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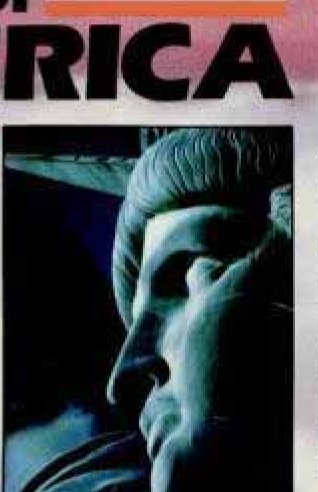

A celebration of American technology and ingenuity by America's greatest writers.

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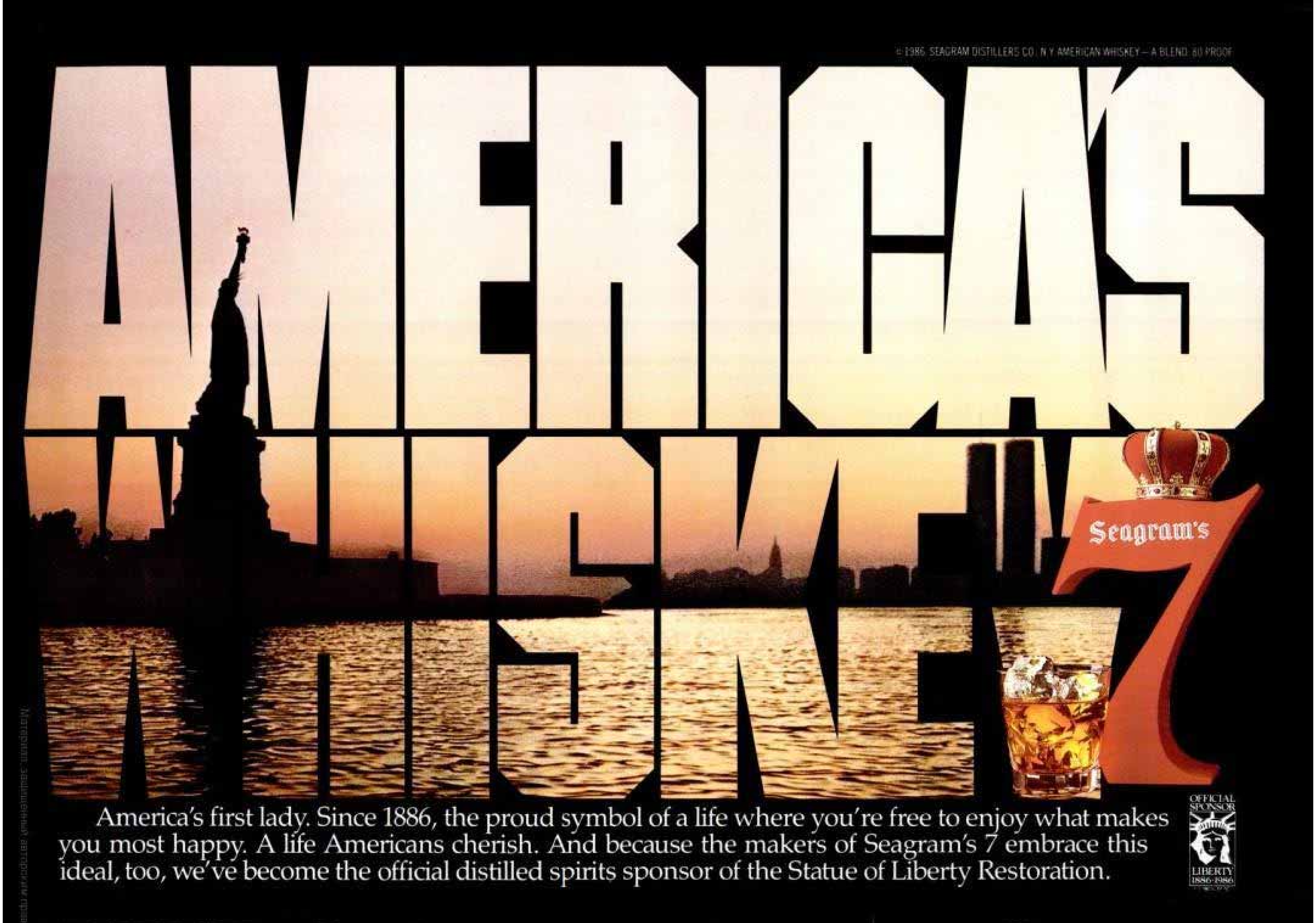
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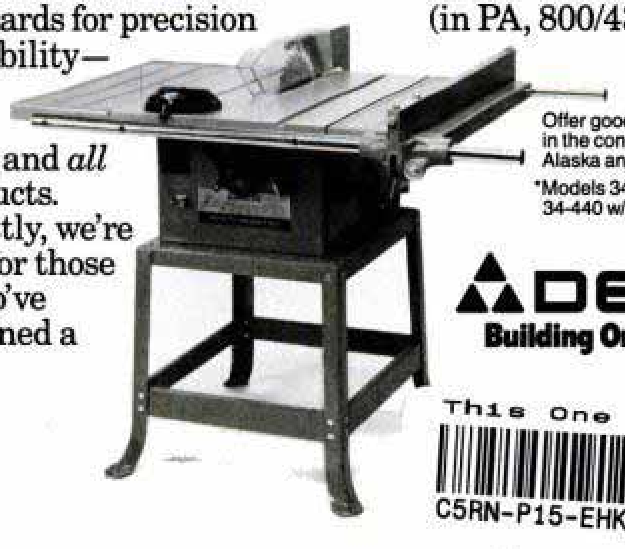

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Popular Mechanics®

JULY 1986 VOLUME 163 NO. 7

ON THE COVER
Goodyear's next blimp will feature state-of-the-art technology and turboprop engines to push the craft to 70 knots and 12,000 feet. But Goodyear won't be alone in the skies over America. Read about the new high-tech airships—which have search-and-rescue, military, entertainment and advertising possibilities—in our story beginning on page 75.
PM Illustration by Edwin Herder
Bottom inset photo: Peter B. Kaplan

78 Super coupes

70 Sport boats

92 Rattan furniture

84 Planes

THE BUILDING OF AMERICA

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AUTOMOBILES

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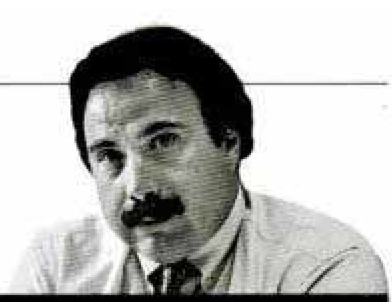
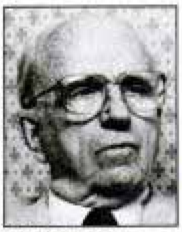
Editor's Notes





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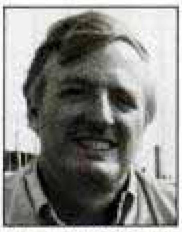

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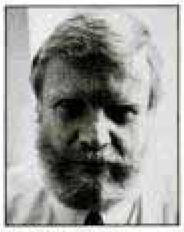

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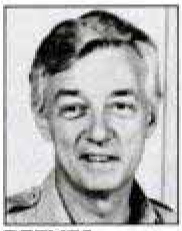

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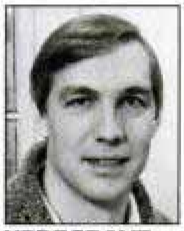

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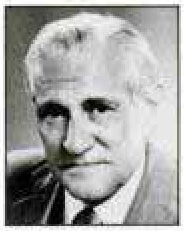
HOWARD



SEVAREID

HOPE

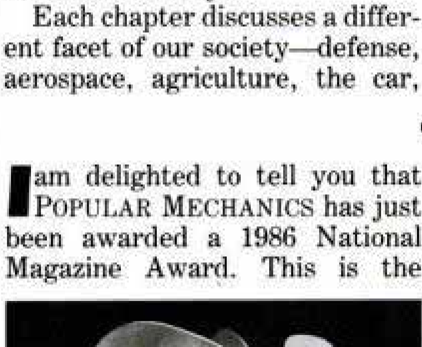
This is a very special issue of POPULAR MECHANICS. As it says on the top of the cover, this is a double issue—in effect, two magazines in one. The front part of the magazine contains all the normal kinds of features you're used to finding in PM. Halfway through, you'll find the "second" magazine, called "The Building Of America." It is, in fact, a celebration of American technology and ingenuity—two ingredients that built this country.

Each chapter discusses a different facet of our society—defense, aerospace, agriculture, the car, recreation, the home, our tall buildings, ships, how we all got here and how we all fit together in this great land. Two special chapters are a look ahead by President Reagan and a look back by perhaps our most famous immigrant, Bob Hope.

I'm very proud of our lineup of writers. In fact, I can't recall ever having seen so many best-selling authors in one magazine at one time. James A. Michener, Tom Wolfe, Isaac Asimov, Richard Reeves, William F. Buckley Jr., Christopher Buckley, John Naisbitt, Jeff Greenfield, William Hoffer, Jane Howard, Eric Sevareid, Betty Friedan, Walter Updegrave. Superstars all.

Putting together such a section was a massive effort. Our writers and photographers traveled literally to every corner of America to gather the material you see on these pages. And our own magnificent staff took it from there to produce what I think is a showcase of America at its best. "The Building Of America" is a superb collection of insight, vision, hope and, yes, patriotism. I hope you enjoy reading "The Building Of America" for many years to come.

I am delighted to tell you that POPULAR MECHANICS has just been awarded a 1986 National Magazine Award. This is the equivalent in the publishing industry of winning an Oscar or an Emmy in the motion picture or television industries. It is the highest honor a magazine can win.



National Magazine Award: PM's "Oscar" is this stabile by Alexander Calder.

The award was in the Special Interests category and we were recognized specifically for our November 1985 issue Woodworking Guide. The judges' citation reads: "Written with grace and clarity, this series of articles goes well beyond the scope of its technical information. It evokes the possibility inherent in all leisure pursuits, that of raising mere craft into the realm of art. For novice or expert, this series is both an instructive and pleasurable reading experience."

I'm particularly proud since the judges for the National Magazine Awards are our peers—other editors and writers, the tops in the business. To be recognized by them is very gratifying. In fact, only one thing can top it—you, the reader, liking POPULAR MECHANICS every month. 'Til next time.

Joe Oldham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Letters

Just ask PM

My husband was very impressed with Outdoors Editor Tim Cole's article *To Alaska And Back* in the February '86 issue (page 100). He wants to drive in this year's Alcan 5000.

This is the first issue of our subscription—are they all this interesting? I hate to think what we've been missing all these years! Keep up the good work.

MRS. RUSSELL TREASE
BUENA VISTA, CO

You have been missing a lot, so we're going to fill you in. First, for Alcan 5000 info, write Jerry Hines at 15 Central Way, P.O. Box No. 300, Kirkland, WA 98033.

Yearly indexes of PM issues for 1971, '73 and '75 through '85 are $2.95 each. If you're having trouble finding a particular article, we can look it up in our in-house index. Call (212) 262-4292 or write PM Reader Service at 224 West 57th St., New York, NY 10019.

For answers to questions concerning editorial content, you can also call or write the number or address above.

PM's catalog of plans, offering hundreds of do-it-yourself projects, is $1.50. The catalog also lists PM books available, such as those on car repair, woodworking and boating. Reprints of plans that appeared in the magazine are 50¢ per photocopied page.

For subscription information, call toll-free: 1-800-247-5470.

Project Woody

Reader West's Woody Wagon shows that he used his weekends well.

Your magazine is great the second time around! A friend gave me a stack of old PM's about a year and a half ago. I spotted the VW Woody (*Build PM's Woody Wagon*, page 137, July '83) and sent for the plans immediately. I found a VW for $400. Just working on weekends it took about a year and $1400 to complete. P.S. It would be fun to see a picture of my car in PM.

CALVIN W. WEST
LIVERMORE, CA

You got it! Others who want to drive to the station in style can get plans and patterns for our VW-based Woody by sending check or money order for $14.95 to PM Woody, Stevenson Projects, Box 584, Del Mar, CA 92014.

If I had a hammer

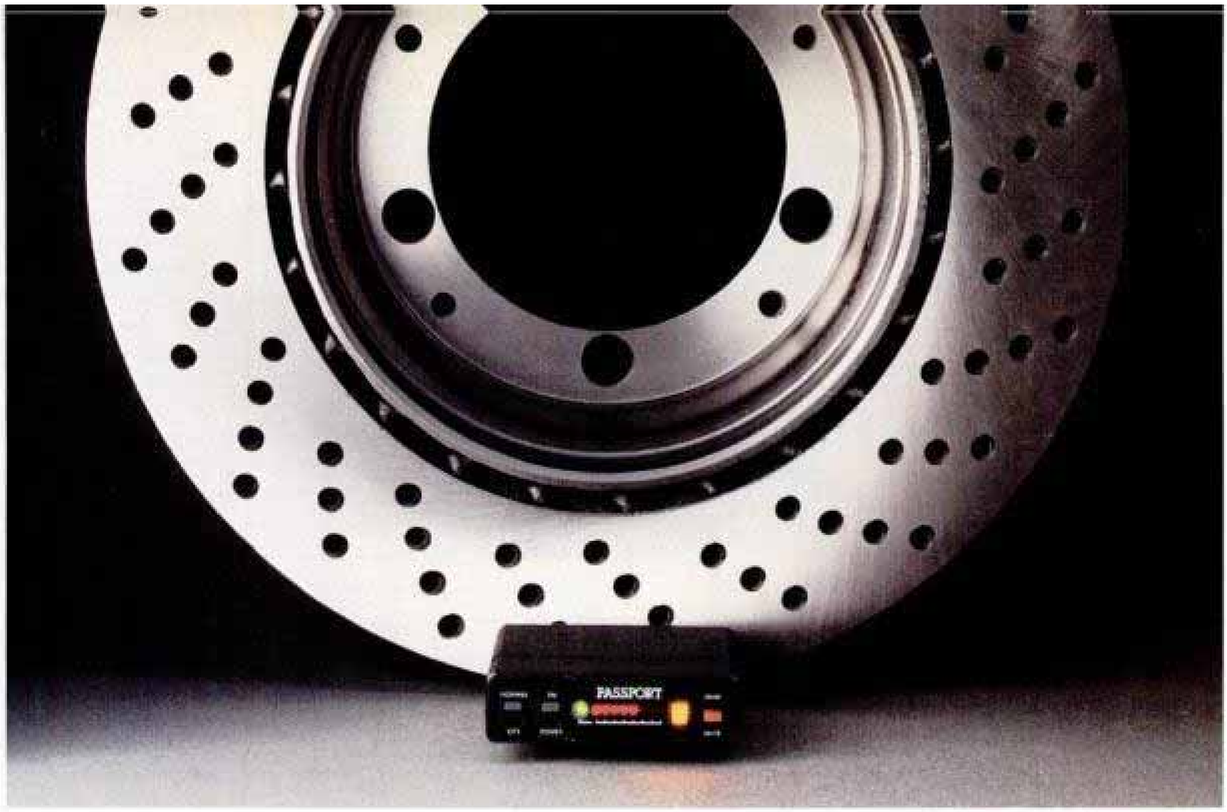
I enjoyed Shop And Tools Editor Joe Truini's article *Hammers* in the January issue (page 97), but there's a hammer that's really unique. It's a homemade version of what I call a wrecking hammer. It's made from two 20-ounce claw hammers, one with the head removed.

The heads are welded together and the added weight helps knock apart nailed-together boards. But the best feature is the double claw to eliminate the need for a block of wood when pulling out long nails.

WILLIAM F. WITTY
HARAHAN, LA

Your "wrecking hammer" is a good one and unusual, but we're aware of an almost identical double-claw made in 1902 that was recently listed as an antique and priced at $185. **PM**

Double-claw "wrecking hammer" is the idea of reader Witty.



Small Wonder

It's here, *pocket-size* radar protection.

Imagine a superbly crafted electronic instrument, powerful enough to protect against traffic radar, miniaturized enough to slide into a shirt pocket, beautiful enough to win an international design award.

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That could only be PASSPORT. It has exactly what the discerning driver needs, superheterodyne performance in a package the size of a cassette tape.

This miniaturization is possible only with SMDs (Surface Mounted Devices), micro-electronics common in satellites but unprecedented in radar detectors. It's no surprise that such a superlative design should be greeted by superlatives from the experts.

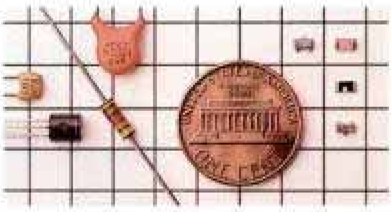
"In a word, the Passport is a winner," said *Car and Driver.*

The experts report excellent performance. Simply switch PASSPORT on and adjust the volume knob. Upon radar contact, the alert lamp glows and the variable-pulse audio

Small means the size of a cassette tape

begins a slow warning: "beep" for X band radar, "brap" for K band. Simultaneously a bar graph of Hewlett-Packard LEDs shows radar proximity.

As you get closer, the pulse quickens and the bar graph lengthens. Should you want to defeat the audible warning during a long radar encounter, a special switch provides silence, yet leaves PASSPORT fully armed for the next encounter. A photocell adjusts alert lamp brightness to the light level in your car. PASSPORT was designed for your protection *and* your convenience.



In PASSPORT, 102 SMDs (right) do the work of ordinary transistors, resistors and capacitors.

PASSPORT comes with a leather case and travels like a pro, in your briefcase or in your pocket—to the job for trips in the company car, on airplanes for use in far-away rentals. Just install on dashtop or visor, then plug into the lighter. PASSPORT keeps such a low profile. It can be on duty without anyone noticing.

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Home Video

BY JAMES B. MEIGS

Can you copy?

First tape with anticopy Macrovision was "The Cotton Club" (left); latest is "Back To The Future."

For years the movie industry has complained that VCRs are little more than home piracy machines. A couple of studios even took Sony to court in the famous "Betamax case," claiming the company's products helped people copy their movies (the Supreme Court ruled for Sony and said it is legal to tape broadcast TV programs).

Now that movie studios make almost as much from prerecorded video sales and rentals as they do from movie theaters, they've calmed down a bit. But they're still worried that you'll rent a movie and then make copies on a second VCR. Perhaps an even greater worry is unscrupulous video stores that make dozens of copies to rent to their customers. (This hurts you too, since you wind up watching inferior dupes instead of the real thing.)

For the past year, movie studios have been experimenting with a process they hope will make video piracy a thing of the past. The process is an American invention called Macrovision. Tapes encoded with Macrovision include a special signal that prevents another VCR from copying the picture. The signal, though, doesn't prevent the tape from playing on your TV set.

Macrovision works by confusing the recording VCR's automatic gain control into thinking it's receiving too strong a signal. The gain control responds by decreasing the strength of the signal the VCR records. The result: an unwatchable picture.

Embassy Home Entertainment tried the process on its release of "The Cotton Club" last year. According to the inventor, Embassy used a fairly low level of Macrovision encoding on the release. Apparently, the level was too low: People so inclined had little trouble making copies of the movie.

More recently, MCA Home Video began employing Macrovision—more successfully. Without warning, MCA put Macrovision on a Julian Lennon music video and the appropriately titled movie "Mask." MCA execs say they haven't heard complaints about people having trouble watching the tapes on TV. But they have heard from some people frustrated because they couldn't make copies of the tapes. MCA says it will use Macrovision on many titles, as it has on the hit release "Back To The Future."

CBS/Fox Home Video says it, too, will use Macrovision on all its upcoming releases. Unless new problems with the anticopying process arise, it seems inevitable that all the major video programmers will join in.

Big-screen breakthrough

Mitsubishi's revolutionary 35-in. TV set has been in a few stores for a couple of months now. But judging by the technological innovations that make this giant tube possible, it might be quite a while before other manufacturers can develop their own large screens. It might take even longer for the $3200 price to come down from the stratosphere.

According to Mitsubishi engineers, one of the toughest things about making a 35-in. picture tube is handling the increased stresses caused by enclosing a vacuum in such a large area.

To rule out the chance of an accidental implosion, the company drastically increased the thickness of the tube's glass. But this raises other problems: The thicker glass has to be optically pure to prevent distortion over the viewing surface.

Mitsubishi solved this problem by making the tube in two steps. First, the company manufactures a tube with a thin face. Then, before the air is evacuated from the tube, another layer of optically corrected glass is laminated over the face.

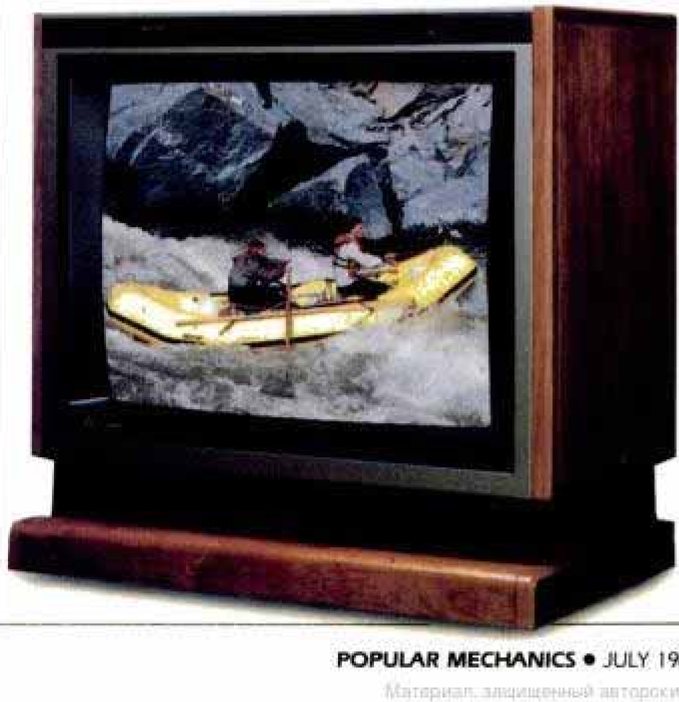
Another problem with giant tubes is shielding them from stray magnetism.

Because of the long distance from the electron gun to the screen surface (where the electrons strike phosphors to create the picture), even minute magnetic deviation of the electrons could degrade the picture.

All tubes have magnetic shielding to prevent this, but Mitsubishi had to add special shielding both inside and outside the tube to deal with the problem.

Until recently, Mitsubishi assembled its giant tubes largely by hand. But the company has started an assembly line for 35-inchers. It will probably be quite some time before other companies catch up—and before competition brings the price down. However, Mitsubishi says it will supply its new tubes to other TV makers, so you'll probably see a few 35-in. sets from other brands late this year. **PM**

Mitsubishi's 35-in. television tube is an opto-electrical feat.



FOR PEOPLE WHO WATCH THEIR MONEY AS MUCH AS THEY WATCH THEIR VCR.

SAMSUNG
Intelligent Electronics

Video Review
WINNER
BEST PRODUCTS
OF 1985

Audio

BY TERRY SHEA

Hard-rock Lincoln

Phantom view shows placement of head unit, amp and speakers.

Ford Motor Co. produces a different sort of hot-rod Lincoln these days. I'm not referring to that critically acclaimed road-burner, the Mark VII LSC, but to the LSC's stately stablemates, the Continental and Town Car. Both now sport one of the hottest sound systems on the highway.

Custom-installed car stereo systems generally outperform what the automakers offer—and often do it for less money. But Ford's new system, jointly developed with loudspeaker manufacturer JBL, easily blows away most any sound system on the road—aftermarket or factory. To my ears, it even sounds better than the excellent General Motors systems produced by Delco and speaker maker Bose.

As with the Delco-GM/Bose venture, the key to the Ford-JBL system's superb sound is that it's tailored to the acoustic properties of the car. A car's interior, you see, determines how a system will sound.

Manufacturers of aftermarket car stereo components haven't any idea what type of car will become home to their equipment. Specifically, they don't know if the speakers will be placed properly within the car for optimum performance. An automaker that studies the acoustics of its own cars has a distinct advantage in designing sound systems for them.

Ford and JBL performed such a study, picked the components needed for topnotch sound, then fine-tuned the system for each of the two car models in which it's first being offered.

The new system consists of a Ford-designed AM/FM cassette/tuner with all the proper standard features: Dolby-B noise reduction, auto-reverse, electronic tuning, automatic station scanning and pushbutton presets. The system also includes 12 speakers—six for each stereo channel—and a trunk-mounted 4-channel power amp that delivers 35 watts into each channel.

The speaker contingent includes a pair of rear-shelf-mounted 3-way systems, each consisting of a 6- by 9-in. woofer, a 3½-in. midrange and a ½-in. tweeter. There's a 5¼-in. woofer in each front door, and the dash houses two midrange/tweeter assemblies the same as those in the rear.

