot An Eagle or Two?

By Mike Henson

MERIDEN, CT — A small golf company in Connecticut has created a new, super ball that flies like a U-2, putts with the steady roll of a cue ball and bites the green on approach shots like a dropped cat. But don't look for it on weekend TV. Long-hitting pros could make a joke out of some of golf's finest courses with it. One pro who tested the ball drove it 400 yards, reaching the green on all but the longest par-fours. Scientific tests by an independent lab using a hitting machine prove the ball out-distances major brands dramatically.

The ball's extraordinary distance comes partly from a revolutionary new dimple design that keeps the ball aloft longer. But there's also a secret change in the core that makes it rise faster off the clubhead. Another change reduces air drag. The result is a ball that gains altitude quickly, then sails like a glider. None of the changes is noticeable in the ball itself.

Despite this extraordinary performance the company has a problem. A spokesman put it this way: "In golf you need endorsements and TV publicity. This is what gets you in the pro shops and stores where 95% of all golf products are sold. Unless the pros use your ball on TV, you're virtually locked out

of these outlets. TV advertising is too expensive to buy on your own, at least for us.

"Now, you've seen how far this ball can fly. Can you imagine a pro using it on TV and eagle-ing par-fours? It would turn the course into a par-three, and real men don't play par-three's. This new fly-power forces us to sell it without relying on pros or pro-shops. One way is to sell it direct from our plant. That way we can keep the name printed on the ball a secret that only a buyer would know. There's more to golf than tournaments, you know."

The company guarantees a golfer a prompt refund if the new ball doesn't cut five to ten strokes off his or her average score. Simply return the balls—new or used—to the address below. "No one else would dare do that," boasted the company's director.

If you would like an eagle or two, here's your best chance yet. Write your name and address and "Code Name S" (the ball's R&D name) on a piece of paper and send it along with a check (or your credit card number and expiration date) to National Golf Center (Dept. S-421), 500 S. Broad St., Meriden, CT 06450. Or phone 800-285-3900 anytime. No P.O. boxes. One dozen "S" balls cost \$24.95 (plus \$3.50 shipping & handling), two to five dozen are only \$22.00 each, six dozen are only \$109.00. You save \$55.70 ordering six. Shipping is free on two or more dozen. Specify white or Hi-Vision yellow.

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## CAR CARE

wiper-blade frame from the rest of the blade—then slide the squeegee along with the locking link off the arm. Then remove the locking link.

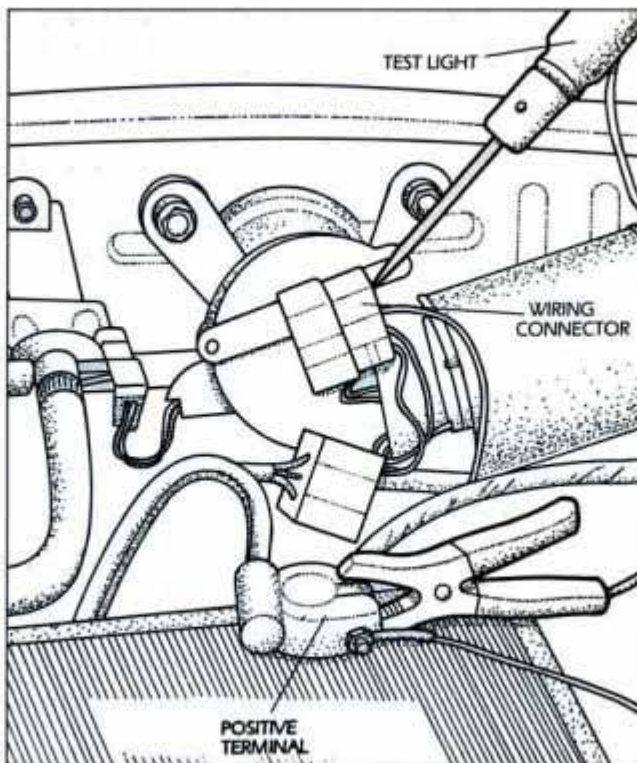
If your car has wipers that park inaccessibly behind the lip of the hood, shut off the ignition while the wipers are in midstroke to stop them in the middle of the glass.

### Chatter

If the squeegees are new and in good shape—not hard or brittle—and are the correct ones for your car, they may still chatter or skip their way across the glass rather than wipe. This can be caused by a wiper arm that is bent or one that is improperly tensioned.

With the wipers parked in the middle of the windshield, look to see if the arm is parallel to the glass—and not twisted. If the arm looks twisted, use two pairs of pliers to reshape it. If this doesn't work, replace the arm.

If the arm is parallel, you may need to increase the arm's spring tension. Inexpensive spring helper



Quick-test wiper motor with jumper wire or test light from battery's positive terminal to wiper motor's wiring connector.

clips are available at auto parts stores. If these don't do the trick, you have to replace the arm again.

While you can buy replacement

wiper arms at an auto parts store or your new-car dealership, you may also be able to buy them at a scrap yard, particularly if you have a popular model car.

To replace the wiper arm, remove or raise any protective cover over the drive spindle. If there is a nut, remove the nut and then gently pry the arm off the spindle's splines.

If there is no nut, check the wiper arm for a small hole which may access a locking tab or retainer spring. If there is a hole, insert a scribe to release the lock. Pry up on the wiper arm.

Some wiper arms are simply pressed onto the drive spindles. If you cannot find evidence of a locking tab or other retainer, pry up on the base of the arm. Take care to not mar the finish or damage the plastic cowl or plastic trim cover, if your car has one.

Reverse the procedure to install the new arm. When installing a wiper arm, place the arm on the drive spindle so the blade will not foul against

## WARNING: Failure To Change Your Wiper Blades May Be Hazardous To Your Health.



An important factor contributing to your driving safety is often overlooked...even when you're looking right at it!

Worn out wiper blades streak and squeal across your windshield. It impairs your driving vision, and it could be the cause of an accident.

TRICO recommends you replace your wipers every six months. That's because when it comes to safe driving, what you don't see, can hurt you!

Look to TRICO, the leading original equipment supplier of wiper blades for auto manufacturers worldwide.

Available wherever quality auto parts are sold.



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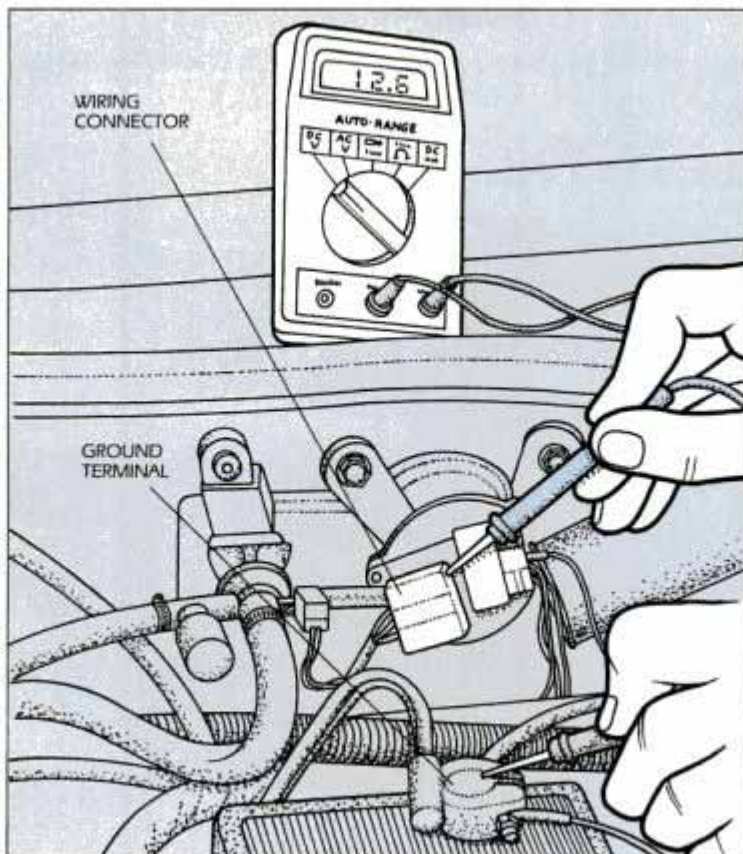
the windshield frame at either end of its stroke. If the blade does hit the frame, carefully remove the arm and reposition it by one or two splines on the spindle. Recheck.

### Total failure

If your problem is a sluggish or erratic interval setting, check to see if your car uses a separate relay for the interval setting. The relay will be at the fuse or relay block, under the dash or in the engine compartment.

If the problem is more severe—namely that the wiper blades do not move at all when you switch on the wipers—there is either an electrical problem in the switch, wiring, fuse or motor, or a mechanical problem with the crank arm, linkage or connecting rods.

First check the fuse. If it is blown, replace it and see if it blows again. The



Test wiring, fuse and switch by connecting voltmeter between battery's ground terminal and wiper motor's connector with the wiper switch on.

fuse may have been done in by a temporary overload, as from trying to operate the wipers when the blades were frozen to the windshield. If the new fuse blows, there is either a short in the wiring or the electric motor, or an overload, as from a seized linkage or motor.

Isolate the motor from the linkage by disconnecting the motor from the crank arm. This may require removing a section of cowl or other cover as well as the wiper arms.

If the motor now runs, the problem is with the linkage (assuming you've already replaced the fuse). If not, there's an electrical problem.

Try moving the linkage by hand by twisting the crank arm. If it's tight, disconnect the crank arm from the linkage rod and try again. Work your way from the motor to the individual drive spindles to

PH ILLUSTRATION BY RON CARBONE



## CAR CARE

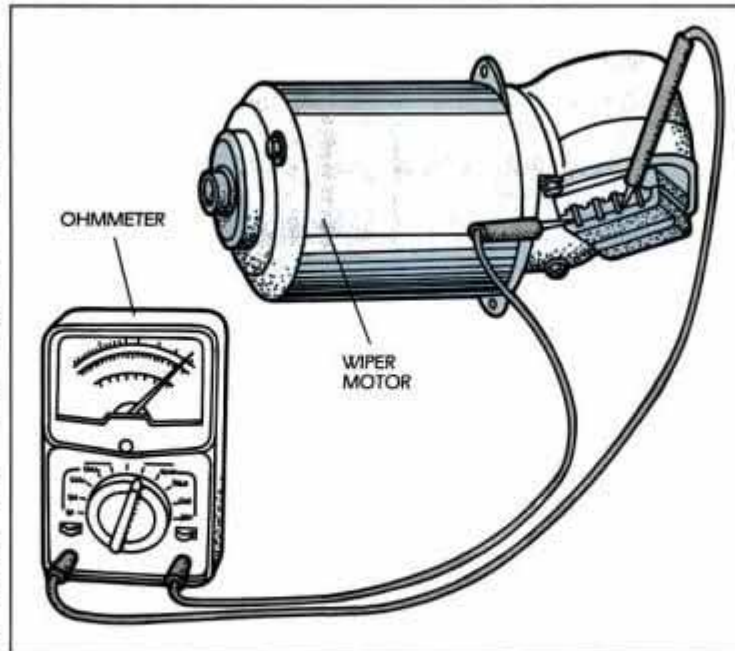
pinpoint the problem.

In some cases, dirt, rust or corrosion can be binding one of the ball joints or the sockets—possibly at the crank arm or either end of the linkage rod or connector rod. Disconnect the ball joint, wire-brush it clean and reassemble it. Lubricate the joint with a dab of white grease.

If part of the linkage is bent or severely corroded, replace it.

However, if the disconnected linkage moves freely, check for an electrical problem at the switch, motor or wiring circuit.

Unplug the motor's wiring connector and probe the wiring harness's connector with a grounded test lamp or voltmeter. With the ignition on, turn on the wiper switch. One of the connections to the motor should show current. Change the switch setting to a higher speed and a different terminal in the connector should show current. If



Bench-test a suspect wiper motor by checking its resistance with an ohmmeter. Check the readings at different terminals.

there is no power to the connector with any switch setting and the fuse is good, there is either an open circuit or a bad switch.

Reconnect the motor's connector and bypass the wiper switch by connecting a jumper wire to the termi-

nals on its back. If the motor now works, the switch is defective. If not, the problem is in the wiring or with the motor itself.

Test the motor by unplugging its wiring connector and attaching a jumper wire directly to the battery's positive terminal. Make sure that the wiper motor is grounded. If the motor runs—and at different speeds as you touch its different terminals—the problem is in the wiring circuit. Use a grounded test lamp to work your way back along the wiring until you find the broken connection.

If the motor does not run, it is defective.

Before replacing the motor, remove it and test

it. Your factory shop manual will have the amperage draw, resistance load and other specific tests you can perform. The motor simply may have stuck, dirty or defective brushes, or a tight bearing—all repairable on your workbench.

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# NEW CARS



## Chrysler LHS And New Yorker

● We were fully prepared to dislike the new New Yorker as we boarded a plane for California to attend the press introduction of it and its sister car, the LHS. After all, we were part of that 45-to-54-year-old market segment that, as one Chrysler marketing executive later put it, "wouldn't be caught dead in a car called the Chrysler New Yorker."

The New Yorker is one of those nameplates associated with the old Detroit way of building cars. Indeed, our last drive in a Chrysler New Yorker left us with an impression of an ostentatious, underpowered, roly-poly car that bent the suspension bumpstops, even on the smallest road imperfections.

Upon landing in San Francisco, we were handed the keys to a New Yorker and a map, and told to head north to Napa Valley, where the press briefings would be held.

Loaded with standard luxury features, like leather upholstery and power moonroof, Chrysler's LHS tops the LH lineup. LHS has sporty touring suspension, standard ABS.

After only a few miles, we had a totally new impression of what the New Yorker nameplate stands for. What a pleasant surprise! The new New Yorker is nothing like the old car. It's big, with tremendous room inside. It's powerful, with a 3.5-liter V6 that moves the car out smartly. And it's luxurious, with all the amenities you would expect in a car that will compete with the likes of the Buick Park Avenue and Mercury Marquis. But its ride is firm and stable in a glass-smooth kind of way that is reminiscent of the best from Europe. After pounding around Napa Valley for two days, we can summarily state that the new car's ride and handling is nothing like the old New Yorker's, and that's the best part of the surprise.

Its sister car, the LHS, is the



archetypal big, contemporary American luxury sedan for the '90s. With such standard features as a touring suspension with 16-in. wheels and tires, a hot-rod 214-horsepower version of the V6, leather interior with bucket seats and console and power everything, as they say in the beer commercials, an LH sedan doesn't get any better than this.

Both the New Yorker and LHS are derivatives of the LH family of cars—Dodge Intrepid, Chrysler Concorde, Eagle Vision—that won one of our '93 PM Design & Engineering Awards. The new cars are built on the same LH platform and have the same wheelbase. But now



New Chrysler New Yorker combines traditional American luxury seating with LH styling and responsive handling.





Ford's new Explorer Limited includes leather upholstery, special body-color exterior trim and several electronic extras.



comes the magic. Move the rear seat back 3 in., add a "nouveau classic" roof, increase the rear overhang (and trunk space) 5 in. and eliminate much of the chrome and cladding found on the Chrysler Concorde, and you have two new cars—the Chrysler New Yorker and LHS. They will do well in the marketplace.

### Ford Explorer Limited

Ford managed to sell more 1992 Explorers than its two closest competitors combined in a crowded and competitive sport/utility vehicle market. They did so without added dealer incentives or marketing gimmicks. In fact, Explorer production has run at the outer limits of plant capacity since day one, three years ago.

In spite of that, they're introducing a new model that is more upscale than the already upscale Eddie Bauer version. Externally, the Limited sports color-keyed grilles, bumpers, bodyside moldings and integrated running boards.

Inside, you can luxuriate on memory-position leather seats, surrounded by leather and cloth door trim and a leather-wrapped steering wheel, while resting your feet on cloth floor mats embroidered with the Ford logo.

Additional standard equipment includes an overhead console with a compass and an outside thermometer, an electrochromically dimmed rearview mirror, automatic headlamps and heated outside mirrors.

Expect to pay about \$750 more than the price of a comparably equipped Eddie Bauer—around \$27,000 to \$28,000.

### Saab Story

After 30 years of continuous development, Saab's revered 900 series is finally rolling to a halt. Although the

unique Swedish sedan never sold in big numbers, it did acquire a cult-like following over the years, particularly in black 3-door turbo trim.

To mark this milestone, Saab is offering a Commemorative Edition, which will be—you guessed it—a black 3-door Turbo with tan leather interior. Besides being the last of its breed, it'll also be the fastest, thanks to a horsepower tweak. Employing the same turbo refinements that helped speed up the 9000 Aero, the 900 Commemorative Edition spools up to 185 hp, 25 more than the standard 900 Turbo.

Saab plans to limit the production of the 900 Commemorative Edition

to just 325 cars. The new 900 series is scheduled to be unveiled at the Frankfurt Auto Show this fall.

### GM Downloads Lotus

In yet another move to restore black ink to its bottom line for worldwide operations, General Motors is about to divest itself of Group Lotus, the British sports-car maker and engineering think tank.

The plan involves a buyout by Group Lotus employees, led by Adrian Palmer, the company's acting managing director. According to GM, the deal would include both the money-losing car operations and the profitable engineering side of the company.

GM is not involved in the Lotus Formula One racing operation, which has been a separate business entity since the death of Lotus-founder Colin Chapman in 1982.

After the failure of its fast-but-pricey Elan roadster, Lotus was down to a single model—the mid-engined Esprit coupe. Lotus sales fell to about 1500 cars worldwide last year, although price cuts and performance upgrades have produced an uptick in '93.