Beyond these basic elements, the Ford-JBL system features circuitry that limits distortion at high volume—but also boosts the bass at low volume to keep the sound full and rich.

After driving an '86 Continental, I can report that the Ford-JBL system numbers among the best I've heard.

Bass performance—always a challenge in a car sound system—is rock solid and deep. True to the company's claim, the bass doesn't disappear at low volume levels. Regardless of volume setting, the system accurately delivers the rumble of a symphony's kettle drums, and remains accurate when you crank it up to belt out some hard-driving rock. In the cranked-up state you'll feel the sound as well as hear it, and your pants leg will occasionally flutter as the door-mounted woofer pumps away. What's impressive, too, is that little bass performance is lost when you listen to the front speakers only. The system's treble performance is superb no matter what the front-to-rear speaker settings.

As for using the system, there's nothing terribly wrong about the front-panel layout, but there's certainly room for improvement.

On the plus side, Ford refrained from crowding the unit's front panel with too many tiny buttons. And wisely, the company stuck with a conventional rotary volume knob rather than the annoying electronic-pushbutton volume controls offered on so many high-priced aftermarket units.

Trouble is, the volume knob is much too small, and too far to the center. To my mind (and hands) the volume control should be the most prominent control on a car radio, and located on the far left—nearest the driver. But on the Ford unit the scan/AM-FM selector is the largest knob and sits right where you'd expect to find the volume control. Swap those two controls in both size and location and things would be fine.

Among other complaints, the digital display for station identification is too small, and the aforementioned scan/AM-FM selector knob gets in the way of the four station-preset pushbuttons. The entire unit could be better illuminated at night.

Fortunately, these gripes don't affect the system's sound one bit. And while I admire well-placed controls on car stereo gear, I'd gladly make do with some inconve-

Control layout could be improved on feature-laden head unit.

nience for the autosound quality that Ford and JBL deliver in sound.

Back-seat rumble

Gut-thumping bass is what separates a merely good car stereo system from a great one, and the way to get it is with plenty of power driving woofers housed in a properly designed enclosure.

You can obtain decent bass by flush-mounting the woofers in your car's rear deck and using the trunk as an enclosure, but such an arrangement will never deliver optimum bass. And what about cars such as hatchbacks that don't have a trunk, or for that matter pickup trucks and vans?

If you own a trunkless vehicle, help is on the way. In fact, there are several fully enclosed speaker systems designed specifically for installation in trucks, vans and hatchback cars.

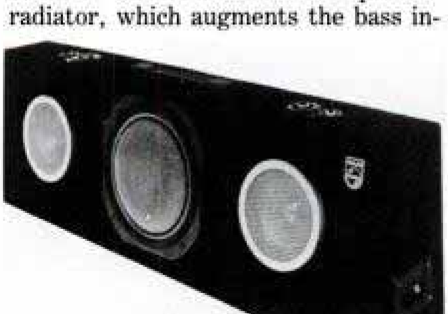
Pyle's P200 Pounder fits in hatchbacks or behind truck seats to provide solid bass.

These systems, if mated with high-quality, high-powered amplifiers, can deliver sound that will rival some custom-designed enclosures that easily cost upward of $500 just to build, let alone install. The beauty of the factory-built speaker boxes is that in most cases you can easily install them yourself.

Manufacturers offering speaker boxes for trunkless cars include Becker, MTX, Philips, Pyle and Stillwater Designs. Most are 1-piece, full-range systems—that is, a single enclosure houses bass woofers and treble tweeters, so no other speakers need be installed.

Typical of the full-range product is Pyle's Pounder, model P200. At a retail price of $290, it has all the makings of a killer sound system.

Housed inside the enclosure is a pair of 6½-in. woofers and a 10-in. passive radiator, which augments the bass information delivered by the two woofers. A pair of dome tweeters handles treble frequencies. Pyle claims that the Pounder can tolerate up to 150 watts per channel of amplifier power. Yet the system, according to its specifications, should deliver solid sound from less horsepower, let's say in the 50 to 70 watts-per-channel range.



Philips S-10 houses two woofers, midrangers and tweeters plus a bass radiator.

Philips, too, offers easy-to-install speaker systems for trucks and hatchbacks. The $250 S-10, part of the company's Sound Series 2000 line, is designed to fit into the area behind the seat of a mini pickup truck or van, without restricting front-seat movement. It can be used alone, as it's a full-range system.

The wedge-shaped S-10 has the same speaker battery as Pyle's, but adds a pair of 1-in. midrange drivers. It also includes a carrying handle for use outside the vehicle. This should add some fireworks to your Independence Day barbecue or picnic!

Late news

Video Compact Discs are coming. Late next year, you'll see CDs with about six minutes of moving pictures and digital sound—and players with the TV output jacks lacking on today's players. **PM**

Computers

BY RON SCIBILIA

Color and legibility for PCs

Hi-res graphics for IBM come from Quadram's EGA+ board (left) and color monitor.

Users of the IBM Personal Computer and compatibles have long dreamt of being able to combine a sharp display for textual work and for high-resolution color graphics—all using a single video display adapter and monitor.

But when IBM introduced its PC back in '81, color graphics still smacked of—perish the thought—video games. So IBM gave you a choice. You could buy the PC with its monochrome video display and get superb, easy-on-the-eyes, high resolution text—without graphics. Or, you could opt for IBM's Color/Graphics adapter and PC Color Display.

The latter route gave you color graphics at a medium resolution of 320 x 200 pixels (the dots that constitute the screen image), or sharper monochrome graphics at 640 x 200 dots. Text with the Color/Graphics Adapter and Color Display was acceptable, but definitely not kind to the eyes during long sessions at the keyboard.

Initial buyers went heavily for the monochrome adapter/display combo. But interest in graphics gradually began to escalate. Enter an enterprising California company called Hercules Computer Technology.

The company, via its Hercules Graphics Card, offered a way of producing hi-res graphics (720 x 348 pixel resolution) on the standard IBM monochrome display—without sacrificing high-resolution text. There was a hitch, though. Software applications needed "drivers" (special short "setup" programs) to use the Hercules display board. Many popular programs (about 75) now provide drivers for the board but PC users might encounter some that don't.

IBM sought to remedy the display/adapter dilemma with its Enhanced Graphics Adapter. Coupled with IBM's new Enhanced Color Display, this multipurpose video board delivered the best of both worlds—high resolution for both text and color graphics.

With the EGA video board/monitor duo you get 640 x 350 dots for both color graphics and text, plus compatibility with most software written for IBM's earlier Color/Graphics adapter and Monochrome Adapter.

There remain a couple of problems with IBM's answer, however: Not all software written for The Color/Graphics Adapter (CGA) runs on the EGA, and the price tag for adapter and monitor is steep—over $1700 with a full complement of video RAM on the board.

What IBM introduces, other companies emulate and sometimes improve. One example of this IBM-and-more philosophy is Quadram's EGA+, which packs in additional video memory, offers greater compatibility with other graphics software and incorporates an additional important software emulation mode that IBM doesn't. At $595, it costs about 40 percent less than IBM's EGA with the same 256 kilobytes of video RAM.

Just listing the Quad EGA+'s abilities is complex. It supports three different monitor types: the IBM Enhanced Graphics Display, IBM Color Display and IBM Monochrome Display.

In its EGA emulation mode the board can display monochrome graphics and text at 640 x 350 resolution on the IBM monochrome monitor; 640 x 200 and 320 x 200 graphics (with 16 colors) on the IBM Color Display; 640 x 350 pixel 16-color graphics and 8 x 14 pixel text characters (very close to the regular monochrome board/monitor's 9 x 14) on the IBM Enhanced Color Display.

In its CGA mode the Quadram board runs virtually all software written for the Color/Graphics Adapter, on either a regular IBM (or compatible) color display or the Enhanced Color Display. Moreover, unlike IBM's own board, Quadram's video adapter includes Hercules emulation to provide 720 x 348 monochrome graphics and hi-res text on the IBM monochrome CRT.

Also new to the market is another product promising high-quality graphics for the IBM PC community.

NEC's new JC-1401P3A "MultiSync" color monitor is a high-resolution CRT that automatically adjusts its scanning frequencies—from 15.75 kilohertz all the way up to 35 kilohertz—to the graphics boards feeding its signals. As a result, the MultiSync boasts compatibility with all of IBM's current graphics boards and adapters. The MultiSync costs $800—$50 less than IBM's Enhanced Color Display. **PM**

NEC's MultiSync monitor varies scanning for all IBM frequencies.

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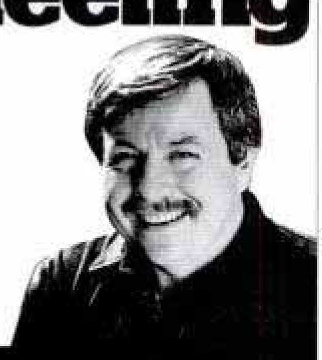
Freewheeling



BY WADE HOYT

Chrysler's on a roll

Plymouth Sundance convertible is the best looking Chrysler ragtop.

It's not easy to be all things to all people with only two chassis to build on, but Chrysler does a darn good job of it. During the next 14 months, Chrysler will introduce nine new models or major facelifts. No sooner were the new P-cars shown to the press than Chrysler unveiled a Sundance convertible "concept car" (above). Featuring aerodynamic flush headlights, air dams and spoilers, the red and silver show car has a slick convertible top that stows out of sight under a body-color fiberglass tonneau cover. While there are no plans to produce it yet, the Sundance ragtop is practical enough to put into production next year. And it's miles better looking than Chrysler's other drop tops!

The Dodge Caravan and Plymouth Voyager minivans have always been favorites around here, and Chrysler has steadily improved them since their '84 introduction. Their only drawbacks are a lack of rear-seat legroom and luggage space. A long-wheelbase option will add some 14½ in. to the T-wagons, allowing them to carry 4 by 8-ft. sheets of plywood inside, with the hatch closed, when the rear seats are removed.

The bad news is that the exciting Omni GLH and Turbo will be dropped to make room on the assembly line for the import-fighting $5499 Omni and Horizon America strippers. The last 500 GLHs will go to Carroll Shelby in California for conversion to 175-hp intercooled GLH-S pocket rockets.

Stretch T-wagon may be the longest little minivan in the world.

Food van is the first OEM propane vehicle built in the U.S.

It's a gas!

What's 13 ft. long, 7 ft. tall, has a Chrysler engine, runs on propane gas and offers such unique options as fresh-water holding tanks, a double sink, refrigerator, mag wheels, a beverage dispenser, p.a. system and a digital billboard? It's the Enterprise commercial van.

Built around a converted Chrysler 2.2-liter Four, the little roach coach has just one fuel tank for locomotion, cooking and refrigeration. It's about $20,000 from the London Group of Beverly Hills, Calif.

Alky problem

Just when gasoline prices are going down all over the world, they're going up in Brazil, thanks to a tax aimed at keeping gasoline prices higher than ethanol. Ten years ago Brazil started a program to encourage the use of alcohol fuel made from sugar cane. Today, 90 percent of the new cars in Brazil run on ethanol. But the price of that fuel has zoomed to $37 a barrel, about three times the cost of gasoline.

The government may lose $2 billion this year selling ethanol at a loss.

LCD dash combines graphic perspective and digital readouts.

Star Wars dash

West Germany's VDO instrument company has out-gimmicked even the Japanese with this prototype for a graphic instrument panel. Fuel level, engine rpm and coolant temperature are shown as bar graphs on a "3-D terrain map." The bars travel sideways along a "valley floor." As they approach danger levels, they climb a "canyon wall" and easily grab the driver's attention. Above the "horizon" are digital displays.

It's not true

The old adage that God protects drunks is not one drivers can depend on. Research out of North Carolina University shows that alcohol will do more harm than good in a car crash. The study found that alcohol reduces the body's resistance to impact, traumatic shock and hemorrhagic shock. Not only do drinking victims suffer more severe injuries in a crash, but they risk greater problems immediately after the accident. PM

Homeowners' Clinic

BY NORMAN BECKER, P.E.

Slow-flushing toilet

My toilet suddenly started acting up. I either have to hold down the handle for three seconds before it flushes or snap it really quick to flush. I prefer to do it the way everyone else does—just flush. What can I do?

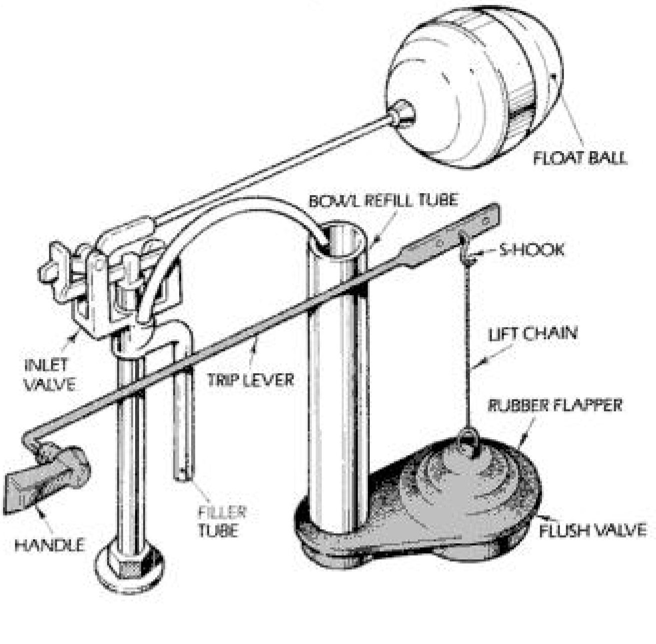
C. TREMBLAY
ACUSHNET, MA

There is probably too much slack in the lift chain. When you flip the handle, the rubber flapper lifts only slightly off the flush valve seat. The pressure of the water on the flapper causes it to reseat on the flush valve, stopping water flow.

By holding the handle for three seconds, you are holding the flapper off the valve seat so that the water will flow into the bowl. The water rushing past the flapper holds it up after you release the handle. It also flushes when you snap the handle quickly because the jerky action forces the flapper up to a point where water flowing into the flush valve holds the flapper open.

There are several causes for a slack lift chain. The chain may be slightly rusted, the hook connecting the chain to the trip lever may have stretched or the flapper may be deteriorating.

Regardless of the cause, the correction is simple: eliminate the excessive slack in the chain. Do this by moving the chain hook to a different hole on the trip lever or replacing the lift chain. Replace the flapper if it shows excessive wear.



Excess slack in the lift chain, a worn flapper valve or a stretched S-hook can cause poor flushing action in a toilet.

Roof condensation

I own a fine old home built about 1925, with a cypress shingle roof installed on 1 x 4-in. wood strips, 8 in. on center. The attic has no ventilation or insulation.

I would like to install a painted sheetmetal roof over the wood strips. My concern is condensation on the bottom of the sheetmetal. What do you suggest?

CHARLES R. DOUCETTE
VINTON, LA

Providing ventilation and a vapor barrier in the attic will control the moisture buildup and resulting attic condensation.

You should also insulate the attic. Even though your house is located in a warm climate, insulation is cost-effective and will help make the house more comfortable.

During the summer, it's possible for the attic temperature to reach as high as 150° F. Attic insulation and ventilation helps reduce the heat load on the ceilings of the rooms below. It also helps reduce air-conditioning costs.

Check with your local utility company to determine the recommended amount of insulation for your attic. It is more practical to install insulation batts with an attached vapor barrier rather than use a separate vapor barrier. Place the batts on the attic floor between the joists with the vapor barrier facing toward the rooms below.

You should also use at least two vent openings to allow for air movement. Installing watertight vents in the sheetmetal roof may be difficult, so your best bet would probably be to use gable vents. A combination of gable and soffit vents would be even more effective.

Since there will be a vapor barrier in the attic, the size of the vent openings can be less than it would be without a vapor barrier. Remember, the vent's effective area is less than its actual opening. Screens or louvers can reduce airflow through a vent by as much as 50 percent. The effective vent area should be at least 1/300 of the attic floor area.

Faulty seals cause foggy panes

I had large insulated glass sliding doors installed three years ago in my Florida home. For the first two years after they were installed, we closed up the house during the summer and vacationed elsewhere.

However, last year we lived in it during the summer months and cooled the house with central air conditioning. Recently, we noticed that the seals were broken on the insulated glass and moisture collected between the panes, making them foggy and dirty.

Local glass companies recommend that I replace the panes, which would be very costly since they are approximately 4 x 7 ft. I would be very pleased if you could tell me how to go about resealing and reusing the existing glass, if possible.

G.M. HILLENBRAND
ROCKLEDGE, FL

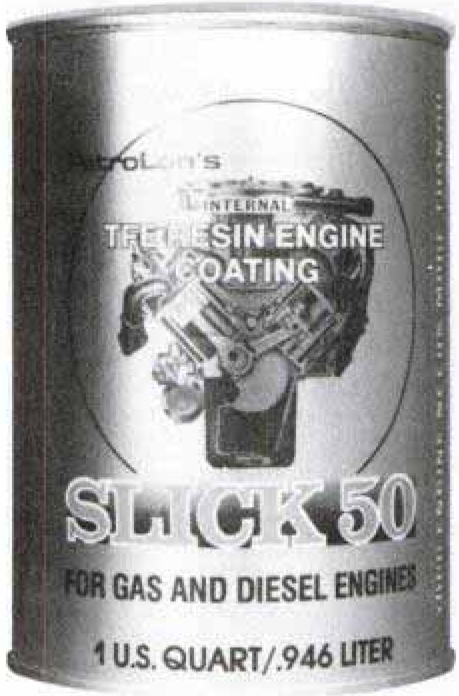
Since your sliding doors are only three years old, you should contact their manufacturer. Most quality manufacturers have a warranty against product failure resulting from a faulty seal. They will replace a pane at no cost for the first five years after installation and at a prorated cost for the next five years.

Repairing a faulty seal is very involved and is not a do-it-yourself project. The chances of someone other than a professional doing this correctly are slim. The process is explained in greater detail in the November '85 Homeowners' Clinic *item, "Foggy Thermal Panes," page 12.* **PM**

Do you have a home-maintenance or repair problem? Send it to Homeowners' Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Letters cannot be answered individually, but problems of wide interest will be discussed in the column. For more home-repair and maintenance help, get PM's Home Care Guide, $2.45 postpaid. Send your order(s) to Popular Mechanics, Box 1014, Radio City Station, New York, NY 10101.

Save Gas, Save Engine with "POLY"

The following introduces one of the most fully tested and proven gas saving, friction-reducing engine treatments ever to reach the market!



The Secret is "Poly"

"Poly" is short for polytetrafluoroethylene (TFE), the slipperiest substance known to man. **(1981 Guiness Book of World Records).** Petrolon Corporation, makers of Slick 50, invented a way to permanently bind this slippery chemical to your engine with one treatment. Just one quart of Slick 50 can reduce engine friction, increase gas mileage and horsepower and reduce engine operating temperature, causing your oil and engine to last longer. . . plus it reduces metal wear, defraying costly overhauls.

Years of Testing and Use Have Proved It True!

Slick 50 has been thoroughly tested in independent laboratories and out on the road:

The March/April 1982, p. 35 issue of **"Consumer Digest"** magazine stated, "Slick 50 does reduce engine heat and ordinary wear, and our informal tests indicate that it will improve gas mileage by about 2 or 3 miles per gallon."

One of the country's **most respected research institutes** reported applying a powerful ultrasonic cleaning process to a Slick 50 treated engine and were surprised at its permanence. "We actually expected the Petrolon Slick 50 TFE Resin coating to also be removed, but later found it was still there."

"Dune Buggies & Hot VWs" magazine April 1983 issue records the results of their one year testing of Slick 50. "We can indeed say scientifically that Slick 50 does work, and that it does reduce engine wear! . . . for the price of one treatment when compared to engine rebuild, we feel that you'd be money ahead using Slick 50."

The **Federal Aviation Administration** has fully accepted a similar product for aircraft—Slick 50 Aircraft Piston Engine Treatment (F.A.R. #33.49). This FAA endurance test simulated 1400 hours of engine use.

The senior engineering researcher at a **leading southern California university** stated, "Slick 50 does increase horsepower and decreases fuel consumption in tests done at the university."

The **Space Shuttle Columbia** uses the chemical "poly" in its gears and bearings because it is the only chemical lubricant which can withstand the heat and corrosive elements of space.

Perhaps most dramatic of all is a torture test overseen by the **Automotive Services Council for Pennsylvania** and shown on WTVE television. Three cars with 75,000 to 129,000 miles on them were treated with Slick 50. Six months later the oil was drained from each vehicle, and the cars driven without the oil plugs for about a half hour. The water temperature never rose and the engines sustained no apparent damage.

There isn't room here to tell you about the dozens of other tests proving that Slick 50 is everything we say. However, if you're still skeptical, send $2.00 to cover printing and postage costs, and we'll send you detailed test results plus actual letters from users who report how Slick 50 saved their engines and saved them money!

It's Easy to Treat Your Engine

A few minutes before oil and filter change, add the **engine flush you get free** with each order to clean out the engine. Let the engine idle for 5 minutes. Then drain the oil, change the filter and add the proper amount of oil, less one quart. Add one quart of Slick 50, drive for 30 minutes, and leave it in the crankcase for at least 3,000 miles. As the engine operates, the oil carries the "poly" between the parts where it is burnished into the pores of the metal.

Only One Treatment Necessary

It's permanent, so you do it only once, not each time you change oil. One quart of Slick 50 will treat all standard 4, 6 and 8-cylinder gasoline and diesel engines.

Works with Most Oils

Slick 50 will work with all petroleum-based oils and all synthetics compatible with petroleum-based oils with the exception of graphite oils. However, once an engine is treated, you can go back to a graphite type if desired.

4 Ways Slick 50 Saves You Money

Your actual percentages may vary depending on your driving, vehicle condition, weather and geographic location, but no matter what your conditions, Slick 50 can:

1. Increase mileage
2. Increase horsepower (small economy cars and large RV's really need this)
3. Reduce operating temperatures, thus increasing the lubrication and life of the oil and engine
4. Minimize or eliminate costly overhauls by reducing engine wear

Up to 90% of the engine wear on a car can be caused by lubrication starvation cars experience when first started before the oil begins to circulate. Slick 50 can eliminate this problem for **less than the cost of two tanks of gas.**

Slick 50 Will Not Affect Your Warranty

Slick 50 is suspended in an excellent grade of petroleum oil which meets or exceeds every manufacturer's engine warranty requirements. In addition, this oil carries an American Petroleum Institute service classification SF-CC-CD.

There's No Risk with Our Money Back Guarantee

Use Slick 50 for 3000 miles. If you don't notice an improvement in engine performance, return your invoice with a short note telling why, for a prompt full refund — no questions asked.

Profit from Selling Slick 50 Yourself

Here's an opportunity to make handsome profits. Having such solid test results from major institutions make Slick 50 easier to sell than many other products. Free dealership information is sent upon request.

Free engine flush sent with each order. Free shipping with orders of 2 or more.

For purchase or further information call toll-free 1-800-525-8624, ext. 7 (in Colorado call 1-303-762-1385) or send to: Progressive Energy Corp., 3148 South York Street, Dept. PM786, Englewood, Colorado 80110.

Yes, I want to improve my car's performance and save my engine — rush me risk free

☐ One Slick 50 at $39.95 + $4.00 shipping and handling.

☐ Give me free shipping and handling for my order of 2 or more at $39.95 each.

☐ Check ☐ C.O.D. ☐ Visa/MasterCard

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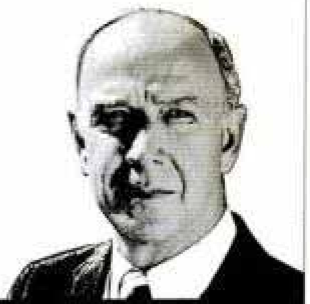

BY JIM DUNNE

GM pickups muscle up

GMC with dual rear wheels has macho, big-rig look truckers like.

Full-size Chevrolet/GMC pickups and related utility vehicles will be completely redesigned for 1987, but the new models will not be ready for sale until early next year. Given GM's experience in recent years with the delays in starting up a new vehicle, the company is taking a phase-in approach to introducing the standard pickups. GM plans to continue building the current trucks while cranking up production for the new models. That will ensure a good supply of GM pickups during the changeover.

Visible changes in the new cab styling include a sloping hoodline, narrower fender fronts and doors that wrap up into the roof.

The big news is in the braking system. GM will offer an antilock brake setup for the rear wheels that will cure one of the pickup truck's major problems: Rear brakes have a strong tendency to lock when the cargo box is empty, especially on slippery roads. With the antilock system, the rear wheels continue to turn while braking, thus allowing the trucks to stop under control. At the same time, there is no loss of braking power when the cargo box is loaded to the limit.