*(Please turn to page 98)*



### Scales Of Justice?

● If your line of work involves the occasional high-speed pursuit, this car has to look like a traffic enforcement officer's dream come true.

But if you're like most of us—an ordinary guy who occasionally finds himself traveling on the high side of the speed limit—it looks like your worst nightmare. Even with a light bar to slow it down, the Dodge Viper RT/10 is one of the quickest rides on the planet. With 400 hp and 450 ft.-lb. of torque, it'll zip to 60 mph in less than 5

seconds, and if the arresting officer keeps his foot in it, he'll see 100 mph about 6 seconds after that. All of which means this badge-bearing reptile can strike from the shadows quicker than you can say, "But officer..."

A nightmarish prospect indeed. But fortunately, this dream won't become reality. The concept cop car was cobbled up by the guys at the Viper factory in Southfield, Michigan. Just for laughs. So okay, we're laughing.

—Tony Swan



General Motors acquired Group Lotus in 1986 for about \$35.6 million, and has since invested almost \$30 million more in the company.

How the management buyout will affect Lotus sales operations in the United States still remains to be seen.



Limited-edition Mustang convertibles are available in yellow or white monochrome.

### Monochrome Mustangs

As the current Mustang nears the end of its production run, Ford is offering a couple of custom convertible packages that could very well become collectibles.

The limited-production specials are available in yellow and white monochromatic paint schemes, with body-color spoilers replacing the luggage rack that adorns standard LX convertibles. Another special touch is leather seats—black for the white car, black or white for the yellow—with the Mustang pony embroidered on the headrests.

Both versions are powered by Ford's 245-hp 5.0-liter V8, mated to a 5-speed manual transmission. The 5-spoke wheels are 16 x 7-in., wearing P225/55ZR16 tires.

The manufacturer's suggested retail price for the white version is \$21,709. The yellow convertible, with its chromed wheels, is \$22,221.

### Mustang '94

Meanwhile, as Ford winds down production on the current Mustang, it looks like the next generation will be here earlier than expected.

Originally slated for mid-'94 introduction as a '95 model, the new Mustang is now scheduled to be in dealer showrooms before the end of the year, probably right after Christmas.

Although there have been a number of chassis revisions, the '94 Mustang will continue to use the current front-engine, rear-drive platform.

Powerplants, too, will be familiar—a 3.8-liter pushrod V6 for the basic car and Ford's veteran 5.0-liter pushrod V8 in upscale editions. The 280-hp dohc 32-valve version of Ford's 4.6-liter modular V8 won't be a Mustang option for at least a year. Or longer. Ford's not saying, for fear sales of 5.0-liter V8s will taper off in anticipation. Our advice: Buy now.



Revised Infiniti G20 gets modest cosmetic and safety upgrades.

### 1993½ Infiniti G20

Although the flagship Q45 got most of the styling money, Nissan's Infiniti team has been busy with the G20 as well, offering a midyear update on its entry-level sport sedan.

Cosmetic revisions are limited to body-color bumpers and bodyside moldings, plus polished cast-alloy wheels—formerly optional—as standard equipment. However, there have

also been several safety-related upgrades, including dual front airbags, front seatbelt pretensioners and height-adjustable rear-seat head restraints.

Infiniti has improved the response of the G20's optional electronically controlled 4-speed automatic transmission, and also retuned the suspension for better ride quality. Revisions include slightly softer bushings and a softer rear antiroll bar, as well as new parallel links for improved rear toe control during hard cornering.

In addition to some minor interior trim changes, a Leather Appointment Package has been added to the G20's option list. The package includes a power-operated tinted-glass sunroof, power-adjustable front seats, keyless remote entry and, of course, leather upholstery.

### Anniversary Accord

Anyone over 30 knows that time is Teflon-coated, and Honda's 10th Anniversary Accord is yet another reminder of how easily it slips by. It doesn't seem like a decade since Honda became the first Japanese car manufacturer to open a U.S. assembly

facility, but that's how long the Marysville, Ohio, plant has been in business.

The factory passed the 3-million-car milestone in January.

Priced at \$18,300, the Accord 10th Anniversary Edition package includes a number of luxury features—power windows, 4-speed automatic transmission, air conditioning, an AM/FM/cassette sound system, cruise control, power door locks, special upholstery fabric and, of course, the all-important 10th anniversary badges.

The Anniversary Accord is available only as a sedan. Three colors—green, white and black—are offered. **FM**



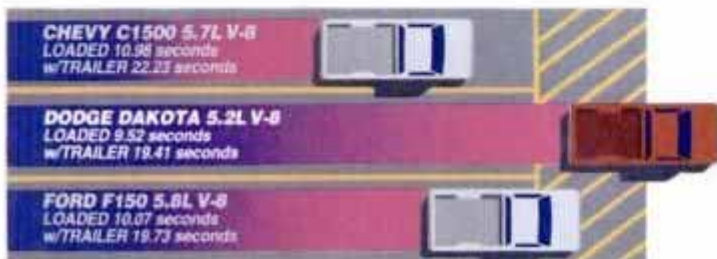
Special Accord celebrates Honda's 10th anniversary as a U.S. manufacturer. The \$18,300 sticker price includes luxury features and special badging.



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-Certified by SCORE International, January 1992

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# INTERACTIVE TV

BY FRANK VIZARD, Electronics Editor



To view the service, you insert a "Smart Card" into the adapter. Viewers make choices by clicking through a menu with the remote control. Program grids are shown in 4-hour groupings and each program is fully described. Programming notes are updated daily. A subscription to the service costs about \$2.95 per month.

Trakker, located in Tulsa, Oklahoma, and affiliated with Prevue Networks Inc., also plans to offer more services. The company will soon test-market a Sports Trakker service offering late-breaking scores and other sports information. Also planned is an advanced TV Trakker, which will simplify VCR programming and offer a variety of entertainment, news, weather and business services.

Trakker is likely to have competition from a variety of sources as far as electronic programming guides are concerned. Looking a little beyond just program guides is the In-

● You may think channel-grazing through television programming is an idle pastime, but actually you're in training. In the near future, TV is going to be interactive, and this means your thumb is going to be on the button more than ever.

Defining "interactivity," as it relates to TV, is open to discussion. Some proponents of interactive TV are promising more interactivity than others. To a large degree, though, more sophisticated technology is pushing TV toward interactivity by necessity.

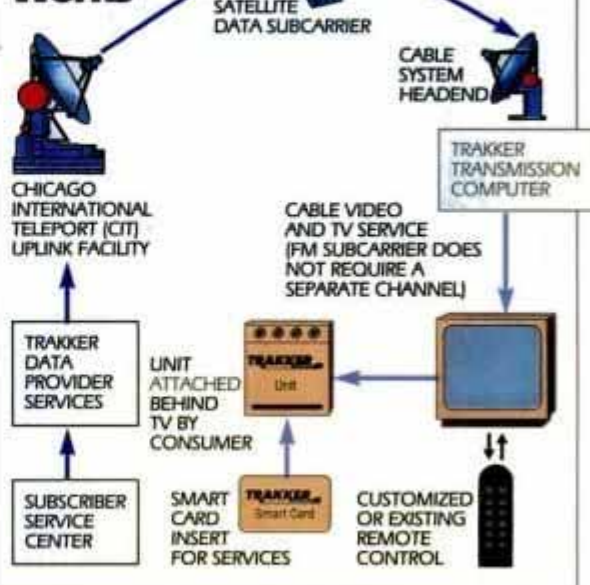
For instance, now that people are talking about cable TV systems with hundreds of channels, how do you figure out what's on? Flipping through a weekly printed guide might prove as cumbersome as letting your fingers do the walking through a metropolitan phone book.

One solution is to electronically

download programming guides directly to your television. TV Trakker is just such an electronic programming guide. It's currently available in some test markets and is expected to have a national rollout this year.

TV Trakker delivers its programming information via an FM subcarrier, so it takes up no additional channel capacity—a feature that appeals to cable operators. To retrofit TV Trakker, you attach a 4 x 5-in. adapter to the back of the TV. In the future, TVs, VCRs and cable boxes may have TV Trakker preinstalled, or there may be a slot so TV Trakker simply can be plugged in.

## How Trakker Works



TV Trakker downloads programming info directly to your TV. A simple adapter gives you access to the data.





Play along with TV game shows and sporting events using IN's wireless controller.

teractive Network (IN) Co., based in Mountain View, California. Currently available in San Francisco, IN hopes to get you directly involved in everything from sports games to quiz shows.

IN simulcasts game information on an FM subcarrier directly to a portable, wireless controller. This allows viewers to play games in real time with the TV broadcast. Play selections are made by using function keys on each side of the controller and by using a touch-sensitive strip at the bottom of the LCD display.