Ford trucks

Ford's F-150 series maintains a husky look in the revamped styling of the 1987 full-size pickup (right) through larger, flush headlights, high peaked fenders and a broad, level hoodline. The cleaner look makes them look all new, but they won't be as extensively revised as GM's '87 pickups. The instrument panels are different, and Ford will have antilock braking for the rear wheels. Diesels, V8s, inline Sixes and a full selection of chassis will be continued.

Corvette flats

Chevy's 1987 sports car will have a unique low-tire-pressure warning system that alerts the driver to a potential flat. When air pressure in any one of the Corvette's four tires falls below a certain level—say when there's a slow leak—a light on the instrument panel warns the driver. Inside each wheel is a small sensor module that signals a radio receiver under the dash to set off the warning. The system is optional on 1987 models, offered as a way to protect the life of the pricey "gatorback" tires.

No more diesels

Chevrolet will quietly drop the Isuzu 4-cylinder 111-cu.-in. diesel engine from its lineup in 1987, leaving GM without an oil burner in any of its cars. Chalk it up not only to lower gas prices and customer disinterest in the gas savings, but to slow and smelly diesels.

Electric power taking over

Maybe the battery-driven engine will never be a success in a production car, but electric power will quickly make inroads on other car systems. Electric steering systems are already in the works and will show up in Chrysler cars and others by this time next year.

Chrysler and Chevy also have an electric speedometer set for some 1987 models that does away with the speedocable, and in its place uses a small wiring harness. Chrysler claims the electric version is easier to install in cars, is more accurate, and is easier to service because all the working parts fit neatly in a module inside the instrument cluster.

Electronic control of transmissions is already here on some cars, and will spread widely to GM designs in the next 18 months. We'll also see wider use of small electric motors in seats and windows because new super magnets allow motors to be built in smaller sizes, but with more power.

Ford's domestic changes

Capri will be dropped along with the turbocharged 4-cylinder SVO Mustang, while Tempo and Topaz will offer a 4-wheel-drive option in the 1987 model lineup. Insiders point out that Capri will soon be replaced by another sporty car based on the Mazda 626 design. By dropping the Capri now, Ford is preparing for that switch.

As for the SVO termination, the move makes sense in light of the lower price and better performance of the V8 Mustang GT. The two models just could not exist profitably side by side in the same showroom. Only 2500 SVOs were sold last year.

Look for lots of smoke and little fire in Ford's plan to ballyhoo the 4-wheel-drive Tempo/Topaz. Sales of 4-wheel-drives should only be a small fraction of the total compacts produced.

(Please turn to page 26)

Ford's '87 pickups feature flush headlights and ABS brakes, too.


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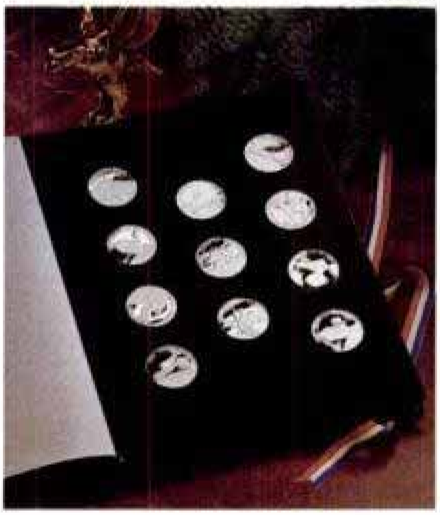

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16

INSIDE DETROIT

(Continued from page 22)

T-Bird turbo faster

The high-performance 1987 Ford personal luxury coupe will get even faster with the addition of an intercooler to the turbocharging system. Estimate 15 to 20 percent more power, or enough to leave no question that the 4-cylinder Turbo model will outperform the low-output V8 offered in this car.

AMC's R 21

American Motors is not finished in the sedan business, despite reports that it will concentrate mostly on the Jeep line in the future. Planned for 1987 is a compact sedan, the Renault 21. This 4-cylinder, front-drive, medium-price model will be imported from France, not built here. In addition, AMC has plans to build an Alliance replacement at a Canadian plant within two years.

High-tech glass

Ford plans to build more window glass of innovative design. For one, heated windshields like those on Taurus and Sable will spread to more cars in the Ford lineup in coming years. This design is faster and more efficient in cleaning off frost than blown hot air. If the ductwork of the traditional defroster can be removed from the car, the cost difference might be a wash.

Ford, which makes its own car glass, is also getting ready to bring out glass that has metal or plastic trim bonded to its surface. This technique gets rid of tack-on body sealers that are difficult to install and can easily pull away from the door frame. In addition, Ford glass will show up on Japanese vehicles built in this country. Mazda will have Ford glass on its U.S.-built vehicle, while Nissan already uses Ford windshields in its American-built pickup truck.

Plasticars

"Hoods, decklids and fenders of plastic are in demand at Ford. Whole plastic cars (bodies) are coming, too." That's the prediction of a Ford vice president who, while not revealing a timetable, confirms that GM is not alone in developing plastic body panels.

Ford will move into plastic more gradually, almost a part at a time, with hoods and decklids first because they are the easiest to make. "We like the shapes we can make with plastic, and its ability to take a punch without denting," explained the Ford official.

Chrysler dumpster

A late change dumps the Lancer 2-door and the Laser, too. Instead, Chrysler will have a LeBaron 2-door for 1987. Earlier plans to have Dodge share the new LeBaron body were scrapped at the last minute. The current plan is for Dodge to continue to sell the Daytona, but Chrysler will drop its Laser twin from the lineup. The new LeBaron GTC (see *'87 Detroit Preview*, page 88) will be built in convertible as well as hardtop body styles.

Chrysler's ultimate turbo

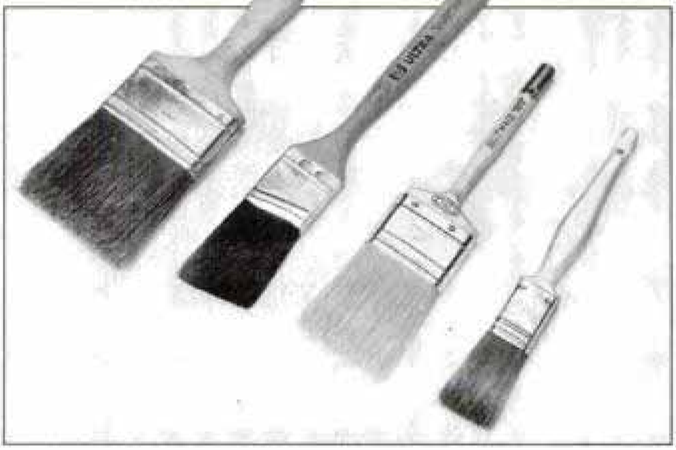
It's called the Turbo II, and will be offered on the 1987 Dodge Daytona Shelby. With an intercooler, the engine develops 19 hp more than the current Chrysler turbo. Torque is up 17 percent.

The intercooler is a kind of radiator that cools the air going into the engine, allowing more air/fuel mixture to be packed into the cylinders at each charge. Also, because the charge is cooler, there is less tendency for engine knock, so the turbo boost can be maintained for a longer period at a higher pressure without damaging the engine.

A number of changes were made in the engine and chassis to handle the added output, including bigger half shafts, forged crankshaft, stronger pistons, connecting rods and bearings, higher capacity radiator and dual tuned intake manifolds. **PM**

Minicourse

BY ROSARIO CAPOTOSTO



A good selection of brushes for the average homeowner should include, left to right, a synthetic 3-in. wall, natural 1½-in. sash, natural 2-in. all purpose and synthetic 1-in. trim.

Brush selection and care

The quality of a hand-applied finish is directly related to the quality of the brush used. Until recently, the best brushes were considered to be those with China (hog hair) bristles. Then came nylon and polyester bristles, called filaments.

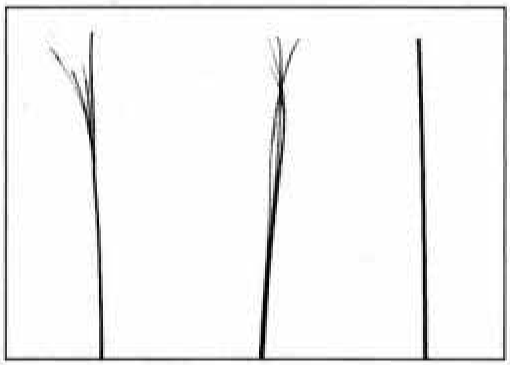
A good brush has flagged (slightly frayed) bristle tips. These hold more material and leave a smoother finish than nonflagged tips.

Seen from the side, good brushes also have bristles that are arranged, not cut, to a chisel-shaped tip. This works better than a blunt tip when painting up to a line and into tight corners. Arranged bristles also preserve all of the flagged ends, many of which are lost in the cutting process.

Use a natural brush for oil, alkyd-base paints and clear finishes, but not for latex; its bristles absorb the water base and become limp. However, high-quality nylon and polyester brushes work well with latex, oil-base paints and clear finishes.

Brushes also come in a variety of shapes—straight, slanted or oval profiles—especially for specialized tasks like painting window sashes. All can work well; it's a matter of personal preference.

When finished, don't soak a brush by standing it on its bristles. Instead, hang it in solvent. Work out stubborn deposits by hand and with a brush comb, then comb the bristles straight before hanging it to dry. Wrap it up before storing. PM



A closeup view of various bristles, left to right: naturally flagged hog hair, machine-flagged nylon and a low-grade blunt nylon.

A quality brush, left, has a chisel tip that allows more bristles to contact the work than the economy, blunt-tip brush, right.

A good brush will have thick, full groups of bristles bound together at the heel. Spread them apart to check when buying.

When cleaning a brush, free stubborn particles by working the solvent into the base of the bristles with your fingers.

Use a brush comb during cleaning and before hanging it up to dry. It separates bristles for solvent access and aligns them for drying.

A soaking brush will be deformed if it rests on its bristles (right). Bore a hole through its handle and hang it from a rod.

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Outdoors

BY TIM COLE

PM's long-term boat test

Test package: MTC 195, MerCruiser Alpha One, Heritage trailer.

Of the many verities you'll stumble across in the world of boating, none is truer, or more humbling, than this: No firsthand boat test illuminates a boat's personality as well as actual ownership. Quirks and flaws can sometimes remain hidden to the short-term tester. As a result, educated initial reactions form the content of PM's sterndrives comparison test on page 70 of this issue, as they do with all our boat evaluations.

In a typical, all-too-brief 4-day test period, PM concentrates on five of boating's most salient issues. On a static basis, we compare stowage volume measurements in cubic feet, which requires several hours of crawling over each entry with a tape measure and calculator. At the same time, we ascertain usable abovedeck and belowdeck space in square feet. These two areas give us a firm basis for comparing physical size and shape.

On the performance side, we concentrate on acceleration time from 0 to 25 mph, an exceedingly important criterion in comparing boats of a similar type. We also assess maneuverability through our fixed performance course, and top-end speed. Where possible, we like to tell you about differences between a boat's fastest time and slowest time to give you an idea of handling consistency.

We combine the physical measurements and the performance data to draw as complete a picture as possible of a given vessel, and throw in subjective analyses of important sidelights like fit and finish and rough-water handling.

We also like to use a boat in the way its designers intended. We'll go fishing in a center-console boat, for instance, or deploy the sunloungers in the case of this issue's sterndrives. The result—after our test boats are subjected to these identical criteria—is probably the most complete comparison of marine products you'll find in America today.

But, alas, our testing is admittedly incomplete in areas that only long-term ownership might reveal—details like hull/deck or stanchion leaks, or how a boat truly *works* when fully loaded with family, friends and gear. Where do you pinch your fingers? Where do you bump your head?

Accordingly, PM has decided to extend its philosophy of long-term auto testing to the marine world. We've invited the Mark Twain MTC 195, which we ranked No. 1 overall in our sterndrives report, to become the subject of a 3-month study. We'll be using the boat in a variety of different settings and sea conditions, and we'll report our findings in a fall issue. It'll also be a chance to report in-depth on MerCruiser's new Alpha One sterndrive package, and to fill you in on what may emerge as the star of this little show—the Mark Twain's long-bunk twin-axle trailer made by Heritage. Stay tuned.

Bushwacker: A fantasymobile?

Chevrolet tackled the assignment with unusual vigor. Build the world's toughest, do-anything, go-anywhere outdoors vehicle and hang the expense.

That camouflaged wonder wallowing in ooze (below) is the result. Chevy calls this Blazer-based show vehicle The Bushwacker, and if you can handle the Ramboesque paint scheme, the Bushwacker offers the ultimate in outdoors utility.

It sports *two* 12,000-pound capacity Warn winches fore and aft (handy when you're scaling the Matterhorn), dual-density diamond-plate steel rocker panels, and high-impact brush bars. Multiple shocks all around cushion the inevitable off-road bumps and berms.

You'll also find roof-mounted and bumper-mounted high-intensity running lights, and a wonderful joystick-operated directional spotlight that you can shine in your neighbor's living room.

A huge 6.7-liter diesel turns four 31X11 Uniroyal off-road tires through a 4-wheel-drive automatic transmission. Tough OD canvas upholstery is meant to absorb the stresses of outdoor life. To keep you in touch with civilization (your option), The Bushwacker comes with an HF scanner, single-sideband and CB, all driven by a 24-volt system under the hood.

While the Chevy Bushwacker hardly feels at home on a freeway, as we discovered, it inspires the kind of confidence you'd need to tackle the Amazon jungle.

Any takers?

Bristling with lights, radio antennas, winches and brush bars, Chevy's Bushwacker feels right at home in megamuck.

Old-time RVing

What did people do before Winnebagos? They "auto-camped."

David Woodworth of Agoura, California, is America's pre-eminent collector of 1920s-era auto-camping equipment, forerunner of today's huge self-contained motor homes. Some of his collection is featured in a Smithsonian Institute Exhibit titled "At Home On The Road" (running in Washington, D.C., until Aug. 31). The exhibit portrays auto-camping as an aristocratic venture complete with Pierce Arrows, servants and even U.S. presidents. Warren Harding, Henry Ford, Thomas Edison and Harvey Firestone were all devoted auto-campers, Woodworth says, and motored into the countryside to enjoy the great outdoors.

David Woodworth shows off his '20 s RV.

Woodworth will leave Los Angeles this month driving an open 1928 Model A Ford towing a mid-'20s Zagelmeyer camping trailer. With help from the Good Sam club, a 1-million-member RV organization, he'll visit RV rallies across the U.S. as well the Smithsonian and Henry Ford museums.

Woodworth's trailer (typical of the day for the well-heeled camper) converts into a cozy tent with two mattressed beds, a screen door and window. A frame in the box on the car's running board folds into either a bed or picnic table. Stove and utensils are carried in a chuck-wagon-like case on the car's rear deck. One person sets it up in about 30 minutes, and you can break camp in even less time. PM

Galley gear is stowed chuck-wagon style.

Appliance Clinic

BY STEVE TOTH

Squeaky door

I have a 1982 Amana SDI-25, 3-door, side-by-side, automatic refrigerator/freezer. For quite some time, the refrigerator door has been squeaking when I open or close it.

I sprayed WD-40 on the hinges but it didn't help. This sound wasn't there when I bought the unit. Can you tell me what I can do to get rid of this annoying squeak?

ROBERT C. WESTON
ORLANDO, FL

The noise may be coming from a worn door closure hinge. This mechanism holds the door open at various points along the arc that it swings through. This way, food can be removed from the refrigerator or the door itself without holding it open.

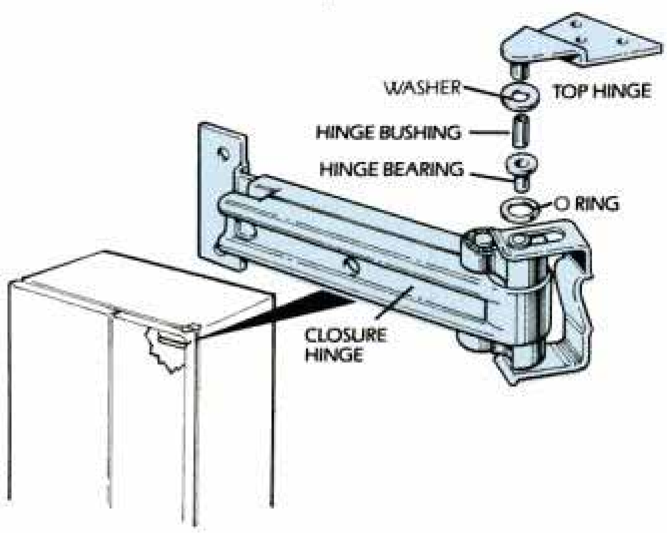
The part number for the hinge is D-70229 and it costs about $13. It can be bought at your local Amana dealer or authorized service agency.

To replace the part, you'll need to disassemble and remove the door—an involved task. First, unplug the refrigerator and lay an old blanket on the floor to put the door on once it's removed. Remove food from the plastic door panel and remove the three screws that hold the top hinge to the cabinet. Hold the door closed with one hand and lift up the top hinge, sliding it out of the top of the door. Grip the door on both sides, tilt it forward and lift it off the lower hinge, setting it face down on the blanket.

Fold back the door gasket to gain access to the ¼-in. screws that hold the door gasket retainer, the door gasket and plastic door panel. Remove the screws from the perimeter of the door, freeing the panel, retainer and gasket. Put them to one side.

Remove the foam block insulation from the outer door panel. You'll now see the door closure mechanism near the upper corner, on the hinge side of the door. It's covered by a cardboard cap. Remove the cap and the two ¼-in. hexhead screws holding the closure. Slip the closure out of the door and replace it. Reassemble the door.

You may need to align the door or adjust it so the door gasket is making good contact all around. Check to be sure there is equal distance between the top and bottom of the door.



The door closure hinge acts as a stop mechanism, holding the refrigerator door open at various positions. The top hinge assembly, on the outside of the door, fits into it.

Rusty microwave

I would like to know what can be done to a microwave oven that's starting to rust inside on its back, about 1 in. from the bottom. Can it be painted to stop the rust?

JOSEPH ROCHA
NEWARK, CA

Check the oven's warranty. The interior finish may be covered. If so, contact your nearest manufacturer's service representative and have them perform the repair.

If the warranty has expired, or if the liner is not covered, you'll have to sand and paint the rusted area of the microwave.

Begin by unplugging the oven. Loosen any rust or paint that is flaking on the inside surface by wiping with a lint-free rag. If the oven has a bottom glass shelf, it will have to be removed to check for rust underneath it. Cut the sealant that holds the shelf in place using a razor knife and remove any loose sealant.

Sand rusted areas with 120- to 200-grit sandpaper. Remove the dust by vacuuming and wiping it clean. Use aerosol paint supplied by your local parts distributor. It will be necessary to supply them with the model and serial number of your oven so they can provide you with a matching color paint. Also, you'll need a tube of RTV (room temperature vulcanizing) sealant to seal around the glass shelf after it's been reinstalled. This silicone-based sealer cures at room temperature—just follow the directions on the tube. Let the paint and the sealer, if you used any, dry thoroughly before using the oven.

Note: if during the repair you find that the sides of the oven liner are deeply pitted or rusted through, you should contact your repair agency to determine if the liner will have to be replaced.

Slow washer

I have a General Electric washer with model No. WWA7050GHLHT, serial No. DS133415G.

When the machine goes into the spin cycle, it struggles to reach full speed. It takes a few minutes. The tub is not overloaded. It's a 2-speed model. Could it be that the tub brake is dragging? I would like to know what's ahead if I attempt a repair.

EDGAR J. SPIGENER
SIERRA VISTA, AZ

Your 1985 washer may be operating normally. The initial slow spinning is inherent in its design.

Here's why: when the washer starts spinning, it also starts pumping water out of its tub. It spins slowly because the water is dragging between the basket and the tub during the first 1½ to 2 minutes of pump-out time. The tub's spinning accelerates as the water is pumped out because the drag on the tub is reduced.

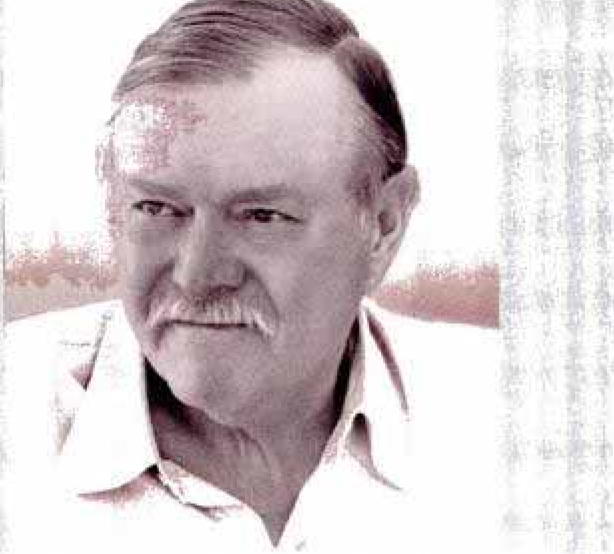
Pump-out times vary depending on the length of the drain hose and the height of the standpipe above the machine's tub. I hope this saves you a service call. **PM**

If you have a problem with any appliance, send your question, along with the model and serial numbers, to Appliance Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. Sorry, but letters cannot be answered individually. Problems of wide interest will be discussed in this column.

RUGER
Quality Firearms
1986

STURM, RUGER & Company, Inc.

"Our direction is towards perfection . . ."



Today, with so much going on around us we have a tendency to forget about the simple pleasures that can be derived from the hunting and shooting sports, especially as they were enjoyed by the generations that preceded us. Their good fortune was to live in a less complex society, one where hunting to put meat on the table was a way of life. Their society was also one in which the marksman was admired and a county fair wasn't a county fair without an exhibition shooter. Although we cannot recreate those past times we can look to the future of the hunting and shooting sports in the United States optimistically and with great enthusiasm.

Ruger's basic business has always been the design and production of quality firearms. To assure our customers of a superior product, every firearm manufactured by us is proof tested for strength, durability and fired for accuracy. Literally, millions of rounds of ammunition are fired on Ruger ranges annually in the development and testing of our products.

Any manufacturer who rests on past accomplishments will not survive in the competitive marketplace that exists today. We are striving to improve not only our manufacturing methodology, but also to pass along technological improvements that benefit our customers both in performance and value.

Ruger products are stocked and sold by thousands of retailers in the United States and in many foreign countries. A large percentage of Ruger sporting arms are sold through the specialty gun dealer who provides expertise and "personal service" in the day-to-day business of meeting the requirements of the hunting, shooting and law enforcement communities. To experience the genuine pleasure that comes from handling fine quality Ruger firearms, visit and support your independent stocking gun dealer.

RUGER® NEW PRODUCT DEVELOPMENT

Scope not included.

Super Redhawk

P-85 Semi-Automatic Pistol

RUGER SUPER REDHAWK™ REVOLVER AND P-85™ AUTOMATIC PISTOL

Ruger has introduced over twenty new products or product improvements in the last two decades. In addition there are several new guns in various stages of development — two of which are planned for introduction in late 1986.

These exciting new handguns are the large frame Super Redhawk double-action revolver chambered for the .44 Magnum cartridge and the Ruger P-85, 9mm double-action automatic pistol. The company's objective is to continue to introduce new products to meet the ever-changing needs of the hunting and shooting public.

RUGER GP-100™ NEW DOUBLE-ACTION REVOLVER

NEW

RUGER GP-100™
Double-Action Revolver
Cal. .357 Magnum

Designed as the ultimate .357 Magnum for police and personal defense use, the new GP-100 incorporates a number of important new features and improvements (patents pending), and offers a greater degree of accuracy, strength, reliability, and effectiveness than ever before realized in any double-action revolver.

The unique GP-100 design includes a heavy, solid frame, rugged .357 Magnum cylinder, and cushioned grip panels which are anatomically designed to fit the hands of the majority of shooters. The interchangeable front sight system allows the installation of sights of various styles, heights and colors. A full length ejector rod shroud helps to achieve the slight muzzle-heavy balance considered desirable for rapid double-action firing. Barrels are constructed with a wide top rib, longitudinally serrated to present a glare-free surface.

The GP-100 revolver serves eminently to confirm Ruger leadership in modern firearms design and manufacture.

The grip portion of the Ruger GP-100 revolver unlike the conventional skeleton type grip frame has been designed to incorporate a variety of functions. It houses the mainspring seat, trigger guard latch, and grip panel locator. The design of this unique frame extension also permits the installation of customized wrap-around grip panels in a variety of shapes and sizes to suit the tastes of the individual owner.

The Ruger cylinder locking system represents a successful mechanical engineering solution to the problem of positive cylinder locking. The Ruger cylinder is locked to the frame by a strong pilot bearing at the rear of the cylinder, and by a sturdy locking bolt at the front of the crane which engages a matching slot at the front of the frame.