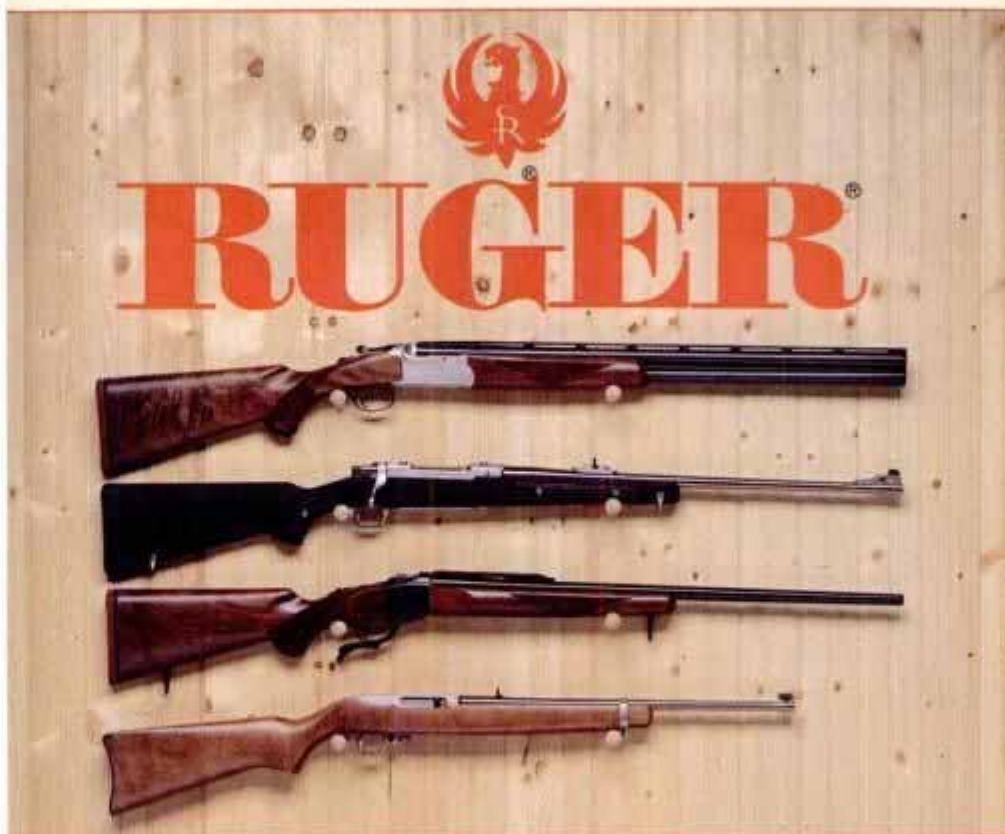
During a football game, for example, viewers can predict whether the next play is a run or a pass. Points are awarded for the correct answer. At the end of the game, viewers plug their controllers into a telephone for a call to IN. Downloading the information takes 20 seconds, and scores are tabulated and sent back to the player in 4 minutes.

The controller also has a retractable keyboard for more complex entries. The controller runs for about 8 hours on rechargeable batteries and also works with an AC adapter.

Controllers list for \$199. Subscribers pay a \$15 monthly fee. For games in which subscribers compete against each other for prizes, an additional fee is charged at the rate of \$1 for a game show and \$2 for a sporting event.

Game players may have a simpler form of interactivity available next year. Videogame-maker Sega is joining with cable-operator Time Warner to offer an interactive game channel for cable TV. Subscribers will connect a cartridge to the cable and the cartridge is inserted into a Sega Genesis game slot. Viewers will see a menu of games available and then pick one. Individual games will be downloaded into the D-RAM cartridge for unlimited play. The monthly fee is estimated at \$10, and players would have access to about 100 titles 24 hours per day.

The Sega Channel, as the service would be called, amounts to game-playing on demand. **FM**



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## OUTDOORS

# IDITAROD: THE LAST GREAT RACE

BY JOE SKORUPA, Boating/Outdoors Editor



PHOTO BY JEFF SCHULTZ

● So, what's all the fuss about a sled-dog race? Sure the dogs competing in Alaska's famed Iditarod Trail race are fabulous athletes. After all, they do the legwork, not the mushers. But why the Indy 500 atmosphere? I was in Anchorage for the start of the recent Iditarod race, and the size and diversity of the media circus made me think that Madonna had just walked through town in thermal underwear.

Let's face it, sports fans, the Iditarod Trail International Sled Dog Race is a strange event. It begins in the middle of a busy city where race personnel and the media outnumber spectators. The racers mush on a veneer of snow that's hauled in the night before. After running 15 miles along a highway, they load everything onto trucks and drive another 20 miles to restart the race—this time for real. Then, they mush out of town

and out of sight. Ten days later, when musher No. 1 arrives at the finish line in Nome, the news is flashed around the world. Is this really the stuff legends are made of?

You bet. Here's why:

- The race covers 1049 roadless miles of jagged mountains, frozen rivers, dense forests, desolate tundra and windswept coast.
- Frequent winter storms push temperatures far below zero, occasional-

ly even down to 50° below.

● The race and the trail itself commemorate a supply route that was used in 1925 to deliver serum to epidemic-stricken Nome.

● Now 21 years old, the race revives the spirit of Alaska's hardy sled-dog past, which was all but forgotten in the 1960s due to the advent of the snowmobile.

● Women are as large a part of the Iditarod story as men. The race itself was conceived and championed by Dorothy G. Page, and two women have won it—Abby Riddles, who took a dramatic shortcut across sea ice during a white-out blizzard, and Susan Butcher, a 4-time champion. In both the 1992 and 1993 races, two women finished in the top five.

● And finally, courage is put to the test. In addition to bitter cold, deep snow, sea ice, white-outs and blizzards, the mushers also con-



Mushers, start your dogs. Downtown Anchorage hosts the ceremonial start of the Iditarod Trail sled-dog race.



tend with crazed moose (one killed several dogs), difficult-to-find trails, fatigue and intense sleep deprivation. In other words, it's a typical Alaskan experience.

The interesting thing about Alaskans is that they take the mythic last-frontier business very seriously. "Where are you from?" they always ask. When you tell them, they invariably respond, "I could never live there. But that's not an insult. I could never live anywhere in the lower 48."

Ah, Alaska. So raw. So untamed. So rude. But, personally, I understand. I'd be defensive, too, if I had to wear mukluks for 11½ months of the year.

Actually, life in Anchorage isn't so bad. It was warmer there (35° F) than it was in New York at race time. One irony about Anchorage is that it's probably as cosmopolitan as any city of its size in the lower 48 states with a comparable population—200,000. Anchorage residents may be rugged individualists, but they aren't exactly roughing it.

On the other hand, Anchorage isn't a good representative of the state. It's an aberration, especially when you consider that Alaska is twice the size of Texas with less than a 20th of the population. Aside from Anchorage, Alaska is true frontier country—uncrowded and virtually undeveloped.

As everyone knows, most Alaskans are non-natives, and it's no secret that they were drawn north by the appeal of the last frontier. Even though they may reside in Anchorage or its suburbs, they still think of themselves as living lives of adventure among majestic mountains, immense herds and curls of fireplace smoke drifting above a solitary cabin in the wilderness.

This archetypal image of Alaska is a powerful myth, and there's little doubt that its attractiveness forms the basis for the enormous appeal of the Iditarod race.

Whatever the reason, the Iditarod is a big-time event. Dodge Trucks, Timberland and a host of other companies chip in to create a cash prize pool of considerable proportions—\$350,000. The winner gets a check for \$50,000, plus a 1993 Dodge Ram 250 4x4 Club Cab Super LE with a Cummins intercooled turbodiesel. This little throw-in has a retail value of about \$28,000. Believe it or not, the overall operating budget for the race is a whopping \$2 million.

I was invited to observe both the false and real starts of the Iditarod race by the good people at Dodge Trucks—one of the two major spon-

sors of the event. Dodge brought a fleet of Dakota pickups to the great white north for a group of the automotive press to play around with in the snow. I've driven Dakotas before, so I wasn't surprised at the successful midsize pickup's outstanding performance, which is somewhat improved this year by the addition of 4-wheel ABS. What did surprise me was that the Dodge Ram T300 wasn't available. Too bad. This is Dodge's all-new full-size pickup, which has an optional V10 engine. Needless to say, I'm looking forward to driving this

baby. Maybe next year.

Ten days and 15½ hours after leaving Anchorage, musher Jeff King was the first to arrive in Nome. The second was DeeDee Jonrowe, who pulled in a half-hour later. What they went through we can only guess. But we know three things: It was extremely difficult, it took place among the last frontier's magnificent mountains and immense herds, and now that it's over the 70 mushers and their dogs have returned to the curls of smoke drifting slowly above solitary cabins in the wilderness. **PM**

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# PERSISTENCE PAYS OFF

BY JEREMY SHAW



• With two drivers on the victory podium, the second round of the 1993 PPG IndyCar World Series—which was also the U.S. opener—provided a near-fairy-tale finish for Team PM and Dick Simon Racing. And it also showed the importance of persistence.