The Ruger concept of integral subassemblies and simple takedown has been proven in previous Ruger designs, and is now brought to perfection. The Ruger GP-100 revolver can be field-stripped to its basic subassemblies in a matter of seconds, without the use of special tools allowing the user to clean and maintain the revolver in the field quickly and with great ease.

RUGER® THE NAME

Scope not included.

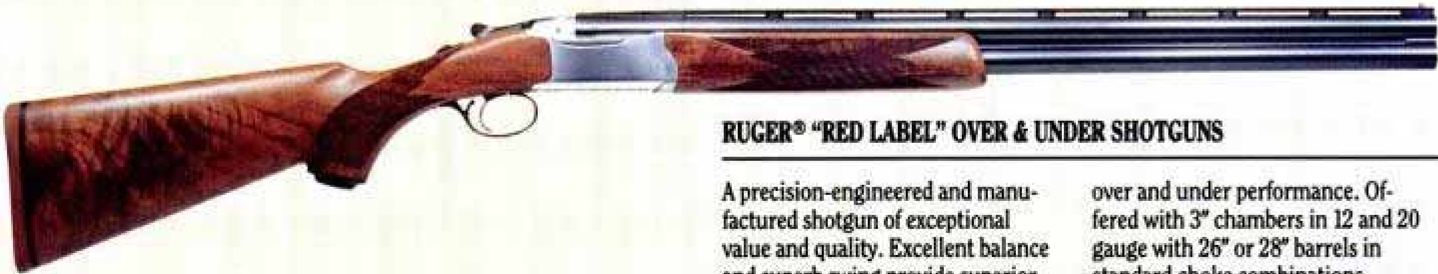
RUGER 77/22™ RIMFIRE BOLT-ACTION RIFLE

The new Ruger .22 rimfire bolt-action is conceived as an elegant small game and target rifle. Unique new 3-position safety offers a new dimension in security.

Ruger 10-shot rotary magazine provides smooth feeding. Receiver with integral scope bases accommodate Ruger rings.

RUGER 10/22® AUTOLOADING CARBINE

The Ruger 10/22 offers lightweight, short overall length, and mechanical dependability. A 10-shot rotary magazine handles .22 rimfire cartridges. The reliable Ruger 10/22 is an excellent choice for small game hunters, target practice or beginning shooters. Standard model or Deluxe Sporter offered.



RUGER® "RED LABEL" OVER & UNDER SHOTGUNS

A precision-engineered and manufactured shotgun of exceptional value and quality. Excellent balance and superb swing provide superior over and under performance. Offered with 3" chambers in 12 and 20 gauge with 26" or 28" barrels in standard choke combinations.

RUGER® BISLEY SINGLE-ACTION REVOLVERS

The first Bisleys were used by competitive target shooters at the British National Rifle Association matches held in Bisley, England in the 1890's. The Ruger Bisleys are offered in two frame sizes chambered for a variety of handgun cartridges and with or without fluted cylinders and roll engraving.

RUGER OLD ARMY® CAP AND BALL REVOLVER

Experienced muzzle loading shooters who have tested and used the Ruger Old Army revolver have been lavish in their praise of this fine cap and ball handgun, one of the finest percussion revolvers ever made. Available in blued finish or corrosion resistant stainless steel. Caliber: .44 Bore.

STANDS FOR QUALITY

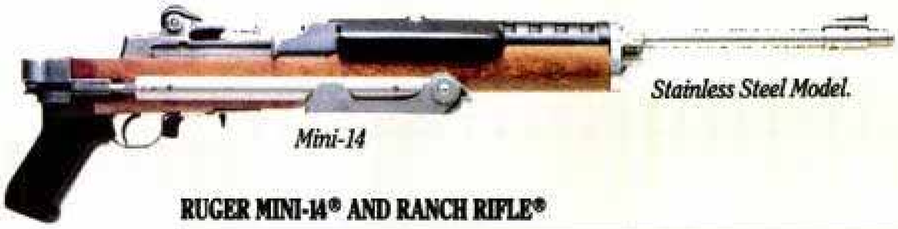
NEW

RUGER XGI™ SEMI-AUTOMATIC RIFLE

The Ruger XGI retains the essentials of the Garand design, proven in U.S. service rifles, but it is much improved in strength and durability. It is a practical sporting rifle designed to withstand rough treatment with minimal maintenance. Chambered for .308 and .243 Win. cartridges.

Scope not included.

Ranch Rifle



Stainless Steel Model.

Mini-14

.223 Rem. .243 Win. .308 Win.

The Ruger semi-automatic rifles are chambered for world-famous hunting cartridges.

RUGER MINI-14® AND RANCH RIFLE®

The Mini-14 and Ruger Ranch Rifle are rugged, easy handling and lightweight. The Ranch Rifle, a powerful sporting auto-loader is designed for use with telescopic sights. Available in full, and compact folding stock models, which are ideal for camping and boating. Offered in blued alloy and stainless steel. Caliber: .223 Rem.

RUGER® MARK II AUTOMATIC PISTOLS

The new Ruger Mark II semi-automatic is basically a refinement of the original Ruger Standard and Mark I Target pistols, over one million of which have been produced. Offered in standard, target and bull barrel models in a variety of barrel lengths. Blued finish or stainless steel. Caliber: .22 Long Rifle.

RUGER REDHAWK® DOUBLE-ACTION REVOLVERS

Knowledgeable sportsmen reaching for perfection in a big bore handgun will find the Redhawk demonstrates its superiority whether silhouette shooting or big game hunting. Scope sight models incorporate bases for Ruger rings. Blued finish or stainless steel. Calibers: .41 Mag., and .44 Mag.

RUGER® AMERICA'S

RUGER M-77® BOLT-ACTION RIFLE

Prized as a trophy rifle, this versatile bolt-action is used to hunt all sizes and species of game. Receivers incorporate integral scope bases that accommodate Ruger rings. Available in both magnum and short actions in calibers ranging from .22-250 to .458 Mag.

RUGER M-77® INTERNATIONAL BOLT-ACTION RIFLE

This high performance sporting rifle has a full-length, high grade American walnut stock. Short 18½" barrel, open sights, and Ruger scope mounting system are features. Calibers: (short action) .22-250, .250-3000, .243 and .308 Win., (long action) .30-06, .270.

RUGER M-77® ULTRA LIGHT BOLT-ACTION RIFLE

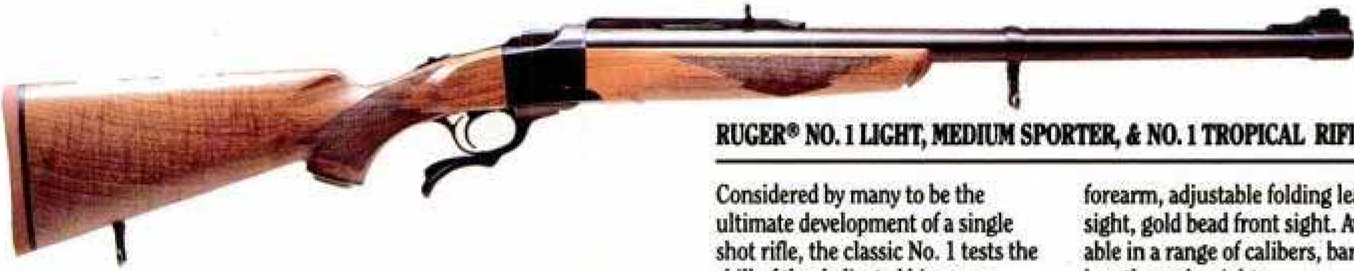
New 6 pound big game rifle in both long and short action versions, with integral base receiver and 1" Ruger scope rings. Calibers: (long action) .270, .30-06, .257 (all with 20" barrels): and (short action) .22-250, .243, .250-3000, .308 (all with 20" barrels).

RUGER SUPER SINGLE-SIX® & SINGLE-SIX® .32 H&R REVOLVERS

The Ruger Single-Six was introduced over three decades ago and remains one of the most coveted single-actions. The patented Ruger transfer-bar ignition mechanism and other refinements have been features of New Models since 1973.

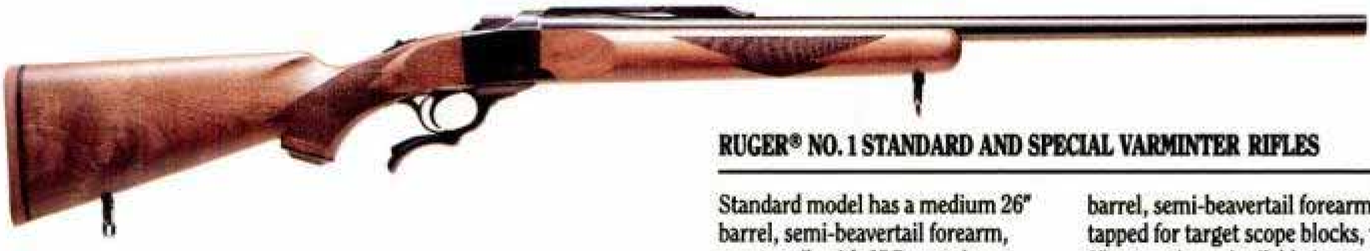
Originally chambered for the .22 Long Rifle rimfire, the Single-Six is now offered in the new .32 H&R Magnum cartridge, a hard-hitting small game, varmint and target load.

NUMBER 1 GUN MAKER



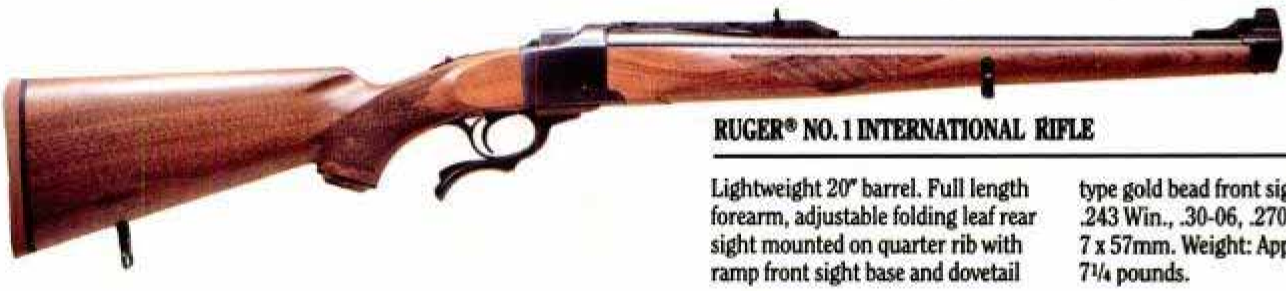
RUGER® NO. 1 LIGHT, MEDIUM SPORTER, & NO. 1 TROPICAL RIFLES

Considered by many to be the ultimate development of a single shot rifle, the classic No. 1 tests the skill of the dedicated big-game hunter. Alexander Henry style forearm, adjustable folding leaf rear sight, gold bead front sight. Available in a range of calibers, barrel lengths and weights.



RUGER® NO. 1 STANDARD AND SPECIAL VARMINTER RIFLES

Standard model has a medium 26" barrel, semi-beavertail forearm, quarter rib with 1" Ruger rings. Varmint model with heavy 24" barrel, semi-beavertail forearm is tapped for target scope blocks, with 1" scope rings. Available in a variety of sporting and varmint calibers.



RUGER® NO. 1 INTERNATIONAL RIFLE

Lightweight 20" barrel. Full length forearm, adjustable folding leaf rear sight mounted on quarter rib with ramp front sight base and dovetail type gold bead front sight. Calibers: .243 Win., .30-06, .270 Win., and 7 x 57mm. Weight: Approx. 7¼ pounds.

Blackhawk

Super Blackhawk

RUGER BLACKHAWK® AND SUPER BLACKHAWK® REVOLVERS

The massive Ruger New Model Blackhawk and Super Blackhawk revolvers have been expressly engineered for use with powerful modern centerfire cartridges. They incorporate all the best features of the proven Ruger New Model centerfire single-action design, including the patented Ruger transfer-bar ignition mechanism.

These revolvers provide the sportsman and competitive shooter with the capability to handle almost any situation in the field or on the range. Calibers: .30 Carbine, .38 Special, .357 Mag., .41 Mag., .44 Mag. and .45 Long Colt.

Security-Six

New Goncalo Alves grips.

Service-Six

Stainless steel model.
New Goncalo Alves grips.

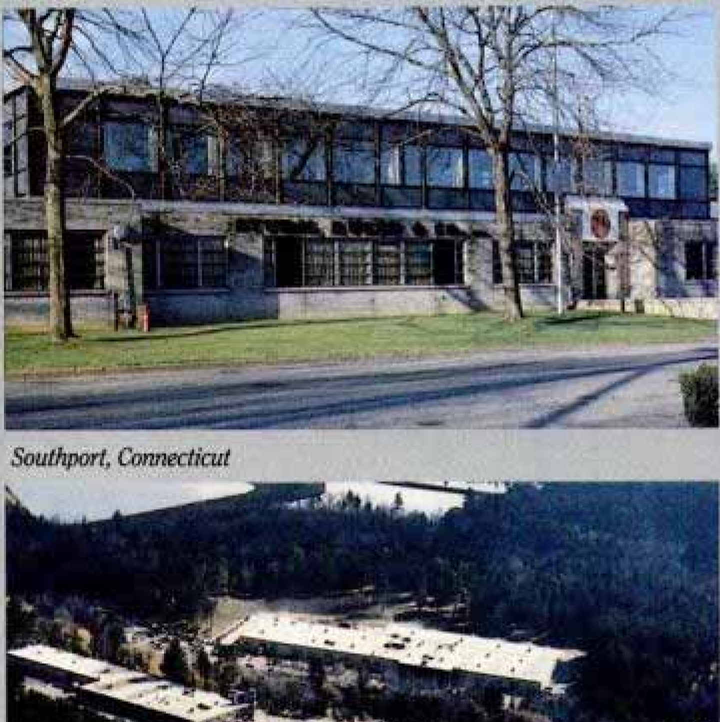
Speed-Six

Stainless steel model.

RUGER SECURITY-SIX®, SERVICE-SIX® AND SPEED-SIX® REVOLVERS

This series of Ruger double-action revolvers are reliable, durable, and perfectly mated to the .357 Mag. and .38 Special cartridges.

Over one million of these revolvers have been made for use by sportsmen and the law enforcement community around the world. Available in blued steel and stainless steel, with 2¾", 4" and 6" barrels, and a selection of Goncalo Alves wood and rubber grip panels.



Southport, Connecticut

Newport, New Hampshire

All Ruger Firearms Are Designed and Manufactured in Ruger Factories in the United States of America.

From a work force composed of a handful of individuals in 1949, Ruger now produces sporting guns in two manufacturing facilities located in Southport, Connecticut and Newport, New Hampshire, occupying more than 300,000 square feet of space including our Pine Tree Castings division which is one of the ten largest producers of ferrous investment castings in the United States. All of our firearms are designed and manufactured in these two Ruger factories.

Amazing as it may seem the personal art of gunsmithing is practiced every work day by Ruger craftsmen in this modern, large scale industrial operation. There is a meticulous attention to detail in the hundreds of machining and polishing operations required to meet Ruger specifications for all metal parts. The Ruger factory in Newport is one of the few places left where stocks and forearms are individually hand checkered by artisans trained to render intricate designs on high quality American walnut.

It has been the goal of the company since its inception to design and manufacture sporting guns of the highest quality, strength and reliability at a reasonable and fair price to the consumer. We continue to pursue that goal in the management of our business and in day-to-day manufacturing operations.

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ALL RUGER FIREARMS ARE DESIGNED AND MANUFACTURED IN RUGER FACTORIES IN THE UNITED STATES OF AMERICA BY

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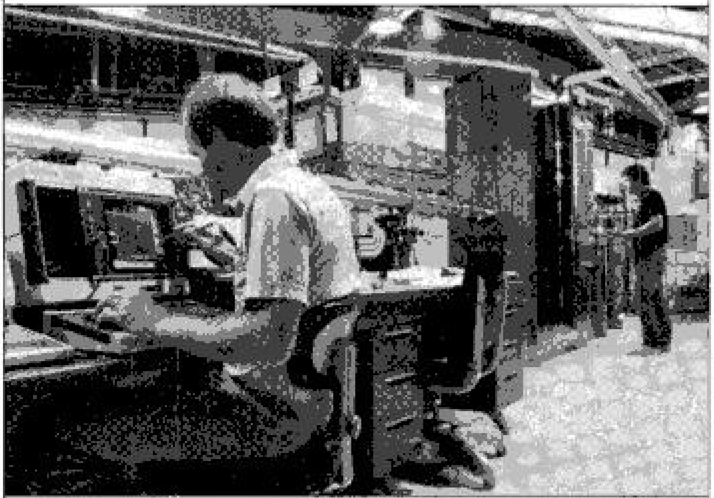
Science

BY DENNIS ESKOW

Physics soap opera



Brookhaven team starts up powerful X-ray source to see molecules.

Dip a silicon wafer of a specific size into a soapy solution of known chemical composition and the resulting film on the wafer is one molecule thick. That was confirmed recently by a research team using Brookhaven National Laboratory's National Synchotron Light Source. The equipment zaps the silicon wafer with X-rays to form an image of a single molecule. The image shows metal ions sitting in the liquid, and chains of carbon and hydrogen sticking out of the water. In further tests, the scientists were able to get an image of a second molecule stacked atop the original one. In fact, the operation was repeated over and again. And now the researchers are sure they have established a method for locating and counting all the individual molecules stacked in any substance. The breakthrough will be applied to more complex research subjects in the coming years.

Amish enamel

University of Michigan researchers were startled to discover that Amish children living in southwestern Michigan have half as many cavities in their teeth as kids from the general American population.

The children under study do not brush every day, and they do eat "a fair number of sweets," according to U-M dentistry Professor Robert A. Bagramian. The Amish don't even use fluoride in their water. A well-balanced diet with no processed foods may be the key to the lack of cavities. But the research continues with an even more intriguing thought in mind: Amish people have a low level of bacteria in their bodies, preventing tooth decay naturally.

Not the ticket

Despite the fact that I've flown the Space Shuttle simulator, despite the hundreds of cards of support from readers, and despite what I thought was a pretty convincing application, I was not among the 100 lucky finalists for the first ride by a journalist on the Shuttle. This will not discourage me from trying other avenues, nor will it diminish PM's interest in the space program. In fact, PM is sending up an experimental package sometime in the year after the Shuttle program resumes. It was fun preparing myself for the training, and it was exciting even to be a candidate. Here's hoping another opportunity arises.

On the beach

NASA likes to think of the region where the upper atmosphere ends and space begins as a beach along the ocean of space. Data transmitted from two satellites that were parked in orbit just on the beach, about 300 miles aloft, continue to provide new information for Earth and space scientists.

Among the facts already deduced from a mountain of data still under study is that Earth's oxygen supply is not being held close to the planet by gravity. It is trickling away at a very slow rate. Scientists are conducting further studies to determine what the exact rate is.

The Dynamics Explorer satellites also discovered that the space between the edge of the atmosphere and space itself has its own weather patterns. The rare air and moisture at the uppermost level of the atmosphere is apparently driven by the electrification of gases by processes not yet fully understood. As researchers pore over the data during the next few years, it may shed new light on the changing global climate. One of the Dynamics Explorer twins has fallen back to Earth. The other continues orbiting and collecting data, which will be feeding the research community for years to come.

Son of bionic man

The field of cybernetics advances so quickly that we have to rewrite history at least a few times a year. The latest breakthrough is a technology called micromechanics. The new field involves placing submicroscopic moving parts on a computer chip. PA Technology of Princeton, New Jersey, says that within five years doctors will be able to connect artificial body parts to nerve cells, thanks to micromechanics. One device already on the drawing board would couple the nerve endings at an amputated limb directly to control servo motors in an artificial arm or leg. That would give the user practically full control of the artificial limb—just like the real thing. Even more startling is the notion that the micromechanical parts will allow the user of an artificial limb to feel heat, cold, pressure, pain and any other stimuli you can think of.

The technology of micromechanical parts is already worked out. Pressure sensors on high-tech automotive engines are one example. The trick now is to get enough parts into a computer chip to provide an arm or leg with the hundreds of impulses it needs to move normally. Look for that to happen by the early 1990s.

The first hunt

The first living beings thought to be hunters lived about 200 million to 300 million years ago during the periods when dinosaurs roamed the Earth. Before that, it has long been held that all living beings ate plants and 1-celled animals. But the theory may soon topple. University of Rochester paleontologist Carlton Brett and his colleagues have found 400-million-year-old seashells with tiny drill holes. Some kind of undersea predator is believed to have created the holes to draw out meat. If the finding holds water, life on Earth may be older than previously believed. PM

Electronics

BY STEPHEN A. BOOTH

Photo-phone arrives

Caller using desktop Luma phone sees (inset) large photo of other party, smaller image of herself taken by the phone's 16-mm lens.

Next time Crockett and Tubbs need a positive I.D. on a suspect, the "Miami Vice" lawmen won't have to wait long for the mug shots and prints. They'll simply dial up Records on their Luma telephone and watch the documents appear on its TV screen. If the computer-age gumshoes need copies of the bad guy's photo, Luma's video processor will spew out prints in seconds.

The Luma telephone is no more a figment of imagination than any of the other high-tech gear used by NBC's prime-time crimefighters (see *The Machines Of Miami Vice*, page 89, May '86). You'll find it in retail stores and the *Sharper Image* mail-order catalog, priced about $1450. That might seem a lot, but the Luma's come a long way.

AT&T first introduced its Picturephone during the 1964 World's Fair in New York. That futuristic product displayed moving video images of the party at either end of the line.

The Picturephone has yet to reach your living room because of cost. Not just the cost of the phone, but of the super-wideband transmission lines needed to accommodate motion video: Compared to a voice signal, full-motion video has about 2000 times more information. It should come as no surprise then that 22 years after Picturephone's debut, only the wealthiest corporations have the transmission lines and hardware needed for video teleconferencing.

Luma does not require special lines or video gear. It sends its black-and-white snapshots over regular phone lines in two to six seconds, depending on size. You can't talk during those few seconds because Luma converts the video information to audio signals for transmission. By sticking to still, black-and-white images about the quality of a newspaper photo, Luma stays within the voice bandwidth of a normal phone line.

What you'll see on the 3-in. screen of your Luma phone is a still photo of the party you're talking to, and a moving image of yourself. To send your image to the other party, you mug before the fixed-focus 16-mm camera lens and press the SEND button. You can change the pictures—or send none at all, since each user controls the camera at his end.

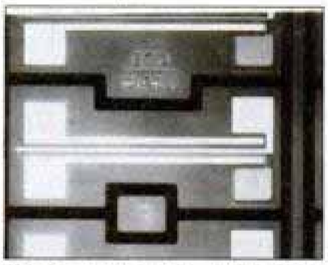
You're not limited to sending your own image. You can place other objects in front of the lens, too (a selection of lens adapters makes it possible to focus other images clearly). In fact, Luma Telecom believes law enforcement agencies will use Luma to exchange identification information. Besides this, there are dozens of business applications for seeing a document immediately. If a hard copy is needed, Luma has a video output port that connects to Mitsubishi's $390 video printer (see *Home Video*, page 43, Mar. '86). Luma Telecom is a subsidiary of Mitsubishi Electric Sales America. Luma was developed in the U.S. and it's made here, too.

Besides being a photophone, Luma also is a telephone. Within its desktop-size chassis (12 in. square, 9 in. tall) is a wide array of automated dialing functions and even an electronic directory with memory for 100 numbers. You can even use this memory in conjunction with the alphanumeric keypad to take down brief notes during a phone conversation.

Muscle chip

Another American company with a unique contribution to electronics progress is Detroit's own Energy Conversion Devices, which recently unveiled its revolutionary DIFET transistor. Among other things, it's one breakthrough needed to make flat-panel LCD televisions possible (see *Futurevision* on page 67 of this issue).

Basically, DIFET (for Double Injection Field Effect Transistor) is a new way of making transistors put out 100 times more current from lower power input—and faster. The new chip is made from amorphous silicon, which is cheaper than the pure crystalline silicon used in conventional high-output transistors. Until now, though, amorphous silicon could not deliver as much current as the real thing. Besides being less costly, amorphous materials can be shaped into larger integrated circuits than pure silicon permits. The result: faster, more powerful microprocessors for video displays and computer operations.



TV breakthrough: microscope enlargement of DIFET chip.

Late news

Speaking of *Futurevision*, as we go to press, Hitachi is showing a flat-panel TV only ⅓ in. thick. The 8-in. diagonal prototype has a gas-plasma screen (see *Traveling Light*, page 97, Feb. '86) that uses 95 percent less power than earlier versions. Hitachi says a 40-in. display (still ⅓ in. thick) would weigh 66 pounds. **PM**

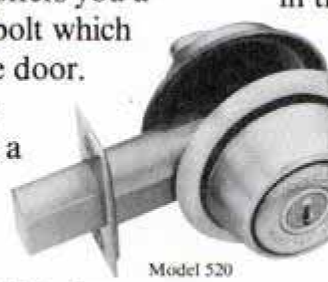
You're safe with a lock from Segal® on your door.

Police and insurance authorities around the country recommend the Segal brand vertical deadbolt lock for top security. You can install it easily with screws, yet it will stand up to a prybar better than the door itself!

The Model 666, shown here, in cast bronze with keyhole outside and thumb-knob inside lists for only $32.53.


Model 666

Segal also offers you a horizontal deadbolt which fits right into the door. Despite its sleek look, it conceals a strong one-inch deadbolt. Fits new doors or existing doors with holes up to 2-1/8 inches diameter. Solid-brass pick-resistant cylinder with keyhole outside and thumb-knob inside. Model 520 lists for $21.88. Easy installation.


Model 520

Compare Segal brand against others. All our locks are made in the USA with the finest parts and a lifetime guarantee.

Buy a Segal brand, instead of an imitation, and relax!

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FREE! Send for your Home Security Test from the makers of Segal products:
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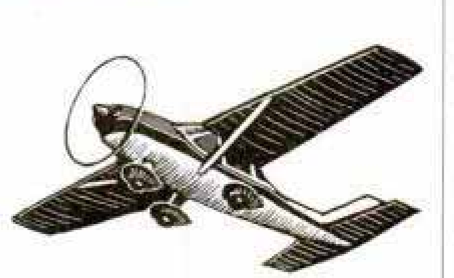
PM

Aviation



Living up to its name

The Velocity cruises at over 200 mph with a 2000-mile range.

Recently, I had the chance to fly one of the most promising of this year's crop of new kit-built aircraft. Dan Maher's Velocity seems to have it all. Modeled somewhat loosely after Burt Rutan's canard-equipped Eze series, Velocity affords impressive stability profile, control response and performance.

Cruise is over 200 mph with a 180-hp engine and a fixed-pitch prop. Maximum range is over 2000 miles. All four seats in the velocity are large enough to keep you from having to announce your engagement to the person next to you after a long flight.

Dan is getting ready to offer a complete Velocity kit that can be fully assembled in about 800 hours. It should come in at $20,000 minus the engine, prop and instruments. A quick visit to his factory at the beautiful airstrip in Sebastian, Florida, convinced me that he's definitely on the right track. A full flight report will be upcoming.

Battle of Britain

The United States Aerobatic Team figures to do well in international competition over Britain next month. One team member in particular will be carrying great expectations aboard a new airplane based somewhat on the "Laser" monoplanes gaining aerobatic prominence today. Clint McHenry is now flying the German-built EXTRA 230 with amazing finesse and skill for the short time he has been privileged to own it. So far, he seems to be quite happy with it—ecstatic, actually.

Clint is an Eastern Airlines pilot due soon to celebrate his 60th birthday, and he's a longtime aerobatic competitor. His EXTRA 230 boasts a Firewall Forward modified Lycoming engine offering 230 hp.

In my test flight of this aircraft, I was thrilled with the handling and performance. Response was breathtakingly fast. Most amazing was the fact that I performed aerobatic maneuvers on only 75 to 80 percent power. The EXTRA 230 retains energy like a miser.

Water wings

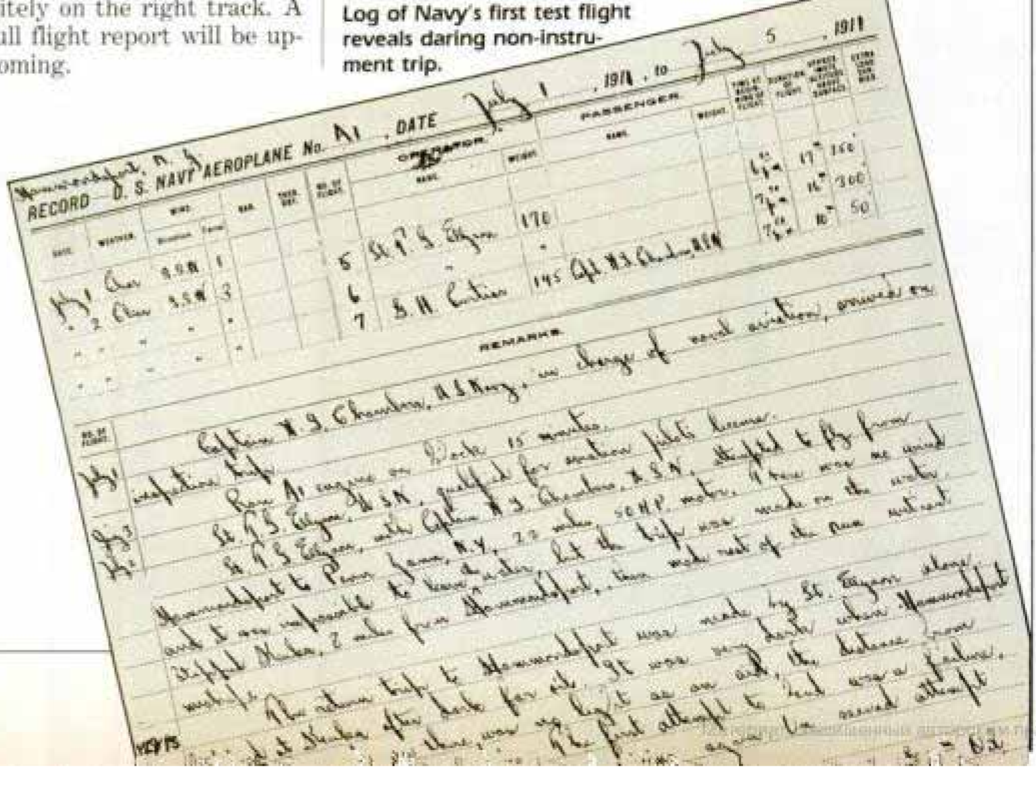
The Navy's first aviator, Lt. Theodore Ellyson, flew the Navy's first aircraft from Glenn Curtiss's base on Lake Keuka in Hammondsport, New York, 75 years ago this month. Hammondsport is celebrating with fly-ins, and a flight of a replica of the Original Curtiss A-1. Thousands flocked to Hammondsport at the end of June for a weekend that included the showing of some interesting first-flight memorabilia, including the flight log shown below signed by both Curtiss and Ellyson. After the first flight to a strip nearby, the log notes, Ellyson made the return trip with no instruments, no radio and in the dark. Now that's flying!

Cub heaven

Speaking of anniversaries, next year marks the 50th of the Piper Cub. The dependable and playful nature of this very popular 2-seat aircraft has made it worthy of a celebration. But first, the warmup: Piper enthusiasts are planning a fly-in this month to the original Cub plant site in Pennsylvania. Dubbed "A Sentimental Journey to Cub Haven," the event is expected to draw hundreds of Cubs and other rag-wing Pipers. Thousands of pilots owe their early tutelage to the forgiving nature of the J-3, often attired in Cub Yellow paint with a black lightning bolt on its side. If you plan to fly in to William T. Piper Memorial Airport July 13 to 19, ask for me. I wouldn't miss it.

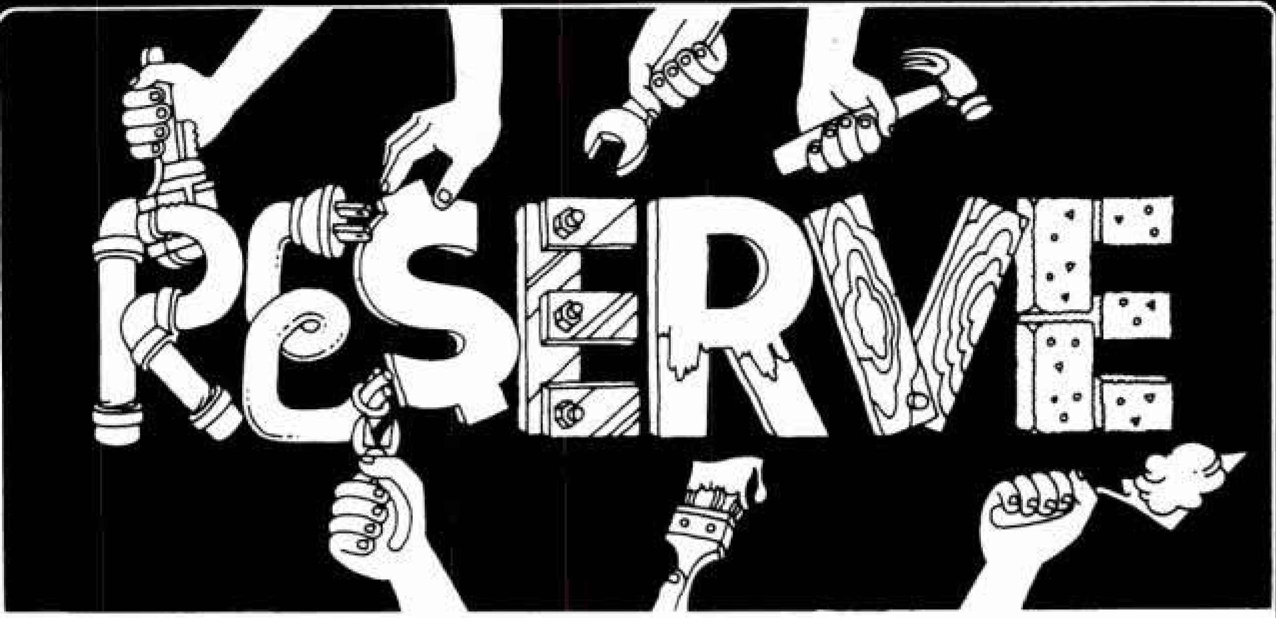
—Jim Campbell

Log of Navy's first test flight reveals daring non-instrument trip.



RECORD — U. S. NAVY AEROPLANE No. A1 , DATE July 1 , 1911 , to July 5 , 1911

REMARKS



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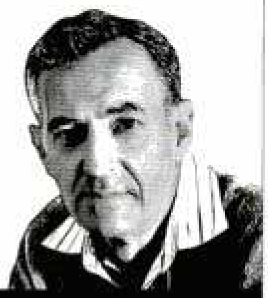


BY MORT SCHULTZ

Help wanted

I have a 1984 Chevy Camaro with the basic 4-cylinder standard-shift engine. My problem is alternators that burn out at an alarming rate—three so far in two years. Help! REG WOODS MERCER, PA

Here it is. In 1984, less-than-perfect integrated-circuit voltage regulators were installed in the alternators on a number of Chevys and other GM models.

The troublesome regulators have been allowing stators and rotors to burn out. Mechanics working on the problem see only the damaged stator or rotor and replace that. But the faulty regulator remains in the system, causing alternator damage to recur.

If your situation fits this description, see if there's an L imprinted on the regulator. If not, get a new regulator from a GM dealer. It should have the L on it.

If the regulator presently in your alternator is marked with an L, whoever works on the car should test the charging system to make certain it's performing the way it should.

Suppose the regulator's okay. What could be causing alternators to fail? There are these possibilities:

1. One or more bad electric grounds. The generating system has three ground connections. One is the battery negative cable. Another is a wire that branches off the battery negative cable and attaches to the car body. The third is a strap between the engine and firewall. Make sure all three connections are in place and are clean and tight.

2. Faulty rebuilt alternators. If you've been replacing burned-out alternators with rebuilt units, you may not be getting sound parts. If you need another replacement, you might want to have a GM Delcotron installed this time around.

3. A loose battery that's bouncing up and down on rough roads, grounding itself against another part of the car. This causes a short circuit that may damage the alternator. It's remote, but a possibility nonetheless.

Up volume

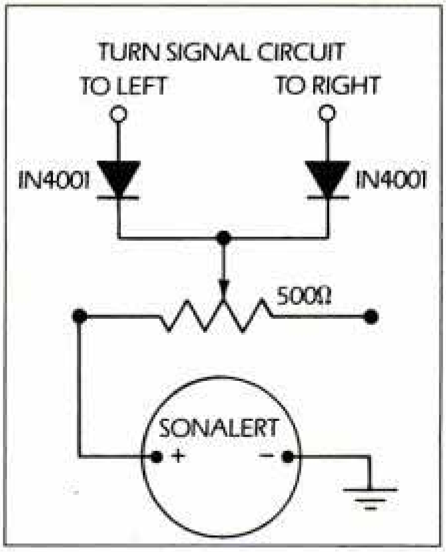
Thanks to all of you who responded to the April Car Clinic *(page 30) about that new, higher noise level GM turn-signal flasher. To refresh your memory, the item concerned a reader who had impaired hearing and needed a loud-sounding flasher to warn him when signals failed to cancel after a turn. I reported that the GM flasher (part No. 10041073) fills the bill but apparently I was misled. Readers tell me the flasher is no louder than the original.*

Maybe ideas other readers suggested to increase turn-signal decibels will help. I have room for only two: One was sent by two readers from different areas—Bob Bryant of Paoli, Pennsylvania, and Neil Power of Columbia, California. Both wrote about a directional light buzzer made by Honda for motorcycles, but which will fit any car. The buzzer, which sells for $4, comes with wiring instructions that describe how to tap the unit into a 12-volt electric system. According to Neil, "I put one on my Cadillac and had to muffle the sound—it was that loud. Tell readers to check cycle shops."

The other suggestion was sent along by John Niolon of Hueytown, Alabama. It's an up-volume device made with two IN4001 diodes, a 500-ohm 10-turn potentiometer and a Mallory SC-628 Sonalert (see illustration above). The volume is set by adjusting the potentiometer.

"The diodes and potentiometer can be installed on

(Please turn to page 42)



Simple circuit features an adjustment for volume level of turn-signal flashes.

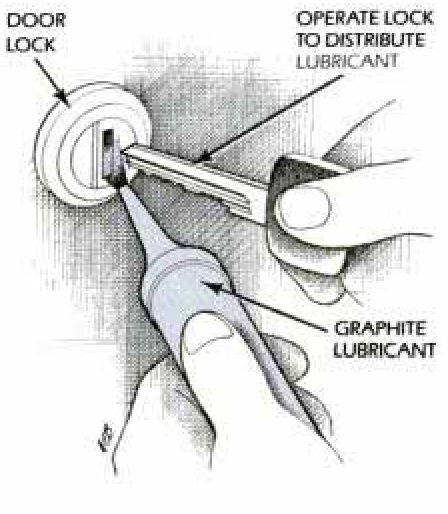
PM CAR CARE **tip**

Oil foils

General Motors says it's seeing too many customer complaints of binding and non-working lock cylinders in doors and in trunk, hatchback and fuel-filler lids. Trouble in many cases is being caused by well-intentioned owners using penetrating oil.

"Penetrating oil does not lubricate lock cylinders, but washes out factory installed lubricant instead," the company claims. This results in a lack of lubricant and trouble. Furthermore, warns GM, lock de-icers that contain alcohol are just as bad, since they also tend to cut the factory-installed lubricant.

To refortify factory lubricant, use a graphite lubricant recommended for lock cylinders. A variety of these are sold in hardware and home supply stores. One mentioned by GM is sold under the brand name Lock-Ease.



(Continued from page 40)

the back of the Sonalert case with some hot glue," John says. "Use a voltmeter or trouble light and a pin to find the left and right turn-signal wires in the harness coming out of the bottom of the steering column. Then, just tap leads of the alert unit into the wires. Incidentally, if you can't get a Mallory Sonalert, Radio Shack and other electronic outlets sell similar type 12-VDC alarms. They also sell other parts you'll need."

S marks the spot

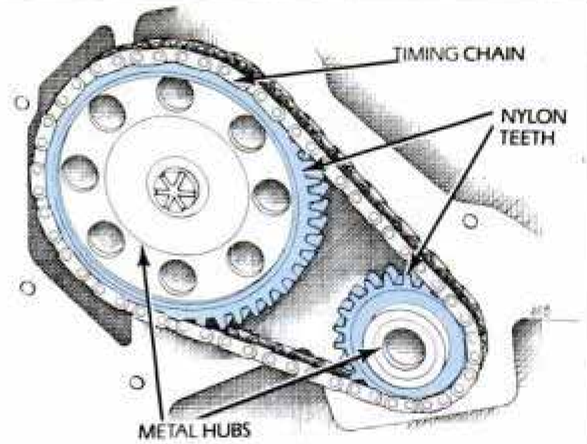
I love my 1985 Nissan Sentra, but can you tell me why it's so hard to start when it's raining? The dealer has gone over the car from one end to the other with his fancy electronic diagnostic equipment and finds everything in order. We need help.

ROBERT LOMBARDI
MACON, GA

I can give you one good reason for your trouble, but don't blame the dealer for not knowing this. It's brand-new information.

Many 1985 Sentras, Stanzas, Pulsar NXs and 300ZXs may start hard and/or hesitate in wet weather because

PM CAR CARE tip



Chain of events

Laurence Kracker of Fort Lee, Virginia, became concerned after reading the warning about rubber timing belts in the Nov. '85 *Car Clinic* (page 18). So despite the fact that his Olds, like most cars of the '60s, '70s and early '80s, uses a metal timing chain, he undressed his 1966 Delta 88 to have a look.

Kracker points out that the chain may be metal, but the gears are nylon. He discovered: "Not a single one of the nylon teeth on the large gear remained. The chain was riding on luck."

He replaced the chain and both gears and now has a shot that his Olds will roll another 152,000 miles without trouble.

Gale Burton of Sun City, Arizona, didn't fare as well with his '72 Plymouth: "The chain on the engine jumped off the worn plastic sprocket at 130,000 miles, resulting in bent pushrods and exhaust valve stems and a big repair bill. From now on, all my cars will be inspected in this area every 60,000 miles, no matter whether they have metal, plastic or rubber timing chain components."

That's a good idea, folks, because drag racers have discovered that the nylon teeth outlast steel ones! But it is a big job that often requires removing the oil pan or raising the engine.

of porous distributor caps. Check the top of the cap for the letter S.

Since you're having this trouble, I'll bet you don't find an S. In fact, many owners of 1985 Sentras and Pulsar NXs having engine numbers between E16-001001A and E16-053635A, or E16-491103 and E16-711337 won't find an S on their distributor caps either, and should tell dealers to get them new caps (part No. 22162-17M03). Owners of Sentras and Pulsar NXs built for sale in California that need the new S distributor cap should use part No. 22162-15M03.

Now that I may have solved your problem, let me help similarly troubled owners of 1985 300ZXs and Stanzas. If your car is a 300ZX with an engine number between VG30-237552 and VG30-365717, use part No. 22162-12P04 to get your new S cap.

If the car is a Stanza with an engine number that's between CA20-214475A and CA20-270131A, or between CA20-100923B and CA20-144274B, you should get an S distributor cap having part No. 22162-D3302.

L of a problem

Is there a fix for a 1985½ Ford Escort L that from day one has started perfectly in the morning, but then falters and stalls until the engine gets warm? The dealer says the idle, choke and timing are adjusted to service manual specifications. The car has a 1.9-liter carbureted engine and 4-speed transmission. Please give us a hand if you can.

ROBERT MAYOTT
SYRACUSE, NY

I doubt if a car this new has had time to develop any of the bug-a-boos normally attributed to older vehicles that have this trouble. I'm speaking of such things as dirty or damaged choke and idle system parts, a defective choke vacuum piston, a faulty hot air system, a bad EFE system, a disruptive EGR valve and vacuum leaks. Save investigating these if what I'm about to suggest doesn't straighten things out.

There's a different idle-speed adjustment procedure for this engine that is not in the service manual and which may have eluded the dealer. It's outlined in technical service bulletin (TSB) 85-19-7. The TSB emphasizes that the idle-speed adjustment for Escort and Lynx 1.9-liter engines should not be done as directed in the service manual. Specs printed in the manual, however, should be used. **PM**

DO YOU HAVE A CAR PROBLEM?
Just ask Mort about it. Send your question to the Car Clinic, Popular Mechanics, 224 West 57th St., New York, NY 10019. While letters cannot be answered individually, problems that are of general interest will be discussed in the column.

SERVICE TIPS

- If you're getting cruise control speed fluctuations in a 1985 Toyota Cressida, Camry or Corolla, the cruise control computer may have to be modified. TSB Electrical-011 says how.
- If you have a 1981-86 GM model that cuts out when shifting from P or N to D or R, determine if the transmission is a THM 200-4R or THM 700-R4. If so, the torque converter clutch (TCC) may be engaging because of a faulty TCC valve in the pump cover. A solution to this problem is available. As a point of reference, Pontiac TSB 86-7-20 tells all.
- The minute that sliding side door on a 1985-86 rwd Dodge Van or Wagon fails to open, have a new nonjamming latch assembly (part No. 4354039) installed as per TSB 23-25-85.
- Stop a transmission fluid leak from a 1980-85 Ford/Mercury or 1982-85 light truck that has automatic overdrive (AOD) by installing a new front pump seal (part No. C2AZ-7A248-A). The repair is discussed in TSB 85-24-7.
- Speaking of leaks, if your 1986½ Nissan D21 light truck has an oil leak from the rear of the engine, it probably isn't serious. Sealing the threads of the oil pressure switch should stop it. Some oil pressure units installed in production didn't seal. Refer your dealer to Service Advisory Bulletin (SAB) TS 86-043.

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Old House Restoration

BY BOB VILA

Home security

When working on an older home, many people will pay close attention to architectural integrity, period detailing and antique fixtures, but give scant attention to the issue of home security. While the latter is less glamorous than the former, it certainly is important. According to the FBI, more than 6 million American homes were burglarized last year, that's about one in 14 homes. Due to this, people are starting to look beyond ordinary security items such as locks or window grates to an assortment of high-tech security products. As a result, the home security business enjoyed a very good year, with almost $6 billion in sales.

Unfortunately, there is no foolproof way to prevent burglary. If a thief wants to get in badly enough, he probably will, regardless of whether your doors are wide open or made of solid steel.

However, here's the good news: The more you're able to increase the risk to the potential intruder, the less tempting a target your home will be.

Most burglars follow a pattern. First, they like to operate without forced entry. More than 40 percent of residential burglaries do not involve a break-in. Many times, a burglar even uses a key.

Burglars are most encouraged to strike when they think your house is unoccupied. A thief looks for signs that you're away: a dark or quiet interior, unretrieved mail, an empty driveway or interior lights which remain either on or off for many hours at a time.

Burglars need to work quickly. They know the more time it takes to break in, the greater the odds of their being detected.

Here's how to fight back:

Lock your doors and windows when you're away from home. And be sure your house keys are accounted for.

Use a remote-control timer to turn your home's lights and appliances on and off at irregular intervals. This will give your home an occupied look. If you go on vacation, arrange with a friend beforehand to pick up your mail and newspapers and eliminate other telltale signs that you're away.

Make sure all doors are strong, tight-fitting and secured by good locks. Windows should be equipped with effective locks or, for certain windows, bars and grilles. Install bright, hard-to-reach exterior lights in doorways and yards.

Doors, windows and locks

A burglar often starts off a heist by examining a home's exterior. If he finds a door with a hollow core, he'll probably rejoice. Most can be broken through quickly. On the other hand, a tight-fitting, solid-core wood door at least 1¾ in. thick or a metal door would be likely to discourage him—especially if it's equipped with a well-built deadbolt lock ($20 to $50) and a properly mounted strike plate.

Doors with glass panes often attract a thief's attention. To prevent him from breaking the glass, reaching in and opening the door from inside, secure the door with a double-keyed deadbolt lock (one that's opened with a key from both inside and outside).

Sliding glass patio doors may also attract a burglar because many are made with flimsy locks. Use three components to reinforce this area. First, insert a length of pipe in the track to prevent door movement in case the lock is removed. Second, to prevent the door from being lifted off its track, put in several large screws, with their heads protruding in the grooved section of track above the door. You'll be able to remove them but the burglar won't. Finally, install a secondary patio door lock (about $10) on the lower or upper portion of the door.

Windows are another weak link in your home's defenses. Nearly all windows

(Please turn to page 46)

Contributing Editor Bob Vila is host of public television's "This Old House," funded by Owens-Corning Fiberglas.

Seven potential entry points for a burglar: 1. Front door, protect it with key and deadbolt locks. Wire it to a perimeter alarm system. 2. Glass lights above the door should also be wired to perimeter alarm. 3. Front casement windows are accessible by a step ladder. Remove the handle crank once they're shut and wire it to perimeter alarm. 4. Basement windows are extremely vulnerable and are a good candidate for perimeter alarm, a key sash lock and bars or grille. 5. Sliding glass doors are easily accessible. Block them with stops, additional locks and wire to perimeter alarm system. 6. Shield the garage door windows from the inside with pieces of shaded acrylic panels. 7. Windows above the garage should be protected with sash locks and wired to perimeter alarm system.