The season opener in Australia showed just how competitive the partnership could be, with Raul Boesel, Jimmy Vasser and Scott Brayton all qualifying in the top 10. And the promise was fulfilled when the series returned to North America for the Valvoline 200 at Phoenix International Raceway.

Boesel, in particular, was close to the front-running pace all weekend, winding up with second place to match his career-best finish. Vasser, with his year-old Lola chassis and Chevy Indy V8/A, drove a strong race to finish third. The only possible improvement, from the Dick Simon/PM point of view, would have been Brayton's presence on the podium in a 1-2-3 sweep, but electrical problems sidelined Brayton's Lola early in the race.

## Compact weekend

The IndyCar authorities trimmed one day off the normal 3-day weekend, making the Phoenix round short but intense. The idea behind the 2-day event was to save running time on the cars and engines, thus reducing costs. The reality was that most of the better teams, including Dick Simon Racing, had to get additional track time through pre-race testing, which is even more expensive.

"The 2-day format also made it



Raul Boesel (left) and Jimmy Vasser in the Phoenix winner's circle.

much more of a thrash," said Julian Robertson, Dick Simon Racing engineer. "In theory, there was going to be a 90-minute break between the two practice sessions on Saturday, and the second session was going to be 1 hour long."

Inevitably, even the abbreviated schedule came in for adjustment as various incidents created delays. Most spectacular under this heading was Nigel Mansell's resounding crash in PIR's high-banked turn one. The reigning Formula One champion backed his Kmart/Valvoline Lola/Ford-Cosworth into the wall at an estimated 180 mph, leaving him with a concussion that kept him out of the starting lineup. And the ensuing cleanup, which included patching a hole in the concrete wall, cut the final practice session to just

30 minutes—a real problem for those who still hadn't found the right handling setup.

"There was only time to make minor changes to the setup of the cars," said Robertson. Fortunately for the POPULAR MECHANICS trio, preseason testing had given the Dick Simon crew a good operating baseline, and when qualifying opened Saturday afternoon the three Simon cars were more ready than most in the 26-car field.

## Boesel's best

Boesel led the way around PIR's fast 1-mile oval for Team PM, claiming grid position No. 6 with his Duracell/Mobil/Sadia-sponsored Lola T93-06/Ford-Cosworth. He was only a half-second off the fastest lap, set by Scott Goodyear in another Lola/Ford-Cosworth. Vasser claimed ninth for the Kodalux/STP Lola, de-



Electrical problems sidelined Scott Brayton early in Phoenix race.





Jimmy Vasser's Lola/Chevy overtakes misfiring Lola/Ford of Scott Brayton during early laps of 1993 U.S. IndyCar opener at Phoenix.

spite problems with a balky throttle-position sensor, while Brayton, plagued by elusive electronic maladies, was 12th in the Amway/Northwest Airlines Lola, another T93-06/Ford-Cosworth.

Race day brought a record IndyCar crowd and perfect Arizona weather to the excellent PIR facility. And, as usual, it provided a kaleidoscopic array of changing fortunes.

This was especially true for the Marlboro Penske team. Paul Tracy, the sensational young Canadian who has taken over for the recently retired Rick Mears, set a sizzling pace, putting his car in the lead on lap 11 and putting the entire field a lap in arrears 30 laps later.

### Two-lap lead

When Goodyear's Lola dropped out with gearbox problems at mid-distance, Tracy held a 2-lap advantage over everyone else, including teammate Emerson Fittipaldi, running in second place.

It looked like a great day for Team Penske—until Tracy attempted a difficult pass on Vasser with just 38 laps

to go and wound up slamming into the turn one wall. After 10 laps under caution, the green flag came out again, whereupon Fittipaldi promptly crashed in turn three, a consequence of running over some debris from Tracy's crash.

That left Mario Andretti's Kmart/Havoline Lola/Ford-Cosworth in front, where he stayed to the finish for his 52nd IndyCar victory. In the process, he became the oldest driver (at 53) ever to win an IndyCar race, and also the only IndyCar driver to win races in four different decades.

### Euphoric finish

Although the mood in the Newman-Haas pits was predictably happy—only 24 hours earlier, with Mansell out of the race, their prospects had looked bleak—there was plenty of euphoria in the PM pits as well.

"Our team has been working very hard," said Simon. "The only podium finish I had as a driver was in Ontario (1970, third place). I retired from driving for the purpose of doing what is starting to happen, and that is to put our team in the victory circle.

"The team is getting stronger. I'm very proud."

### Boesel in the clutch

Looking back over the day's events, Julian Robertson—who learned his trade with the Lotus Formula One team—noted that with a little luck the team's strong finish could have been even stronger. Robertson cited a cracked clutch plate in Boesel's car, which showed up when Boesel made his second pit stop.

Instead of a routine 17-second stop, Boesel was in the pits for 40 seconds, enough to lose a lap, even though the field was running under the caution flag at the time. Boesel persisted the rest of the way without a clutch, and persisted very well.

"It's a pity we weren't on the same lap as Mario toward the end," said Robertson, "because I think Raul might have been able to give him a hard time."

But that, as they say, is racing. And by any racing standard, Team PM's day in Phoenix was exceptional. So what do you suppose will happen at the next one? **PM**



PM rides with Scott Brayton's Lola/Ford (left), Jimmy Vasser's Lola/Chevy (center) and Raul Boesel's Lola/Ford (right) in 1993.



# SAVING THE CONDOR

BY ABE DANE, Science/Technology Editor



AVIATION WEEK & SPACE TECHNOLOGY PHOTO

● Right before press time, we learned that Boeing's incredible *Condor*, the highest-flying propeller aircraft ever built, has been saved from the scrap heap. The immense unmanned aerial vehicle (UAV), along with associated equipment totaling 72 truckloads, is now said to be on its way to Lawrence Livermore National Labs. There, it will serve in a range of military and civilian research projects, including research into global warming and ozone depletion. A happy ending for what was very nearly a story of scandalous waste.

The *Condor* was built during the 1980s for the Defense Department at a cost of more than \$300 million. It shattered records with its ability to fly at extreme altitudes for days at a time. But with the Cold War fading, Boeing and the DOD sponsors couldn't find a military customer able to afford it. After a series of successful test flights, the *Condor* was mothballed. Anxious to keep its secrets out of the wrong hands, and burdened by storage and maintenance costs estimated at \$1.8 million a year, the DOD decided the easiest thing

would be just to cut the great robotic bird to pieces and wash its hands of it.

Not surprisingly, that brought an outcry from scientists, who saw in the *Condor* an irreplaceable research tool. For months now, they've been pulling every string they could find to get a stay of execution. Now, although neither Boeing nor Lawrence Livermore will say anything about it officially, sources involved in the lobbying effort tell us that the *Condor* has at last found a place to roost.

Why is a last-minute reprieve for a piece of Cold-War surplus such a big deal? Because the aircraft does things that so far scientists have only been able to dream about. "It's a truly amazing machine," says Adrian Tuck, chief of meteorological chemistry at the National Oceanic and Atmospheric Administration's aeronomy laboratory.

The first thing that strikes anyone who sees the *Condor* up close is simply its size. "The most jaded, blasé people can't believe their eyes," says Bryan Zetlen, president of Seattle Scientific Inc., and a former Boeing employee on the project. From

wingtip to wingtip, the *Condor* measures about 200 ft.—longer than the span of a 747. Yet by using ultralight carbon-fiber composite over a Nomex honeycomb core, the empty weight of the whole aircraft was kept to less than 10,000 pounds. These composites are so strong that, in one test, the wings reportedly survived being bent up to the point where their tips nearly touched.

Even more remarkable are the *Condor's* flying capabilities. As an approximate illustration, Tuck offers, "It can basically take a ton of payload to 73,000 ft., stay for five days and do 88% of a great circle route." Right now, NASA-modified U-2 spyplanes, called ER-2s, can manage comparable payloads and altitudes. But they can only stay on station for a few hours at a time. Furthermore, getting to some of the remote locations of greatest interest to researchers puts pilots' lives at risk. ER-2s are single-engine planes, and even the thought of a flameout during, say, Antarctic ozone measurements is harrowing.

*Condor's* flight duration would



help with a wide range of atmospheric studies. "You can stay on top of things and watch not only what's out there but see how it evolves," says Dr. James Weinman, who is studying the impact of rainfall on global climate change at NASA's Goddard Space Flight Center.

Lifting capacity is another key element of *Condor's* appeal. Although smaller drones under development, such as Aurora Flight Sciences' *Perseus* series (see *Tech Update*, page 14, Mar. '92), may fly as high, they can't carry the large batteries of instruments needed to monitor several different aspects of an event at once.

Creating *Condor's* unique combination of attributes placed tremendous demands on the Boeing team. Probably the most sophisticated of the systems they had to devise was the interweaving of computers, communications gear and navigation sensors that allow it to function without human intervention. With a single command, *Condor* can embark on whatever mission is programmed into its computers. It revs its engines and rolls down the runway, steering by signals from a microwave landing system. At about 65 knots, it rotates, lifts off from a jettisonable dolly and departs the field under the guidance of an inertial navigator. Multilayered redundancy and a highly adaptable computer system allow it to diagnose failures and limp home even after key systems quit.

Not everything aboard the *Condor* represents the newest technology. The twin 175-horsepower piston powerplants are built around a humble 6-cylinder block not too far removed from what you might find in a 4-seat Cessna. But 2-stage turbochargers allow them to breathe at altitude, and 2-speed gearboxes optimize efficiency by changing ratios as the aircraft climbs. According to Zetlen, getting the system to perform required that Boeing bring in some retired engineers whose experience stretched back to WWII fighters like the P-51 Mustang.

On Feb. 26, 1989, the *Condor* made a 29.4-hour flight, breaking records that had stood for as long as 51 years. According to Tuck, the aircraft was flying on one engine and still climbing when it hit its peak of 66,980 ft. There are rumors that with some tweaks the ultimate ceiling may lie somewhere beyond 100,000 ft.

It's terrible to think that such a machine was so nearly wrecked with its potential unexplored, and it's a credit to those who built it and spoke up for it that the *Condor* will fly again. **PM**

dressed by Acclaim Entertainment, a successful game developer and publisher for Nintendo's and Sega's 16-bit videogame systems as it begins investigating CD-based games.

Acclaim, which markets a number of games based on entertainment like television's "The Simpsons" and movies such as "T2," "Alien" and "Predator," is working to establish a database library of what it calls synthetic or "mathematical" actors, which can be used to create any number of realistic 3-dimensional characters and objects across multiple game platforms.

Since using real actors can be prohibitively expensive, Acclaim's approach is to develop a stable of lifelike, 3D geometric models that are "texture mapped," or overlaid, with artwork or even photos.

Wes Trager, Acclaim's director of research and development, says the process begins with the creation of a computer-generated 3D model, with scanning used to record data pertaining to the object's contours. "Once the geometric model is created, texture mapping is used to complete the image. Then skin tone and color are applied," Trager explains.

In a separate motion-capture studio, movements made by a live actor

outfitted with sensors are recorded. For example, work being done for a possible "Spiderman" title involved the use of a martial artist to create the original, realistic motions. Once recorded, the captured motions are then compiled and stored in a motion library.

"When motion-capture and geometric modeling are combined, the synthetic actor is brought to life," Trager says. "The procedure has the potential to blur the lines of the real and the imaginary."

While disc-based videogaming for 16-bit systems is still in its infancy, some companies are already looking to develop faster, more powerful hardware, with double-speed CD-ROM drives to achieve real television-quality video images. For example, a California company called 3DO is expected to launch such a system later this fall, and Pioneer has developed a laserdisc-based videogame machine.

It is clear, however, that developers for games designed to play even on existing Nintendo and Sega videogame systems are increasingly borrowing some tips from the Hollywood studios. So pull up a chair, pick up a joystick and get ready for action—the popcorn should be just about done. **PM**

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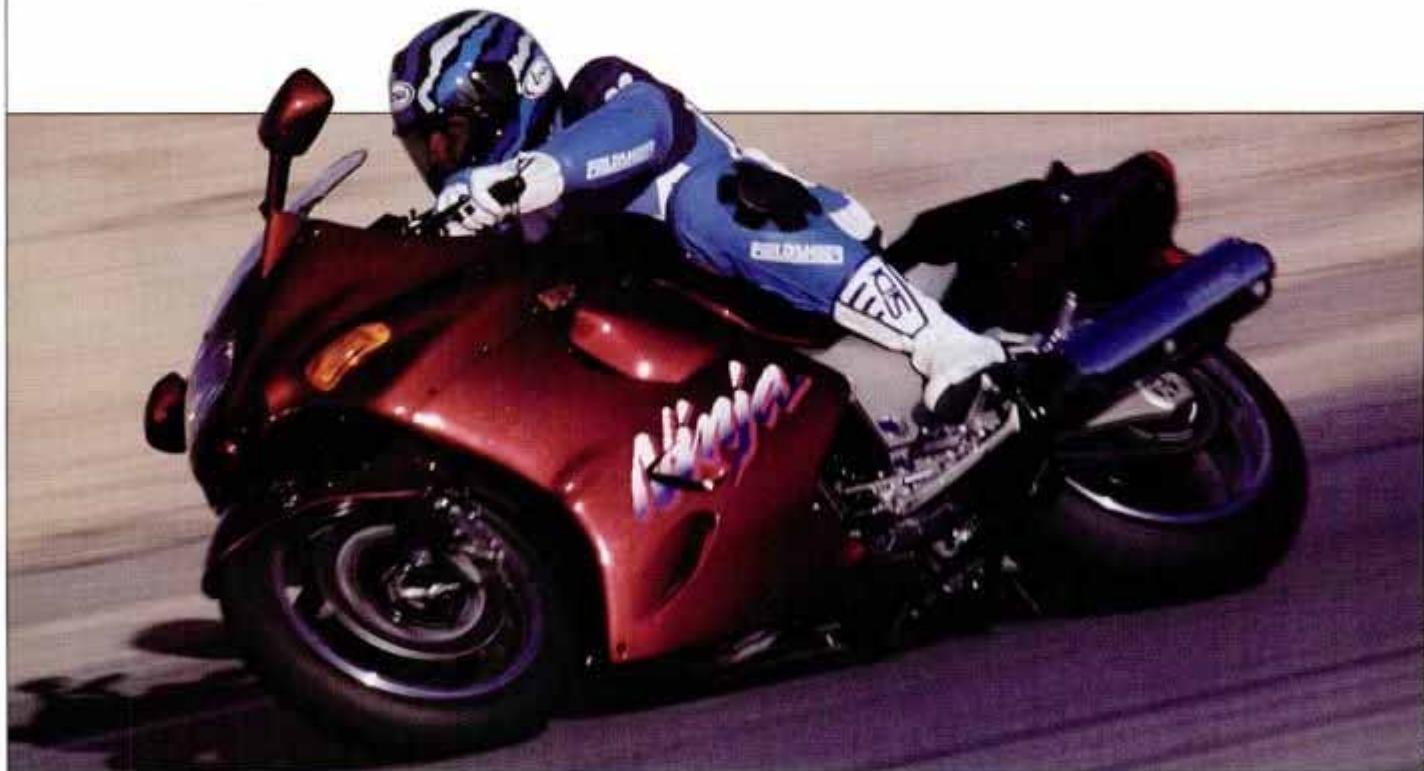
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## MOTORCYCLES

# ROCKET BIKE

BY CLIFF GROMER



TM PHOTO BY CLIFF GROMER

● If there was ever a ticket to the twilight zone, the new Kawasaki Ninja ZX-11 D is it. Professional-racer types might take the bike's low 10-second quarter-mile acceleration and 175-mph top speed as (ho-hum) routine. But mere mortals accustomed to plying the interstates at 65 mph on full-dress touring machines had better recalibrate their nervous systems for a new dimension in time and space before yawning the D's quartet of 40mm Keihin carburetors and kicking six gears at 11,500 rpm. Yes, it's that fast. Any faster and it'd come with a warhead.

Kawasaki's flagship sportbike—"sportbike" being more socially acceptable than "superbike"—is the latest in a line of Kawi tarmac melters that stretches back to the '60s and early '70s with their Mach III 500cc and Mach IV 750cc 2-stroke triples. These bikes set the motorcycle world on its ear, gobbling up and spitting out all of the larger-displacement hot bikes of the day.

The Ninja nameplate itself first meteorized onto the scene in 1990 with the ZX-11 C model. That motorcycle promptly shattered existing production street-bike acceleration and top-speed records. The C model has received minor improvements and updates each year, and currently is

offered for '93 in sinister black, as the ZX-11 C4. Its stablemate D model, clothed in flashier candywine red, carries even more power, extensive refinements and a \$300-stiffer price tag.

The heart of the ZX-11 D is a liquid-cooled 11:1-compression 4-stroke double-overhead cam 16-valve inline Four, displacing 1052cc. New is a twin-intake ram-air system with ducts leading from dual scoops in the nose of the fairing to a common airbox which, in turn, force-feeds the carburetor venturis. The C model is fitted with a single ram-air intake and a smaller airbox. The D's bigger appetite is balanced by an exhaust with 30% larger silencers.

Kawasaki rates the horsepower of its engines with the bikes tied down on a dyno, which doesn't take into account the benefit of ram air. But just the additional airflow capacity, and the resulting carburetor rejetting, plus the less restrictive exhaust, shows up as a 2-hp gain on the D from the C—147 hp versus 145 hp. You start cashing horsepower dividend checks as the speedo needle whips across the dial face. Collect an additional 5 to 7 ponies in ram-air payout as you peg the needle and pass Go.