OLD HOUSE RESTORATION

(Continued from page 45)

are accessible to burglars, especially first floor, basement, and those near balconies and fire escapes.

Take these precautions:

Double-hung windows should be locked with a keyed sash lock with a large, protected latch area. Basement windows should be secured with grilles or bars with a safety latch for inside opening. Windows with air conditioners should be secured by fastening to the sill or window frame.

Alarm systems

You should consider buying an alarm system if you live in a neighborhood with a consistent history of burglaries or if your house is frequently unoccupied for long periods. Self-installed alarm systems cost from about \$50 to more than \$500. Professionally installed systems start at about \$1000 and typically cost \$2000 for a 3-bedroom house.

Most-do-it-yourself security systems come with a "local" alarm, namely one that activates a bell, siren or lights inside or outside of the house. A wide variety of these devices are available, often in kit form, at hardware and electronics stores. They are intended to safeguard your property by scaring off a burglar when you're away.

A professionally installed system, however, is better equipped to protect you while you're at home. For a small monthly fee, the alarm can be hooked up directly to the police station (where allowed), to a monitoring service (usually the company which installed the system) or the telephone of a friend or relative. Smoke, temperature and moisture sensors can also be included.

Alarm systems have perimeter or interior sensors. Perimeter sensors guard exterior windows and doors, while interior sensors detect movement or intrusion inside your home.

A perimeter system is designed to sound an alarm before an intruder has entered. However, this system involves many components and considerable installation time and expense. In large houses, the wiring in a perimeter system can be expensive and even intrusive. A wireless system may be more appropriate.

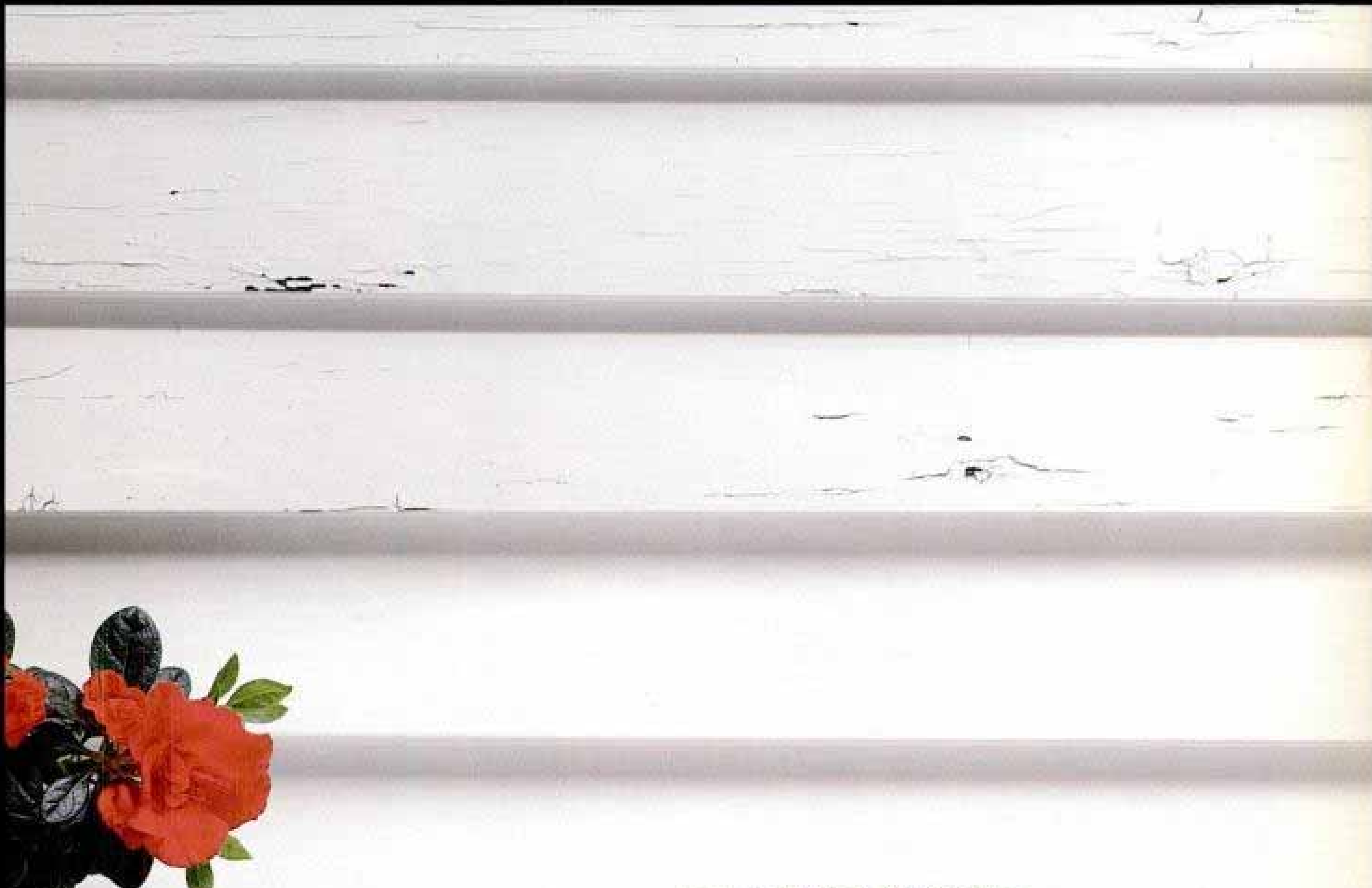
Interior sensors detect an intruder who has managed to break in. Photoelectric, ultrasonic, microwave and passive infrared sensors can do the job. Obviously, since these devices can't distinguish between you and a burglar, the best time to use them is when you're upstairs in bed or away from home.

I believe the infrared interior systems are the best. They can detect changes in heat radiation and, thus, sense the body heat of a person entering the protected area. They are less prone to false alarms than motion-detectors, as long as they're not in direct sunlight or pointing at objects that change temperature rapidly, such as air conditioners or radiators. They are especially good for homes with pets because they can be pointed at the top half of the room so pets won't set them off.

I recommend combining perimeter and interior sensors in the same system. In a 2-story house with a basement and second-story windows, you might employ magnetic contact switches at all entry doors and infrared sensors to guard rooms and halls.

Select an alarm company by asking your friends; they might have recommendations. Before signing a contract, get at least three written estimates.

Finally, if you're fortunate enough to live in a Crime Watch community, join in. You'll be looking out for your neighbors' homes while they look out for yours. PM



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ON OCTOBER 24, 1985, IMPA (INTERNATIONAL MOTOR PRESS ASSOCIATION) invited domestic and imported car manufacturers to participate in its annual Test Day event held at the Lime Rock Park road racing facility. Kolb-American Motorcars was there with a 1986 Aero GT Intercooled Turbo Thunderbird.

Here are some comments from IMPA members after driving the Aero GT:

WADE HOYT, Auto Editor, POPULAR MECHANICS, "Most distinctive T-Bird I have ever driven. It goes like a rocket! We liked it so much we chose to build a special Project Car around one."

RICHARD STEPLER, Executive Editor, POPULAR SCIENCE, "It really handled much more like a European car than I ever expected from an American car, handling was firm, flat and fast. The turbo boost was super-smooth and really powerful. Styling is different–I liked it, especially the unique asymmetrical-design grille which is a real grabber. Styling is clean, tasteful, not gimmicky."

BOB WRIGHT, ROB ST. FRANCIS SYNDICATE, "We've long thought that Ford's SVO group should do its stuff on the T-Bird. Well, Ford hasn't! It has taken Bill Kolb and Kolb-American Motorcars to create a SVO Thunderbird."

TOM INCANTALUPO, Auto Editor, NEW YORK NEWSDAY, "It looks racier than any production car–between a factory stocker and a NASCAR race car. The tight, firm suspension translates into terrific cornering on the Lime Rock circuit."

MUSCLECARS MAGAZINE, "Bill Kolb's expertise results in a T-Bird that can swoop down on many imports that are far more pricey, and run circles around them. One such dead duck is the $40,000 BMW 635 CSi! Kolb can deliver a fully-loaded Intercooled, Injection and Turbocharged Aero GT for less than half that tab."

DON VORDERMAN, Consumers Automobile Rating Service, "It ran the legs off a bunch of serious, high-priced sports cars on the race track. It was one of only two cars at the Lime Rock which made me smile–the other was a $48,000 Porsche 911SC!"

DIANA KURYLKO, Auto Editor, THE DAILY RECORD, "Kolb's Aero GT is hot performance refined in a sleek, quiet package with a form that makes the pulse race. It gracefully takes the curves with the prowess of a car accustomed to being pushed to its limit."

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BY BILL HARTFORD

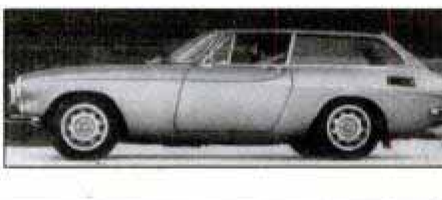
1988 Volvo 480ES

New sportswagon is on sale in Europe; will be here fall '87.

Cars come and cars go. And some are reincarnated. The 480ES—Volvo's first front-wheel-drive car—can't escape comparison with the Volvo 1800ES of the early '70s. We lauded the stretched sports-car concept after driving the old sportswagon 1500 miles through Sweden (*One-Of-A-Kind Car*, page 40, Oct. '72). The 1800ES was an extended-roofline, tailgated version of the high-tailing 1800S sport coupe. The 480ES has the same 2+2 sportswagon layout, but in a thoroughly modern adaptation. First of all, it's front-wheel drive—no bumps and humps to keep driver and passenger inextricably bundled in their buckets. And it's a real 2+2, with civilized seating for the +2. With transverse, 107-hp, fuel-injected Four, the base model should make an excellent commuter-scooter. With intercooled turbo on the 1.7-liter ohc block, it's pure GT.

Fastest 480ES will have 1.7-liter intercooled turbo.

Both versions will come from Volvo BV in the Netherlands. There'll be a choice of 5-speed or automatic and made-in-the-U.S.A. air conditioning. Standard are 4-wheel discs, but unique is ABS plastic for hood and front-end bodywork. Price of the 480ES should start at \$11,000—which means that after a decade of gentrification, there will again be an affordable Volvo.



The '72 sportswagon: a unique and desirable car, but the interior was "too much like the cockpit of an old dive-bomber."

VW gull-wing

Three-wheel Scooter could be another Beetle if VW makes it.

Three-wheelers go way back. The first true automobile was Karl Benz's 1886 3-wheeler. Most since then have been wimpy, slow, odd-looking little commercial delivery vehicles. But those designed recently have been screamers. The 150-mph Badsey Bullet was featured on PM's cover in Oct. '84. In our story were hot trikes like the front-drive Trihawk, and experimentals like GM's Lean Machine and Ford's Cockpit (*Three-Wheelers Are Back!*, page 91). The latest in the experimental category is VW's Scooter, a 120-mph gull-wing that could be hotter than a Swatch—if VW puts it into production. The 2-seater has a good-looking, aerodynamic (0.25 Cd), fiberglass body with great versatility: The gull wings and rear window can be removed for "motorcycling." Buttoned-up, the Scooter is a tight, comfortable sports car. It mounts an 88-hp Four transversely up front to drive the 13-in. alloys; a swing axle holds the wide, 15-in.-dia. rear wheel and tire. If the Scooter were in dealerships for the right price, VW would have another Beetle.

100

100 YEARS OF THE AUTOMOBILE
DAIMLER-BENZ 1886-1986

Year of heavy horsepower

When you've been making cars—great cars—for 100 years, you don't celebrate by goofing off. The creative juices are always flowing at Mercedes-Benz. And especially this year. To commemorate the birthday of the car, and the company, Mercedes sponsored a design competition for a poster image. The winning entry is simplicity itself: The number 100 suggesting the shape of a car. Another winning entry for this year is the Mercedes 300SDL, the most powerful diesel available anywhere in the world. Top speed with the new, 148-hp turbo Six is 121 mph. With 27-mpg fuel economy, the diesel has a cruising range of over 600 miles. The \$44,000 300SDL has ABS antilock brakes, driver-side air bag and anti-theft AM/FM. The Mercedes diesel heritage now goes back 50 years, to the '36 260D, first production car with a diesel.

The 1987 SL, disguised in this unofficial photo, gets computer-controlled 4wd.

Mercedes 300SDL with 3-liter turbo-diesel Six is quiet and fast. Top speed is 121 mph from the 148-hp powerplant.

To start its second century, M-B will have a new SL sports car. The luxurious SL will be rear-wheel drive—normally. But if you get into trouble on a slippery road and the computer detects wheel slip, a 4-wheel-drive system is instantly engaged to keep you on track. **PM**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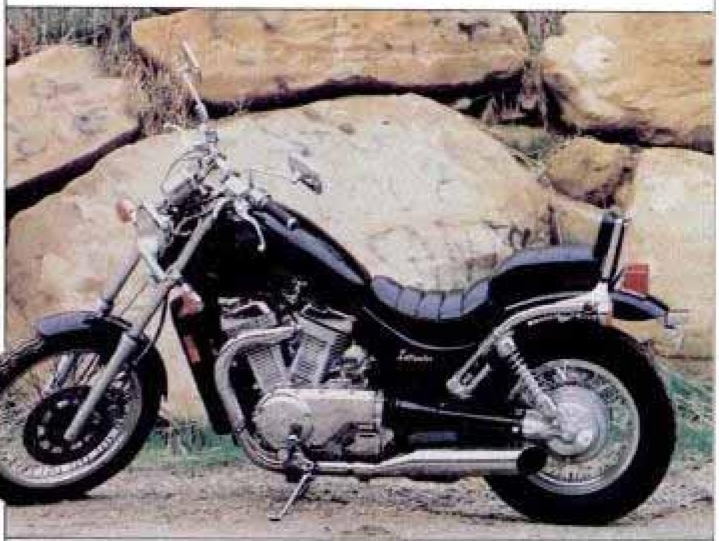
Intruders or imposters



Among the crowd of Harley-Davidson look-alikes, Suzuki's Intruder stands out as most faithful to the original concept.

With such superior technology built into today's motorcycles, you'd think that all value-minded riders would flock to the very latest machines with smooth-running Fours and multi-adjustable suspensions. Fortunately, the world of cycle riders is a rather diverse group, many of whom value simplicity of design and a classic profile over a 150-mph top-speed potential. As dazzling as superbike spec sheets are, the demand for mechanically spare V-twins has never let up, much to the delight of Harley-Davidson.

Unable to blind all of their buyers with science, the Japanese Big Four resorted to building their own clones of the venerable Milwaukee original. Clearly the best execution to date has been performed by Suzuki.

Suzuki pulled out all stops to make its VS700 Intruder a worthy contender. For authenticity the engineers drew up a 45° V-twin powerplant, equipping it with staggered crankpins and a 699-cc displacement. Though the V-twin layout dates back to the Stone Age of motorcycles, the mechanicals are up to the minute.

The chain-driven single-overhead cams in each head open four valves per cylinder via forked rocker arm assemblies. Rubber front engine mounts keep vibration at a level appropriate for a machine of this genre.

Flat handlebar set makes for reasonably comfortable riding.

V-twin is a true 45°, uses 4-valve layout.

A *very* close look at the Intruder reveals that the engine is in fact liquid cooled, despite the presence of deep, cast-in fins on the cylinders and heads. The radiator is downplayed by its tall and thin profile, to the point where you'll almost overlook it in the side view. The water jackets keep a lot of the mechanical racket inside, so only an authoritative V-twin burble escapes from the split exhaust system.

After establishing the mechanical basis of an H-D look-alike, Suzuki's engineers went to work on the fine points. Picking up every styling clue and subtle nuance usually credited to the Milwaukee marque, Suzuki softpeddled the manufacturer's identity with a simple winged "S" on the gas tank and barely a mention beyond that. The designers did their homework well, studying American choppers in their natural habitat, as they successfully pulled off the image of a graceful, bare-bones machine. That means that a number of features we've come to think of as standard equipment are trimmed from the Intruder: There's no tachometer, gas gauge or trip odometer to clutter the rider's view.

Instrument panel is just the classic speedo.

Shaft drive may be slightly unconventional from a traditionalist's point of view, but in terms of low-maintenance riding enjoyment, there's nothing like it. The twin-shock rear suspension is adjustable only for preload; by using strong springs it does a good job of damping the up and down gyrations of the shaft as throttle position changes.

Around-town cruiser or not, the Intruder could certainly stand more braking power. A rear drum and single disc up front don't have the power to make you feel like pressing your luck on any stretch of road, and the long front fork is given to flexing when pushed hard.

The Intruder buyer's big decision will be choosing between the flat, drag handlebars or a buckhorn set, and whether the classic spoke or newfangled cast-alloy rims best suit his psyche. Depending on those options, the price runs from $3199 to $3399.

With its Buick-sized helping of chrome plate, low 27-in. saddle height and sensible 465-pound net weight (35 to 70 pounds lighter than the competition), the Suzuki Intruder makes a powerful case that the Japanese can build a bike that appeals to the most apple-pie-addicted Yankee out there. Will they run Harley-Davidson out of business? Never happen, because H-D's diehard following seems genetically dis-

(Please turn to page 52)

PM PHOTOS BY DON GREEN

(Continued from page 51)

posed to buying only real American steel.

At least now we do have a viable factory custom, right down to the molded frame neck, that combines reasonable price with leading-edge engineering and all-American styling to fill the needs of those who choose to stray from the ranks of the H-D faithful.

Long-haul mountaineer

From the off-road bicycle innovators at Fisher Mountainbikes comes a class of 2-wheelers you may not be familiar with—the expedition bike.

The model is known as the Mt. Tam in the hip Marin County dialect, but what it means to you is that this bicycle has been designed for both short bursts up fire roads as well as long-distance treks.

The specific geometry employed on the Mt. Tam is a combination of a relatively short rear triangle and moderately steep head and seat-tube angles. In theory, that will make it stable for the long haul without giving up responsiveness in sprint work. Frame sizes range from 14.5 in. up to 24.5-in., and all but the smallest use 26-in. wheels.

Fisher Mt. Tam is an expedition bike built for both fire-road sprints and long hauls.

Engineering is the key to Fisher's great popularity among the hard-core mountain bikers, and the Mt. Tam further displays that leadership. Built up of Fisher Tange Prestige quad-butted tubing, the tubes are sized in proportion to the frame size under construction. Beautifully radiused, fillet-brazed joints make the frame a joy to behold. This construction technique is an American specialty and, by Fisher's criteria, an advantage over European and Japanese methods.

Imron paint and a clear coat over the decals ought to keep it all looking sharp for a good long time.

Icing on the cake includes a New Tange Unicrown fork, Shimano forged forktips and mounts for two water bottles and a rear rack.

If your idea of roughing it off road goes further than an afternoon in the forest, the versatility of an expedition machine offers what you could only build for yourself in the past. With the Fisher name on it, you'd have to feel certain that the $1340 Mt. Tam is capable of getting you there and back, with loads of fun in between.

Classic appeal

While I'm the first to gush adoringly over the newest high-tech innovation on any 2-wheeler, I'll also have to admit to harboring a soft spot for the elegant motorcycles of yesteryear. The one company that still seems to produce cycles with one wheel locked in the 1920s, Harley-Davidson, makes no pretenses about heritage and tradition. While the mechanicals have been modernized, H-D has done a land-office business in marketing nostalgia to the affluent rider class.

Take a look at Harley's latest back-to-the-future machine, the FLST Heritage Softail. Every bit of it is designed to rekindle fond emotions of 1949. Founding-family descendant and vice president of styling Willie G. Davidson calls his Classic American creation the New Nostalgia look. If it were a car, we'd lump it with the neoclassic category, much like the replica Cords and Duesenbergs built on today's modern chassis.

The front end harks back to the original Hydra Glide telescopic front fork. The rear has the shock-absorberless look of the hardtail design, but concealed gas-charged, horizontally mounted shocks soak up the bumps. A cream and red 2-tone paint scheme solidifies the classic look, covering the Fat Bob fuel tank and extra-wide front fender every place where chrome has not been plated on.

Lest you think that this is nothing more than a replica of an antique, check out the running gear: the torquey 80-cu.-in. Evolution V-twin powerplant, 5-speed transmission and Kevlar-reinforced belt final drive. Everything about the Heritage Softail is big. It weighs in at 650 pounds dry, and the price tag is a breathtaking $9099. As a nostalgia trip and an alternative to restoring a basket case, that may make good sense. But simply, it's a lot of cool for the money. **PM**

Heritage Softail is all nostalgia in looks, but thoroughly modern in mechanicals.

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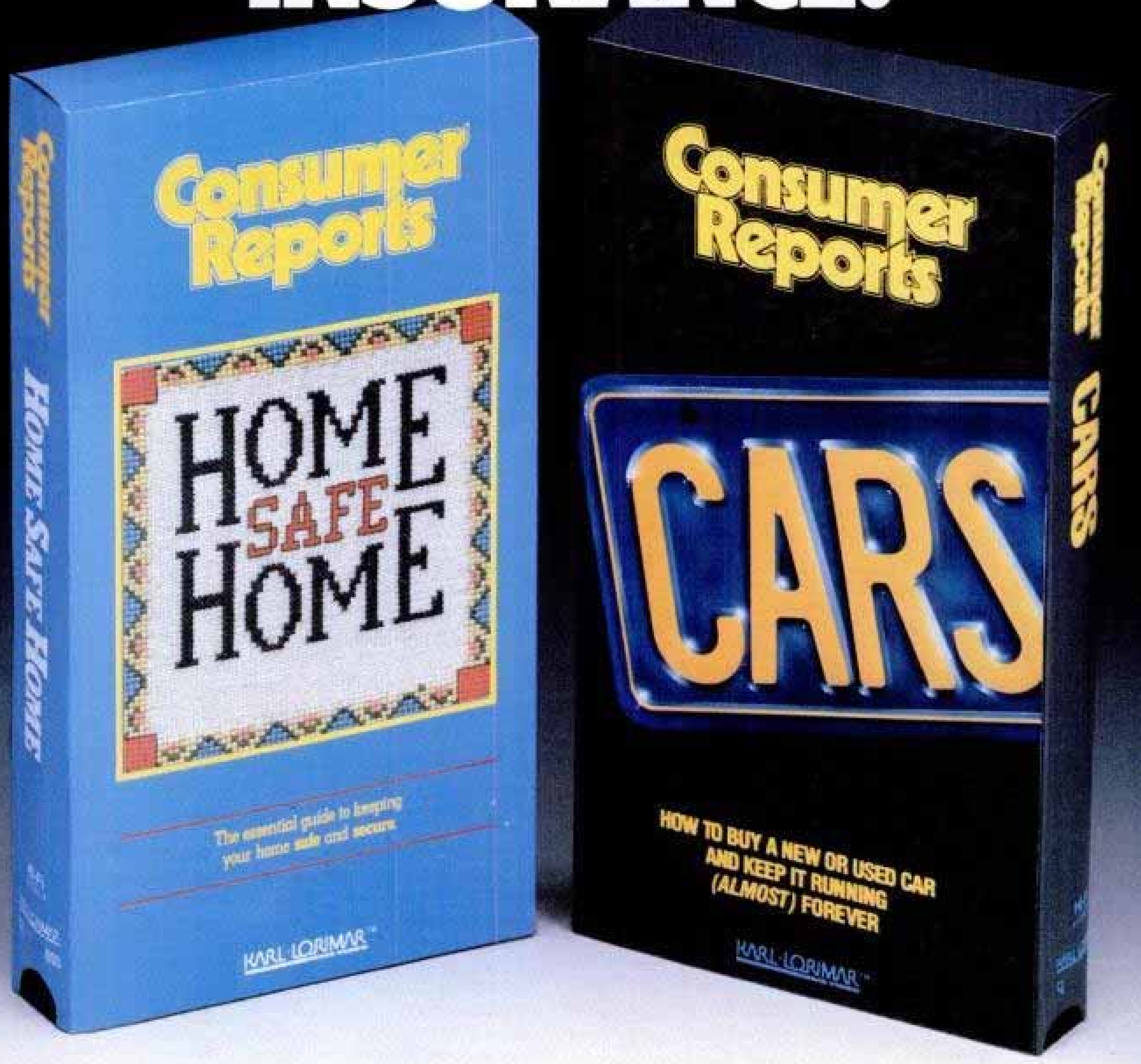

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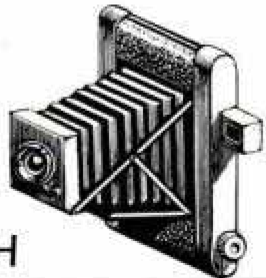
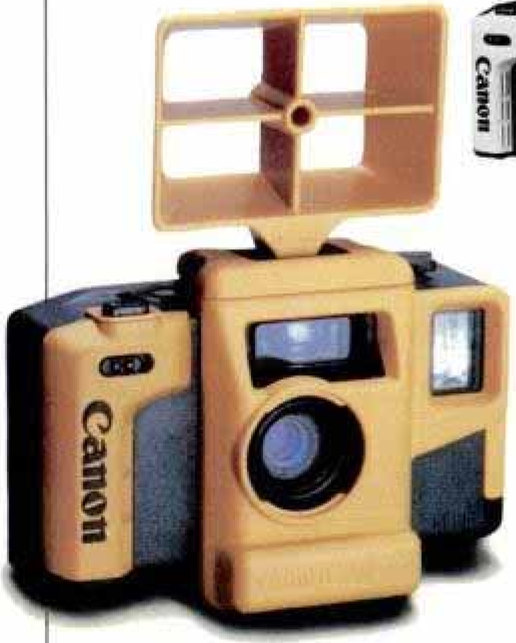


BY STEPHEN A. BOOTH

Splash 'n' flash



Canon 35-mm Aqua Snappy (above) floats; accessory sportsfinder base (left) makes it easy to frame underwater shots when you're wearing a mask.

Summer is here, and photo opportunities abound. Trouble is, many of them could be hazardous to your camera's health. There's boating, snorkeling, fishing, waterskiing and white-water rafting, to name a few. But even just splashing in the surf or kicking around on the beach will expose your camera to ruinous water and sand—unless you have one of the new breed of go-anywhere 35-mm compacts.

Tough waterproof cameras have been around for a while. Minolta brought out its Weathermatic-A in 1980, for 110-film photography. At the sophisticated end of the imaging spectrum Nikon still reigns with its Nikonos—a 35-mm SLR.

Happily, the latest group of environment-proof compact cameras gives you 35-mm quality in a package not much bigger than an Instamatic. Some are watertight down to 10 ft. These include the new Canon Aqua Snappy and Nikon Action-Touch. Waterproof down to 6 ft. is Fuji's HD-M (*Photo Update*, page 156, Sept. '85).

Most compact 35s give you some form of automatic focus system—usually infrared. Unfortunately, these systems don't work underwater, so the Aqua Snappy and Action-Touch (even the HD-M) rely on fixed or zone focusing. Like all compact 35s, they still select exposure values automatically for you—including flash when needed. Another feature they share is automatic, motorized film advance—important underwater.

Canon's Aqua Snappy has a fixed-focus 35-mm lens. Submerged, it focuses from 3 to 10 ft. Out of water, focus ranges from 5 ft. to infinity. Though the yellow-and-gray Aqua Snappy floats, you can fit it with an accessory base and sports finder. The latter makes it easy to frame pictures when you're wearing a face mask or goggles.

Also included in the accessory base kit is a closeup lens. This lets you focus within a foot underwater and 5 in. when above. For accurate measuring underwater, a closeup rod attaches to the base; a snap-on viewfinder performs the same chore above water.

The Aqua Snappy uses either 100- or 400-ASA film. It costs $200 with accessories, $160 without.

Nikon's Action-Touch lacks the accessory package (a float-belt is available), but for $267.50 gives you the versatility of autofocusing above water. When submerged, you have a choice of four fixed-focus zones (2 to 3½ ft., 3½ to 5 ft., 5 to 12 ft., 12 ft. to infinity). It automatically selects the proper speed for 50- to -1600-ASA films.

Flash!

■ The film-less camera has arrived. By the time you read this, Canon will introduce an electronic still camera for professional use (*Photo Update*, page 70, Feb. '85 and page 156, Sept. '85). Like the Canon prototype used during the '84 Olympics, the new model records up to 50 photos on a 2-in. magnetic disc. An amateur version will follow in two years. Stay tuned for more details.

Nikon: autofocus by land, manual by sea.

■ Kodachrome is getting turbocharged. Kodak acknowledges that it's preparing a speedier ASA-200 version to join the venerable ASA-25 and -64 slide films later this year. PM

PM PHOTO-TIPS ALBUM

A good fireworks shot can evoke as many ooh's and aah's as the real thing. Here's how to capture the Independence Day action.

Your camera sees fireworks as moving light sources and will trace the explosion's pattern on film for as long as the shutter is open. For best results, aim your camera at a predetermined spot and set the focus to infinity.

With adjustable SLR cameras, set the shutter speed to B. Use ASA-400 slide film, and vary the aperture from f/8 to f/16 between shots.

Open the shutter just before the explosion and close it before the embers start to fall.

With auto-everything 35-mm compacts, make sure your model goes down to a shutter speed of at least 1/8 sec.—and will operate in darkness (you might have to trick it by covering the electric light-metering eye, and also the flash). Shoot with ASA-100 slide film, and snap the shutter as the rocket explodes.

No matter what camera or film you use, the slow shutter speeds involved mean that hand-held shots risk jiggled images (see the upper burst in our multi-exposure example). Support your camera on a tripod or steady base and use a cable release if possible.—*Armand Ensanian*

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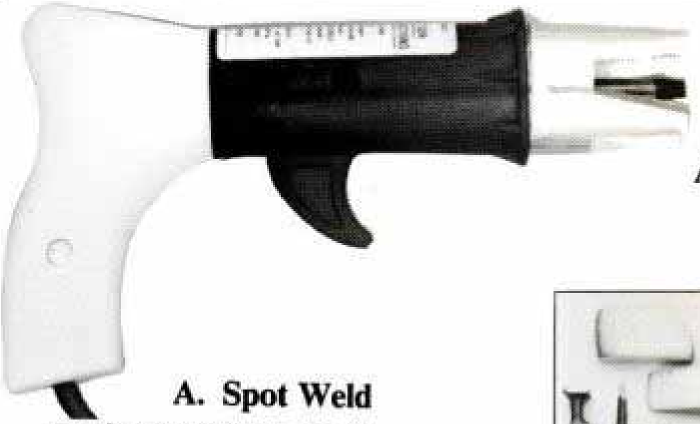
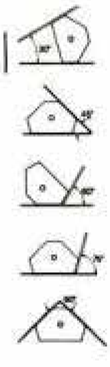
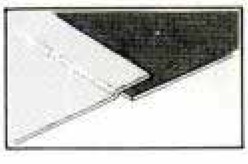


A. *Spot Weld Gun*

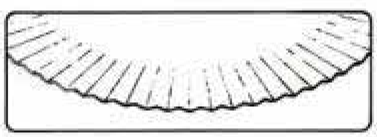
B. *Body and Fender Tool Kit*

C. *Magnetic Welding Jig*

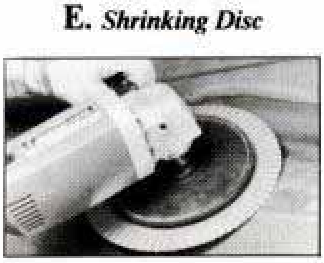




D. *Panel Flanger*



E. *Shrinking Disc*



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Easy to Use — Even for Beginners
Hook it to the electrode holder of your A.C. arc welder (set at 50 amps) and ground to car body. Just pull back trigger to retract electrode, line up weld point and press head against the metal. Metal must be free of rust, paint or grease. Release the trigger and allow the electrode to contact the metal and glow for 1-2 seconds. Then raise the electrode with the trigger and allow an arc to form a molten puddle of metal (always use welding goggles or shield). Each weld takes about 5-6 seconds. Auto manufacturers used spot welds to build your car; you can restore it with the same authentic technique.

Converts an Arc Welder to a Spot Welder
It welds any steel between 18-26 gauge. (Auto body sheet metal is between 18 and 22 gauge). Ideal for welding replacement panels, floors, brackets, clips, braces, etc. Welds from one side so it can even do blind panels that ordinarily can't be spot welded. Comes with two pressure heads — four prong for control on flat areas and two prong for reaching into edge and recess work. Proper replacement electrodes available through Eastwood. Gun comes complete with connection wire, spare electrode, 2 pressure heads and complete instructions.
4355 Spot Weld Gun — **$35.95**
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4343A Powerpack for stitch welder-**$109.00**

B. Body and Fender Tool Kit

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D. Flangers For Flush Fit Panels

Adjust tool to metal thickness, flange repair area and lay in patch panel. Lets you weld flush with body metal, which minimizes grinding and filling. Works in tight areas and on sharp curves. Perfect results with very little effort.
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Just attach this 9", 18 gauge stainless steel disc to your heavy-duty body grinder and you'll level stretched metal to its original factory-smooth shape. The secret's in the unique blade that creates heat to shrink metal back into shape. It has a ⅞" arbor to fit standard grinders (maximum speed 8000 r.p.m.; 5000 r.p.m. ideal).
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Most arc welders have been designed for joining ¼" metal; our stitch welder attachment controls welding heat to produce smooth, even welds on body panels — limits distortion and burn-through.

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Welding's easy: once you strike the self-starting arc, lay the rod on the metal and let the machine do the work. Resulting bead is smooth and even, with slag coming off in large pieces. Easy to master with practice.

The stitch welder's five foot power cord attaches to any A.C. arc welder's electrode holder (must run at 80 amps or less). Uses arc welding rods up to 3/32" steel and stainless. Tool body cast aluminum with vinyl insulated grip for positve control. Electrodes held with set screw and can be easily replaced. Designed for years of trouble-free service.

4369 Stitch Welder — **$49.95**
4372 Arc Welding Rods (2mm dia, 3 lb. pkg. approx 120 rods) designed with special flux for welding sheetmetal — **$9.95**
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G. Nibbler Cuts Metal Fast

Our nibbler cuts curves, straight lines — any shape you need. Leaves flat, no-distortion, burr-free finish. Uses less effort than ordinary snips. Chromed steel construction with cushioned vinyl grips. Heat-treated tool steel jaws. Cuts up to 18 gauge steel, 16 gauge aluminum. Jaws replace easily.
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6284 Replacement Blades (pkg. 2) — **$9.95**

H. Fabricate Panels With A Sheet Metal Bender

Will form 90° angles in 20 gauge up to 18" wide. Bends heavier gauge metal in smaller widths. Great for reproducing body panels, covers, etc. All-aluminum. Bolts or screws to workbench.
6260 Bender — **$29.95**
6261 Clamps — **$4.50**

I. The Ultimate Guide For Home Arc Welders

At last — a welding book that explains techniques in plain English. Takes all the mystery out of arc welding. Also gives a guide for selecting the right welder for specialty jobs. Many sample weld beads analyzed so you can improve your work. Over 170 pages.
6630 Electric and Gas Welding — **$9.95**

J. Cut Spotwelds In Seconds

Remove spotwelds without cutting through the lower panel. ¼" arbor has adjustable pilot to insure perfect cuts without damaging metal. Pilot pops out slug after cutting. Works on air and electric drills (900 rpm max) with ¼" chuck. Use with sheetmetal up to 3/16".
3219 Spotweld Cutter — **$12.95**
3220 Replacement Cutter — **$4.50**

K. Sandblast Away Rust

Our sandblaster is field proven (thousands in use) and priced right. This sandblaster gives you the ability to remove rust, scale, paint and corrosion in minutes. Also doubles as air gun/degreaser for cleaning parts.

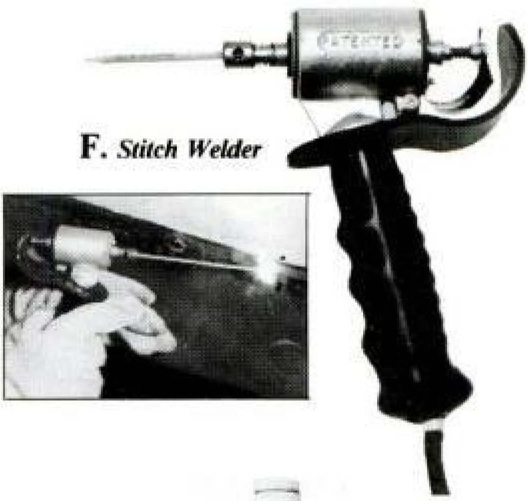
The Eastwood sandblaster package includes all-metal power (same as used on our larger units), ten foot hose, 14" pickup tube, spare nozzle and complete instructions. Just attach to 1 HP compressor, insert pickup tube into sand or other abrasive and you're ready.
8532 Sandblast Gun — **$30.95**
9536 Blast Hood w/Replacable Lens – **$19.95**

L. Remove Rust Without Harming Good Metal

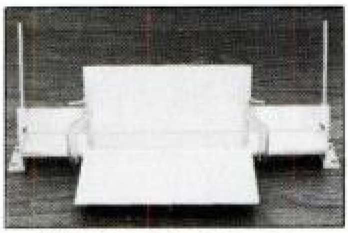
Oxi-Solv removes rust and corrosion fast on any metal. Just spray, dip, or brush on and see it work!! Oxi-Solv is non-flammable, non-toxic, non-caustic and odorless.

Extra bonus: After removing rust, Oxi-Solv gives a zinc phosphate coating to metal for better paint adhesion. Reusable.
3430 Oxi-Solv, 16 oz. — **$8.95**
3432 Oxi-Solv, 1 gallon — **$24.95**

G. *Nibbler*



F. *Stitch Welder*



H. *Sheet Metal Bender*

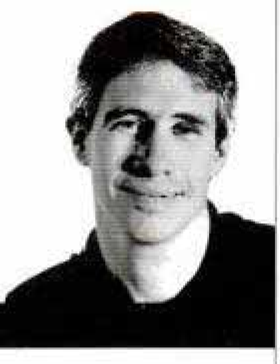
I. *Electric and Gas Welding*

J. *Spotweld Cutter*

L. *Rust Remover*

K. *Sandblaster*

Motorsports



BY STEVE POTTER

Ultimate power play

PHOTO COURTESY ON TRACK MAGAZINE

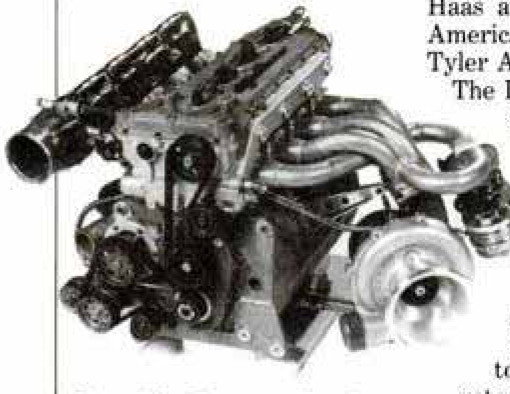
Brabham lowrider may be the next hot setup in Formula One cars.

Formula One may not have quite the presence that it did a few years ago in North America, when a quarter of the Grand Prix schedule took place on this continent, but it still represents the zenith of motorsports technology. The two North American races on the international schedule are the Canadian Grand Prix at Montreal (June 15) and the United States Grand Prix at Detroit (June 22).

The technological advances that make Formula One exciting are concentrated in the engine compartment, where prodigious amounts of power are extracted from little, 1.5-liter engines running on gasoline, not the exotic alcohol blends used at Indy and in drag racing. Carmakers like Alfa, BMW, Ferrari, Ford, Honda, Porsche and Renault spend millions to develop these high-tech engines for use in various race chassis.

One American team has a Lola chassis. Although the car and its engines are built in England, the team is owned by Chicago's Carl Haas and is run by fellow Americans Teddy Mayer and Tyler Alexander.

The Lola started life with a 4-cylinder Hart-turbo engine, but the intention all along had been to run the 1986 season with the new Ford-Cosworth V6 turbo. The new engine is the successor to the normally aspirated 3-liter Ford-Cosworth V8, which was the most successful Formula One engine in history. Like the V8 two decades ago, the new V6 was designed by Keith Duckworth, and represents the culmination of this engineering genius's thoughts on engine design over the past 20 years.



New Alfa Romeo turbo Four puts out 830 hp in race trim.

Equipped with a sophisticated electronic engine-management system based on the EEC-IV system used in road cars, the new Ford in qualifying trim is expected to produce better than 1000 hp. (The 4-cylinder BMW used by several teams has the ability to blast out a rumored 1250 horses for short qualifying sprints!)

The most interesting chassis in which the BMW will be found is the stunning new Brabham BT55.

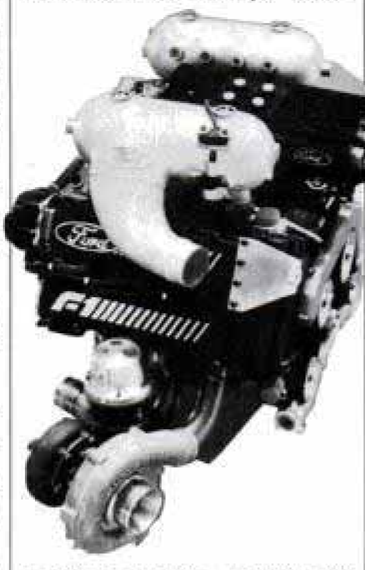
What sets the new Brabham apart from its contemporaries is the low-line silhouette the BT55 presents to the wind. The top of the body stands only 24 in. high. With the exception of the rear wing and the roll bar, the tallest parts of the car are the four tires.

To achieve this low profile, team-owner Bernie Ecclestone had to persuade BMW to modify its tall 4-cylinder engine so that it could run on its side. Another key component in the BT55 is its new 7-speed transverse transmission, designed by American gearbox whiz Pete Weissman.

While super-efficient turbocharger systems can yield better than 1200 hp for short periods of time, the amount of fuel a team can use for a 200-mile Grand Prix is limited to a little over 50 gallons. It takes fuel to make horsepower, so the race horsepower is effectively limited to about 850.

The chief edge in race horsepower comes from squeezing the most horsepower per hour from a gallon of gas, and just as it is in the case of highway cars, electronics plays the key role here. McLaren's Porsche-TAG turbo V6 appears to get more horsepower from every drop of fuel than any of its competitors. A lot of the credit for that goes to the engineers at Bosch who designed, built and maintain the advanced Motronic system of electronic engine controls for the TAG.

McLaren driver Keke Rosberg has won most of his races on tight circuits like Montreal and Detroit, and McLaren has always done well at these two events, so that makes them doubly favored.



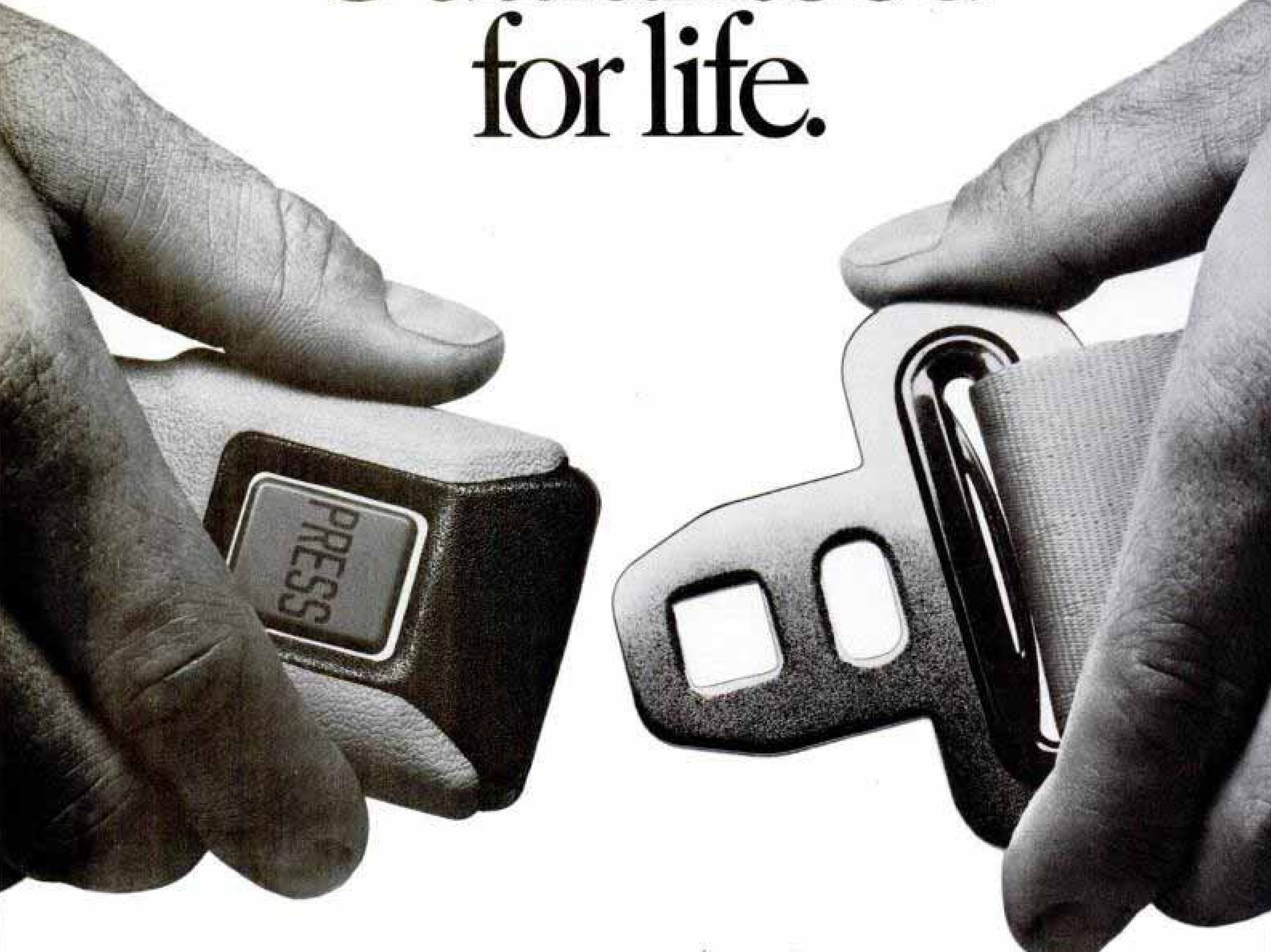
Ford's twin-turbo 1.5-liter V6 has EEC-IV computer control.

Actually, when it comes to favorites, there are no teams more fervently cheered by the fans than Ferrari and Lotus. Based on the merits of recent performance, the Renault-engined Lotus 98T, in the hands of Brazilian newcomer Ayrton Senna deserves to be a favorite. Many longtime Formula One watchers say that the 25-year-old Senna shows more pure speed than anyone they can remember.

Ferrari, on the other hand, looked strong at the beginning of the 1985 season, but faded as the season went on. Ferrari didn't show much promise in preseason testing or in the early '86 races, so if they only come to the races to see their favorite team, Ferrari fans may leave the circuits disappointed.

But if they are coming to see a technical spectacle, they won't be disappointed at all—and they're likely to see a heck of a race. PM

Seat belts. Guaranteed for life.



Seat belts help save lives. Seat belts help reduce injuries. Seat belts work. Guaranteed.

But sometimes even seat belts don't work properly. For some people that's the perfect excuse not to wear one.

Well, when it comes to seat belts, Honda does not believe in excuses. That's why if any seat belt in any Honda ever fails to function properly, Honda will repair or replace it.* Free. You see, Honda wants you to wear your seat belt whenever you're in a car.