With acceleration capable of slamming you back into the saddle at 130

mph, the last thing you want from your motorcycle is a second opinion on your line through a corner or a series of twisties. So Kawasaki engineers came up with a new perimeter-style frame that is 3.5 pounds lighter, but more rigid, than the extruded-aluminum tube design that ties together the C model. Computer analysis shows that replacing the tubes with sheets of pressed aluminum could decrease weight and increase torsional rigidity. Extruded tubes have a constant weight throughout the frame member. But with pressed aluminum, areas subject to more stress and flex can be built up while less stressed areas can be relatively lean. The D uses a main frame rail made up of two pressed-aluminum sections welded together. This in turn is welded to the cast-aluminum steering head, swing-arm pivot and shock mount.

The swing arm also is new and is 58% more rigid than the C's. It's a hybrid aluminum design, combining a hollow-cast pivot-shock mount with extruded arms. The swing arm is controlled by a single gas shock with adjustable preload and rebound damping.

Compared to the other contenders in the sportbike class, the ZX-11 D is not only the quickest and fastest, it's

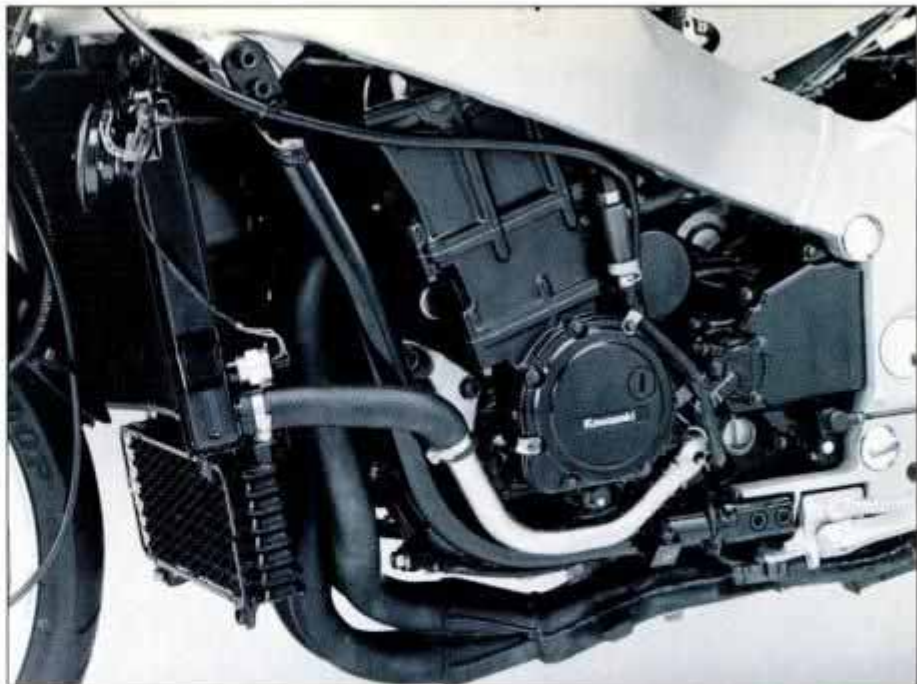


also the largest and heaviest—more than 600 pounds in fighting trim. So don't expect to flick this motorcycle around like a nimbleweight. Punch the starter button and the big Ninja fires and settles into a mellow burble. A touch of choke brings the engine and twistgrip to the same wavelength, but the beast is warmblooded by nature. The huge hump of the 6.3-gallon fuel tank seems, at first, a threat to all the things the anatomy books show as residing inside your midsection. But the formidable tank virtually disappears as you lean forward in the saddle and hook onto the bars in traditional "sport" riding position. If you're used to a chairlike touring posture, assuredly, sport riding will work your joints and muscles into a new groove. Ninja's riding position is less radical than the competition in that your knees are farther from your chin and you have a bit more room in the saddle to shift and fidget.

One last scan of the integrated dash shows the new fuel gauge, and a speedometer with so many numbers squeezed so close together it should come with a pair of bifocals. Clutch action is light, and First gear snicks in with typical Japanese-bike precision. Clear for takeoff and let out the clutch. Impressive low-end grunt gets you rolling easily with the big mill just ticking over. Power comes on smoothly and evenly, and the bike quickly sheds its pounds as you get off the dime. Steering effort is light at low speeds, making this Ninja a real pussycat in traffic. Sort of gets comfy too after awhile. Hey, this wouldn't make a bad daily commuter. You could ride the ZX-11 D all day and never realize the potent surprise that Kawasaki packed away behind those red fiberglass body panels.

But resisting temptation was never our forte. Crack the whip in First and the D rips off its mild-mannered Clark Kent attitude to reveal its true superbike nature. The mellow burble escalates to a mean howl and the world is hurled toward you at cosmic speeds. Seventy miles per hour—the top of First gear—is instant. But if you don't watch the tach, the rev limiter will save you from possible warranty paperwork. Five miles over the legal speed limit already, and still five gears to go.

On the track, where it's relatively safe (and legal) to extract triple-digit speeds from the bike, the D delivers handling to match its performance. It won't turn lap speeds as fast as its lighter and more nimble competition. Those bikes give up comfort with their more radical riding positions and harsher ergonomics. But the D



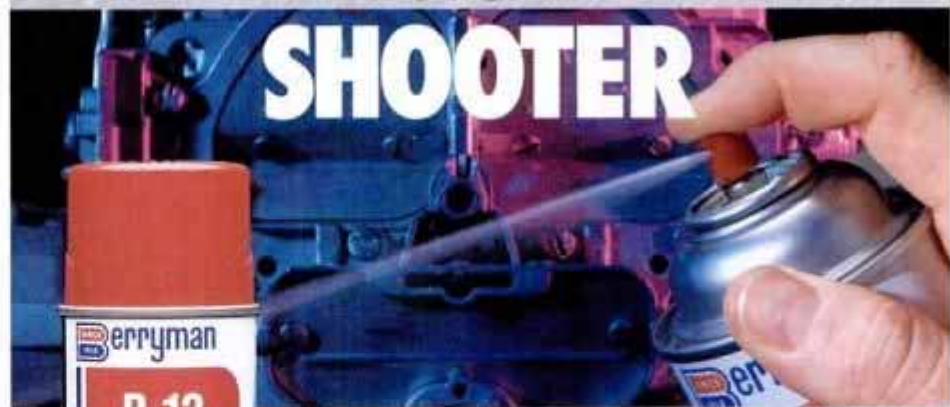
ZX-11 D Four is good for 150-plus hp at speed, and mind-wrenching acceleration.

rates an "A" on twisty public roads, where it is rock solid and smugly competent. Larger Z-rated 17-in. tires combined with a brake system featuring stronger dual 320mm floating-disc rotors with dual opposed 4-piston calipers up front and a single 250mm rear disc out back are welcome improvements, as is a larger

fairing for more rider protection.

With a list price of \$8799, the ZX-11 D is an absolute bargain compared with what it would cost you to buy this kind of explosive performance in a car. Of course, for the really low-buck types, there's always the fallback of a large rubber band stretched between two trees. **PM**

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# DETROIT SPY REPORT

BY JIM DUNNE, Detroit Editor



## Ford Taurus

● Despite the lack of a rear bumper and the presence of a bra on the nose of this prototype, it's obviously a 1996 Taurus. And it is just as obvious that Ford's best seller is in store for a radical restyling. The windshield base is located way out in front, directly over the front axle, à la Chrysler's LH sedans. The new Taurus also has shorter overhangs than the current model, also like the Chrysler design. One curious detail of this future Taurus is its door handle treatment. The door locks are above the doors' sheetmetal, perhaps because the doors themselves have been made thinner to allow for increased hip- and shoulder-room.

## Mustang Motor Update

Though the new Mustang will eventually get Ford's 280-hp dohc 4.6-liter modular V8, some modifications will be necessary to get it to fit—barely—into the engine bay. For one thing, the engine will lose the individual intake runners used in the Mark VIII version. For another, the cramped space underhood will dic-

tate revisions to the engine's exhaust plumbing, which in turn will probably take a small bite out of peak horsepower ratings.

When this high-performance modular V8 is installed in the car—company insiders say this could happen by 1995—it will be teamed with ei-



Ford's 4.6-liter V8 makes for a crowded Mustang engine bay.

ther a 4-speed automatic or a 6-speed manual transmission.

## Buick Riviera

Coming as a 1994 model, the newly designed Riv features a new, rounded body shape with a sharply angled backlite and large window areas.

While the Riviera coupe will be introduced this fall, the convertible has been delayed, perhaps even dropped, from the Riviera's future.

## Pontiac Sunbird

It is quite common for a carmaker to install the components of one future model in the body of a different model. GM used a 1993 Chevy Beretta to check out the cooling/heating efficiency of the 1995 Pontiac Sunbird by grafting a Sunbird's nose and drivetrain on the Chevy's body. And while this type of mix-and-match component evaluation is common, in this case it has added significance. The Chevrolet Beretta/Corsica chassis will be the basis for all the new GM small cars, including the next-generation Chevrolet Cavalier and Pontiac Sunbird.

## GM's World Car

Various pieces of a puzzle are falling into place to reveal that General Motors may be working on a "world car." The No. 1 carmaker's European subsidiary, Adam Opel AG, is currently working on a project involving



Chevy Beretta test mule wears a '95 Pontiac Sunbird nose.

Look for the new Buick Riviera coupe sometime in the '94 model year.







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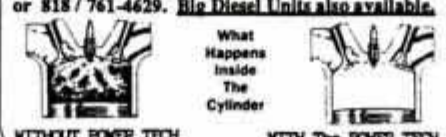
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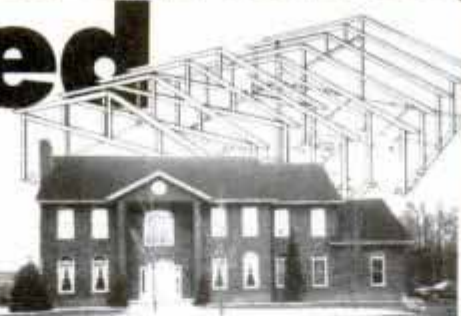
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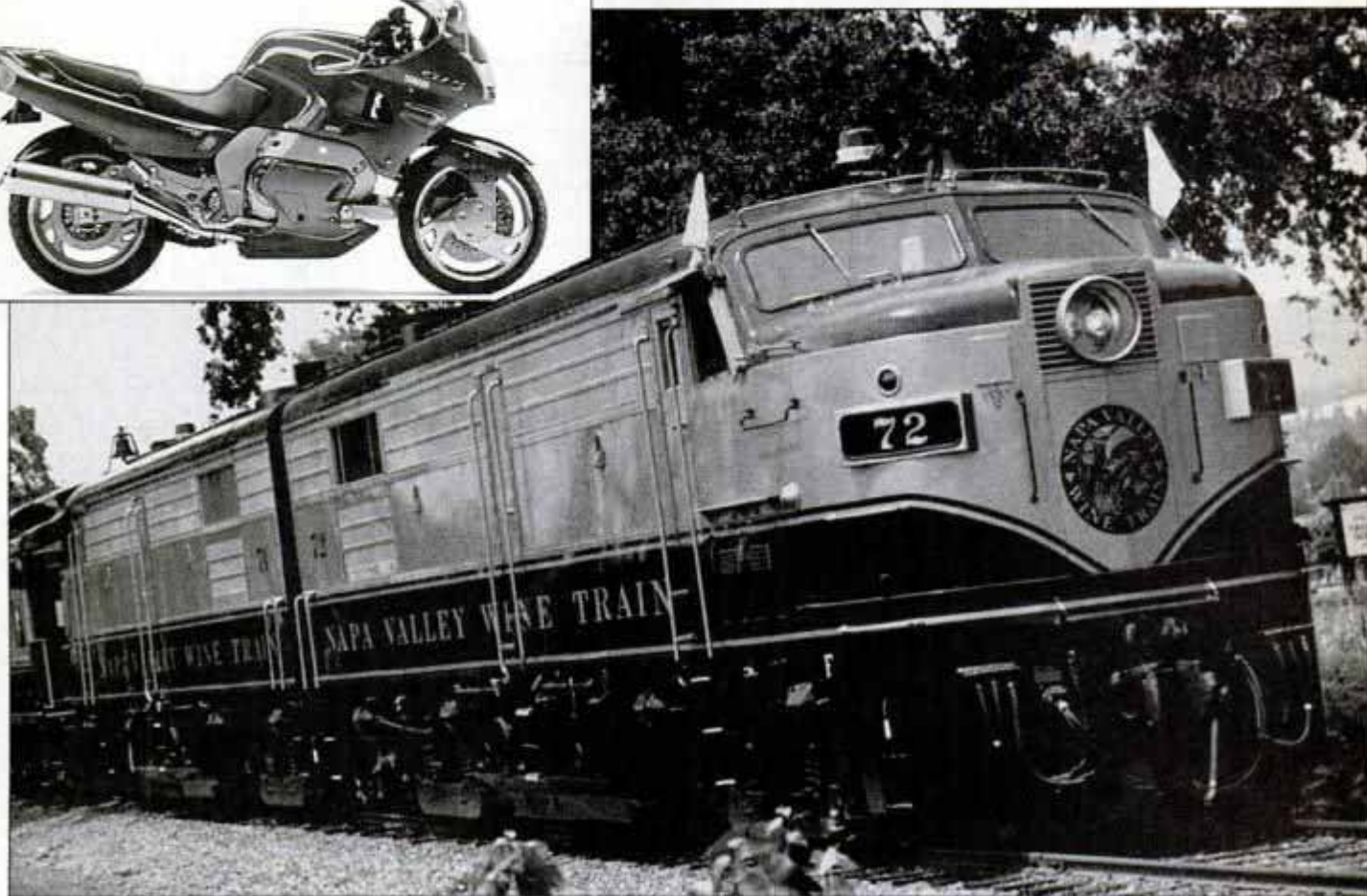
**SECRETS** Of Winemaking From Fruits/Berries \$6.00. Slaters, Box 118, Port Townsend, WA 98368

**FREE.** Homebrewer's catalog. Brewery, 1300 Quincey, Minneapolis, MN 55413. 800-347-4042.

**FREE** Catalog. Sebastian Brewers, 7710 91 Avenue, Vero Beach, Florida 32967. 1-800-780-SUDS.



# COMING NEXT MONTH



## Great Train Rides You Can Still Take

Our cover story takes you aboard 15 great train rides that still operate, including nostalgic steam locomotives. Find out how modern technology is keeping the old rails alive. Plus, our directory details more than a dozen nostalgic train rides operating nationwide. (Originally scheduled for our July issue.)

## Dust Busters

Looking for a new 4x4 sport/utility vehicle? Don't buy one until you read our giant on/off-road shootout that compares nine of the newest models.

## On The Rocks

Always running short on ice cubes? Our step-by-step guide shows you how to install an icemaker yourself.

## Motorcycle Masterpiece

Yamaha's GTS1000A motorcycle is state of the art. We examine the bike's hub-steer (no fork) front end, five valves per cylinder and computerized fuel injection, and take you along for a ride.

## Elements Of Style

Queen Anne chair? What's that? Chipendale chest? Huh? Our complete guide to furniture styles illustrates and explains the characteristics and differences of popular styles so you can discuss them like an expert.

## Supercharge Your Computer

Want to add more power and versatility to your home computer? Our roundup of the newest hardware and software shows you the possibilities.





**"The best defense  
is not to offend."**

*Chuck Norris*



**Introducing New Right Guard® Sport Stick.**

A time-release formula for longer lasting odor protection.  
Two new defenses: Spice and Unscented.

In bold new Wide Sticks. Your move.

**NEW!**

**Anything less would be uncivilized.**

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# IT CARRIES ENOUGH 4x8 SHEETS TO COVER A BASKETBALL COURT.



*The Toyota T100 One Ton.*

If you've ever been to a lumberyard, you know that wood only comes in one size. The one that doesn't quite fit into the bed of your truck.

So when we designed the all-new 1993 Toyota T100, we made sure it could fit a 4x8 sheet between the wheelwells. And with its larger cargo capacity, you can haul up to 2,570 lbs.\* in our One Ton model. That's enough sheets to cover a basketball court.

It's just the kind of bigger, roomier, heavy-hauling pickup you've always wanted in a tough Toyota Truck. But we didn't just build it big, we built it smart.

The rugged double-wall bed is constructed with anti-rust galvanized steel sheets for longer life. So it's built tough to stand up to bricks, gravel, and yes, even a load of basketballs.

The practical two-tiered bed has handy notches in the side for convenient double-stack loading. It also has six stake pockets that let you turn your standard bed into a stake bed whenever you need it.

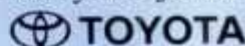
As you can see, the all-new Toyota T100 is

one big idea after another. But that's a story better told at your nearest Toyota dealer.

Call 1-800-GO TOYOTA if you'd like a Truck brochure or the location of your nearest dealer.

*Toyota T100 features roomy 3-across seating and a bed big enough for 4x8 panels.*

*"I love what you do for me."*



*A winning lineup: Toyota T100 (available in 2WD and 4WD), Toyota Compact 4x4 and 4x2.*



**NOT FOR QUALITY**

TOYOTA T100.

\*Includes occupants, cargo, and equipment with 5-speed manual transmission. Buckle Up! Do it for those who love you. © 1992 Toyota Motor Sales, U.S.A., Inc.

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