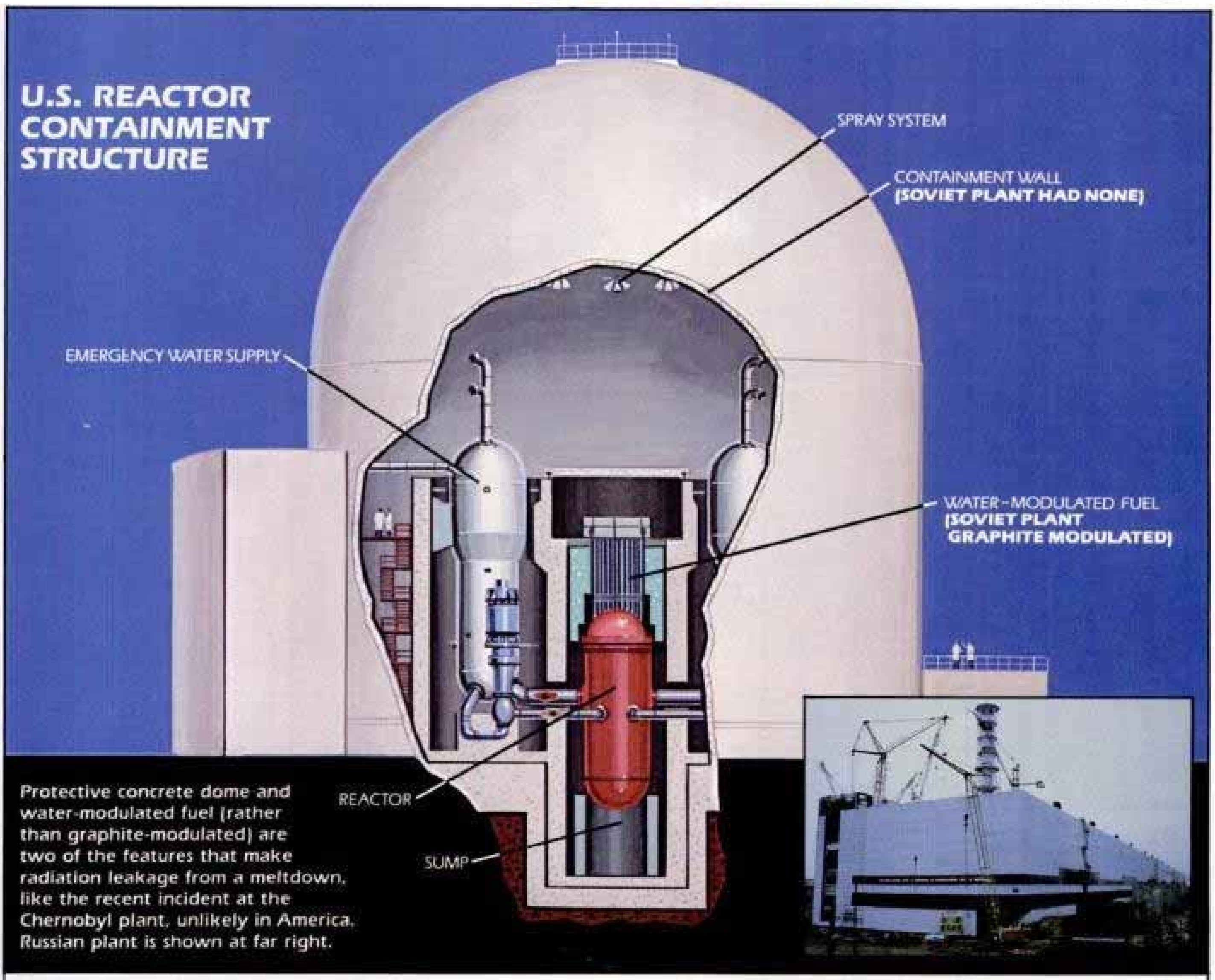
All you have to do is bring your Honda to an authorized Honda dealer. It doesn't matter if you drive a 1970 Honda or a 1986 Honda. It doesn't matter if you bought it third hand or brand new. The only thing that is important is that your seat belts work. If they don't, we fix them, free.* Regardless of automobile's age or mileage.

After that, it's up to you to wear one. Just remember, seat belts are a simple fact of life.

*Limited written warranty. Some restrictions apply. See dealer for details. Applies to model years 1970-1986.

HONDA

PM TECHNOLOGY UPDATE 7/86



Protective concrete dome and water-modulated fuel (rather than graphite-modulated) are two of the features that make radiation leakage from a meltdown, like the recent incident at the Chernobyl plant, unlikely in America. Russian plant is shown at far right.

Why a Russian-type nuke disaster can't happen here

The nuclear disaster at Chernobyl that spawned a large radioactive cloud also created a new shadow of doubt about the safety of reactors in the U.S. But several nuclear experts tell PM that U.S. reactors are safer than Soviet facilities.

For one thing, the Chernobyl plant (under construction in photo, above right) was housed in a factorylike building, not in the containment structure typical of U.S. reactors (illustration). With yard-thick reinforced-concrete walls, these steel-lined fortresses are built to imprison radioactive products. Secondly, the Russians use graphite in the core to sustain a chain reaction. It's flammable and tricky, and hot enough to release hydrogen from any stray water it touches. The two working graphite reactors in the U.S., at Hanford, Washington, and Fort St. Vrain, Colorado, are operated with extra care. For instance, both are shut down during refueling, unlike the Russian reactors. But most of our 100 reactors use water, not graphite, for fission. American reactors typically have sprinkler systems to cool a meltdown and sumps to handle radioactive spillover.

True, U.S. investigators recently cited 12 serious nuclear incidents during 1984 and '85. But none led to major radiation releases. Critics also argue that containment buildings can easily rupture. But after Chernobyl our safety record seems relatively solid.

Experts in the American atomic energy industry say over 300 changes have been made in the basic design of our nuclear powerplants since the disaster at Three Mile Island in Pennsylvania. New safety valves, water inlets and monitoring systems are now required, all aimed at eliminating the hazardous effects of a meltdown.

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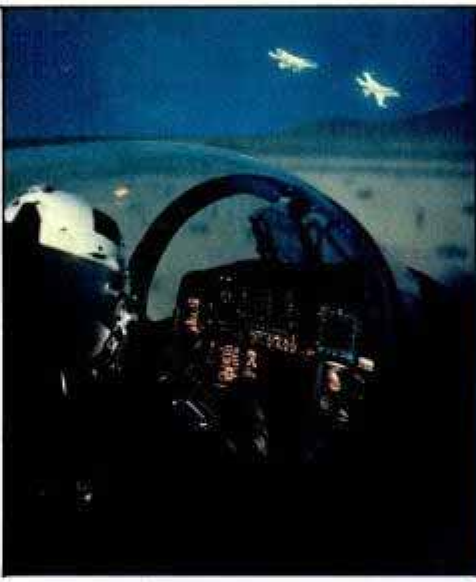
PM ILLUSTRATION BY ED VALIGURSKY. PHOTO BY SOVFOTO

TECHNOLOGY UPDATE 7/86

ELECTRONICS

Wraparound simulator

Fighter pilots will experience all the sights, sounds and feel of combat flying in this new simulator from Hughes. Not just target shooting at a movie screen, this F-18 mockup (right) is a complete 360° image of Earth, sky and targets. Pilots inside the dome (far right) can become hotshots with all the right stuff without bills for fuel and weapons, or dangerous accidents.

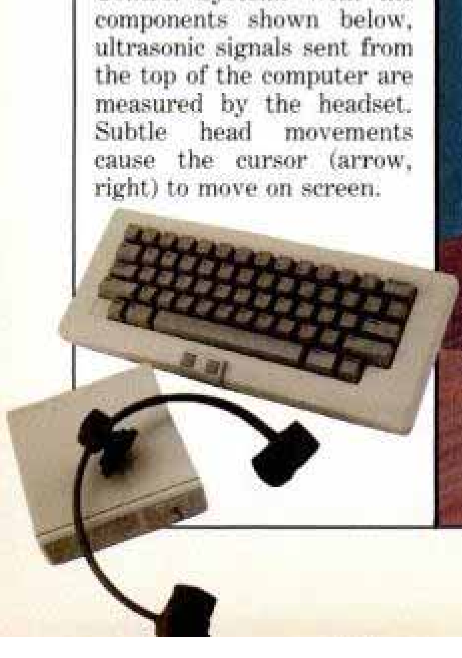


Big-screen war games

Training without mud, mosquitos or costly operations will be done on GE's new Compu-Scene IV visual simulation system. A computer provides color images from digitized data to project scenes or the landscape of specific targets. Screen view (left) could be used for tank crew training. Sky scenes would flash by a pilot's cockpit mockup.

High-tech headgear

Now, users of Macintosh computers can rearrange onscreen data with just a nod of the head using the View Control System. With the components shown below, ultrasonic signals sent from the top of the computer are measured by the headset. Subtle head movements cause the cursor (arrow, right) to move on screen.



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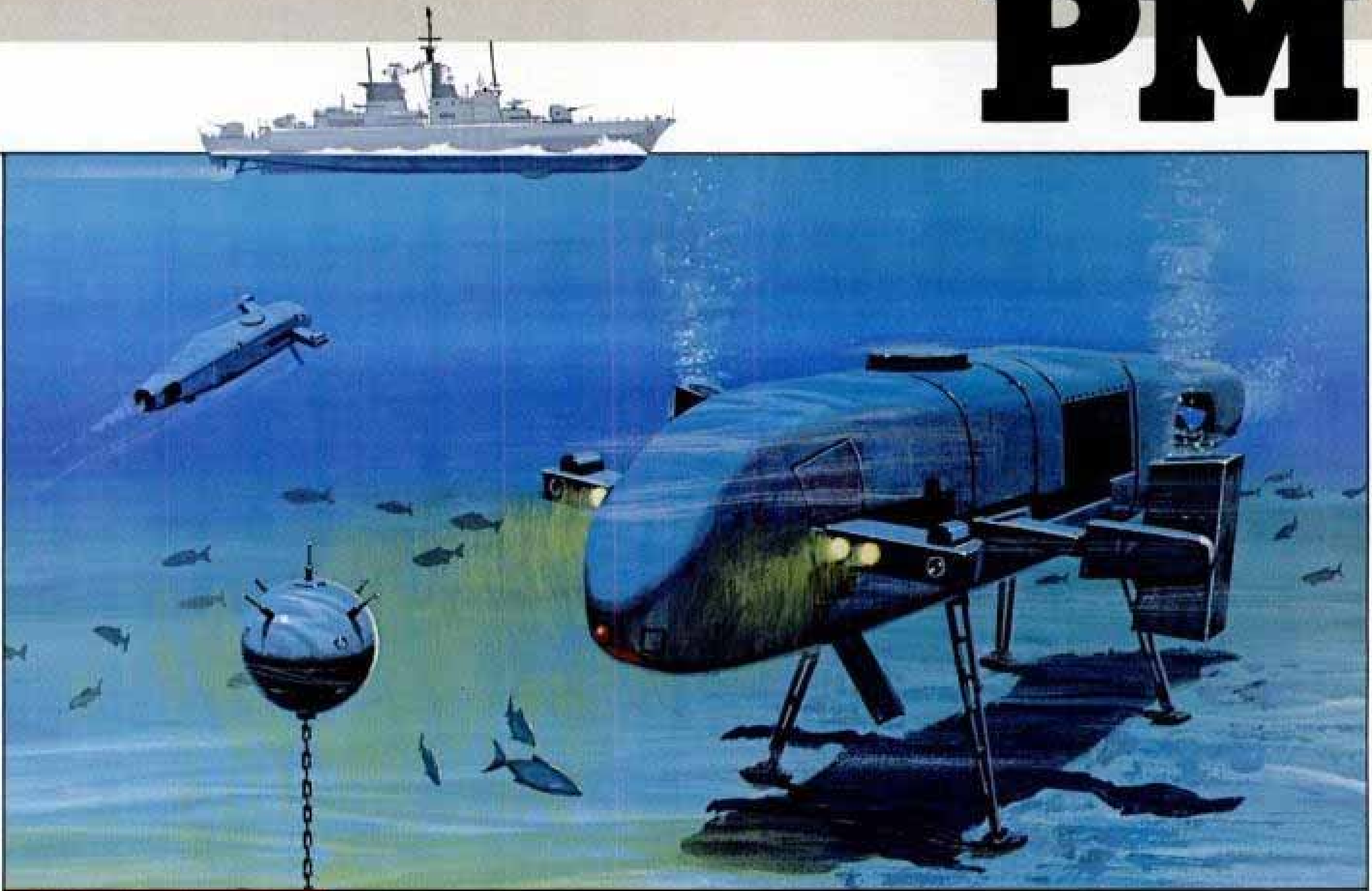


PM ILLUSTRATION BY ED VALIGURSKY

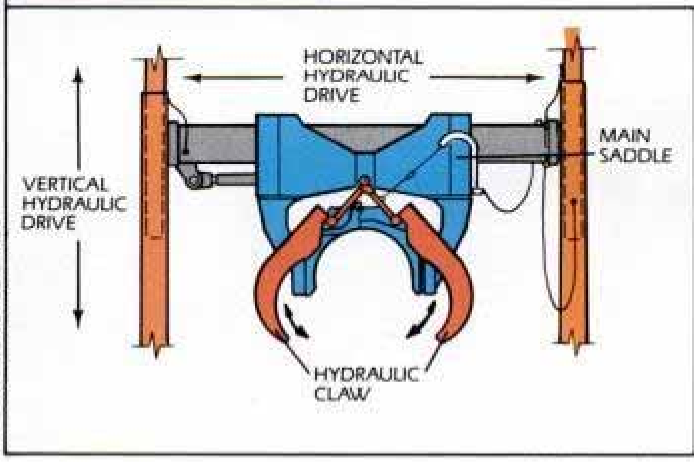
MARINE

Underwater spy

There may be more than just fish snooping about down in the world's oceans. A new military toy from Great Britain is already in swimming prototype. The Scicon Patroling Underwater Robot (SPUR) can navigate autonomously and communicate electronically to tattle or take orders. While mainly a snoop with its lights, videos and radar, SPURs could deactivate mines or carry torpedoes or explosives.

Underwater workshop

SUPRA, a German seagoing prototype is a robot, a mini-submarine, a diver's workshop and an underwater derrick. By remote control or with a crew of two, it can perform heavy underwater jobs, lifting up to 20 tons, that until now required surface ships. For pipeline laying and repair, SUPRA's claws (below) will make quicker, better work beneath troubled seas.



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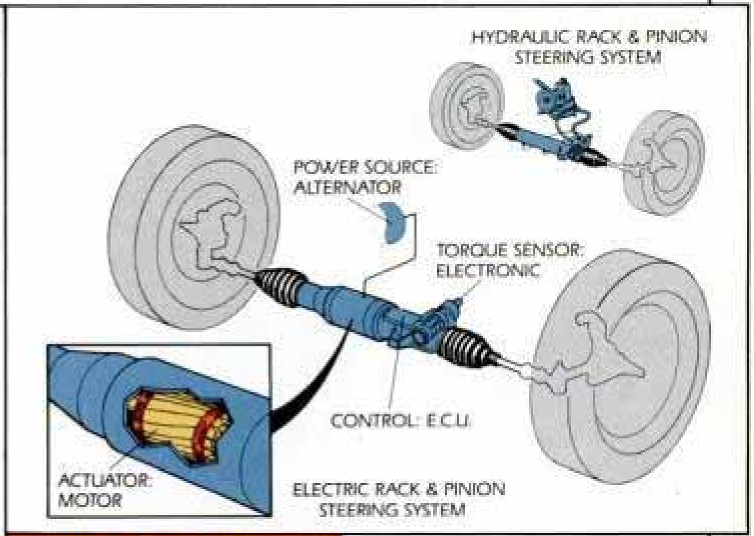


PM ILLUSTRATION BY HANK IKEN

AUTOMOTIVE

Electric steering

TRW may have borrowed from its sophisticated aerospace and military designers to develop this new, simple electronic steering system for the ordinary automobile. This modular system weighs and costs less, but is more responsive than conventional hydraulic power steering. The actuator, torque sensor and rack-and-pinion drive are faster than a human driver, and the system does away with the belts, fluid, pumps and hoses of traditional steering.

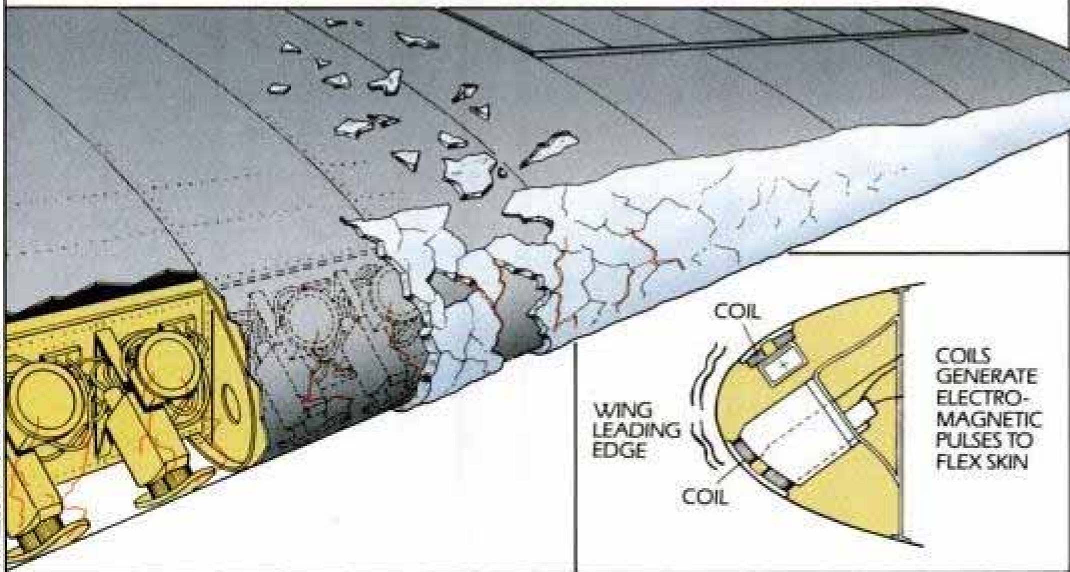
TECHNOLOGY UPDATE 7/86

AVIATION

Super Concorde

While many aerospace companies are talking about SST prototypes, a second-generation Concorde model is being tested by Aerospatiale. Due by 2000, the new Concorde will be faster, larger and twice as fuel efficient. The 200-passenger craft will have variable-cycle engines with a bypass mode for slower subsonic flight. Digital technologies and computer screens will do most of the work, as only a 2-man crew watches the cockpit.

PM ILLUSTRATION BY ED VALIGURSKY



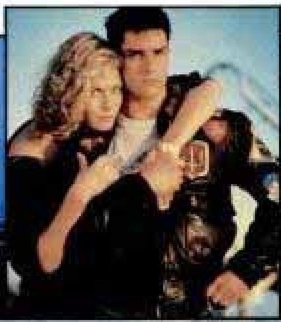
PM ILLUSTRATION BY HANK IKEN

Removes ice electrically

A new system being developed by NASA would fracture in-flight ice by electric shock. This electromagnetic impulse deicing (EID) system consists of a series of copper coils connected to high-voltage transformers. A millisecond's charge causes a leading-edge deflection with a force up to 10,000 G. In tests, a couple of these shock waves, or pulses, will completely deice a surface. EID is fast and safe, without the corrosion or fire danger of chemical systems.

An old bird flies again

The prehistoric pterodactyl flaps in the sky again with battery-powered muscles and an onboard autopilot. Paul MacCready's half-scale high-tech model is 18 ft. between wingtips but simulates the skin, feathers and flight abilities of the giant birds of 65 million years ago. By combining aerodynamics, electronics and paleontology, scientists can unlock the flight recorder of the past. Created from fossil details, MacCready's bird has been making special flights before making its final roost at the Smithsonian's Air & Space Museum.



MOVIES

In the pilot's seat

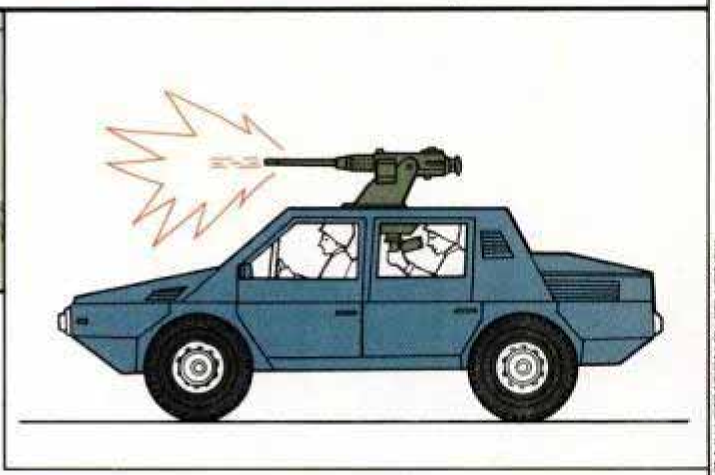
Combat flying is usually simulated in films, since these stunts are dangerous and too tricky to shoot. But in "Top Gun"—just released by Paramount—Hollywood pulled out every technological stop for the most daring aerobatics ever performed for a film. (Stars are Tom Cruise and Kelly McGillis, center left.)

NASA tracking cameras were mounted in F-14s, gimbaled cockpit cameras were hidden in F-5s painted like MIGs, and a specially modified Learjet chased the stunt fliers. Its Astrovision system had cameras shooting above and below its nose through special periscopes for film so realistic that when the jet buzzes or banks you duck in your seat.

MILITARY

Italian tank, sports model

Most armored security vehicles are large clunky tanks. This new Italian model zips around like a Maseratti and packs a Rocky punch. The Guardian is designed for VIP and airport security. It goes on land or water and has bulletproof glass and steel doors that withstand up to 30-cal. hits. Its steel inner tires roll even if the wheels are shot up. With the pop-up machine gun, this little car can be a big shot.



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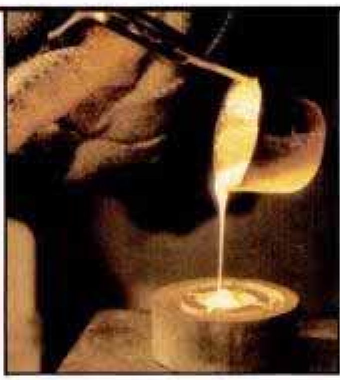
CHEMISTRY

Glass stores electricity



Glass that can store electricity in a superbattery has been developed at Argonne National Lab. Used to conduct sodium ions, this battery has the potential to store five times as much energy as a conventional lead-acid battery of the same weight. This could speed development of realistic electric road vehicles, machines for space and even electric powerplants.

ELECTRONICS

Foreman of the future

A new system from Hughes incorporates artificial intelligence into electronics manufacturing. Currently, when engineers figure out a better way, it takes weeks to change production. In 90 minutes, this computer system converts design data into new step-by-step instructions for the assembler, who can fabricate from onscreen instructions. TU

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Popular Mechanics
JULY 1986

Super-wide screens. Ultra-fine detail. Split-channel viewing. Picture-frame monitors. Television's future is racing through more channels than ever before.

FUTUREVISION

BY STEPHEN A. BOOTH, Electronics Editor
Illustration by Ted Lodigensky

B*ottom of ninth. The score is tied. Two outs. Bases loaded. The count's three-and-two.*

We all know it's the decisive pitch. All time stops. Sitting in your family room it seems that the playing field glows with a richer green now that the night lights are on.

There's the windup.

In the same fraction of a second the batter has to make his decision, the TV cameras have taken his image—composed of thousands of pixels—and put it right in front of you. You can see the perspiration. The knuckles around the bat go white.

Artist's conception of wide-screen, square-cornered, wall-mounted TV of future is seen above. Blocks of color to the left represent simplified picture elements (pixels) that make up details of the TV image. Future High-Definition TV will provide five times more pixels than today's TVs to deliver sharper detail, more realistic color.

Here's the pitch. He swings.

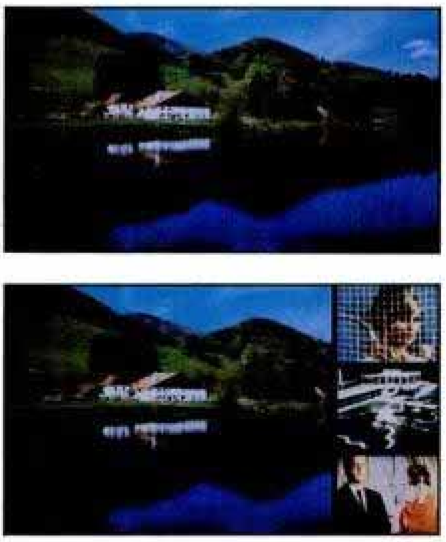
The crack of the bat pulses from left to right across the room. Your speakers wash you with sound as the stadium crowd roars.

The photo-quality images and hi-fi digital stereo sound in this experimental TV broadcast are harbingers of things to come. For the first time since color hit the airwaves, major changes are under way in television. Even the familiar receiver is under review: The

NOVABEAM PHOTOS BY LOU JONES

Image-enhancing (Faroudja) circuitry restores detail-rich high-frequency video signals often lost in transmission. Photo of Kloss Novabeam screen image (right) shows sharp detail in flesh texture, moustache and around eye. These are softer in photo (above) of unprocessed image.

Split-screen comparison of conventional TV (far right) and High-Definition TV (near right) shows HDTV's tighter image detail and more realistic color. That's because HDTV has more scan lines and pixels than regular TV.



Wide-screen TV pictures (top) can be sent by Scientific Atlanta's B-MAC system. So can conventional-size images (left side of screen, above). B-MAC will also allow multiprogram viewing on future wide-screen sets.

longtime dream of a flat, thin display you'll wall-mount like a painting is in various states of development in labs around the world.

The immediate goal is to improve TV's image resolution. Simply stated, that means putting more picture detail on the screen. Additional picture information would give TV's relatively crude, cartoon-like dot-and-line pattern more of the fine-pitched tones and sense of depth that a photo provides.

Beyond this, some proposed changes would alter the shape of the picture itself. The objective is a more natural field of view that corresponds to human vision. The solution: wider TV display, closer in proportion to screens you watch in movie theaters. Right now, one such proposal is being studied by an international standards committee.

High-Definition TV

The system proposed for worldwide adoption is called High-Definition Television (HDTV), developed by NHK—Japan's public TV service. Compared to what we watch today, it would deliver wider images with more detail.

Current TV display screens have a width-to-height ratio of 4 to 3. The picture itself is composed of 525 horizontal scan lines (625 in some countries). Dots of color (called pixels, for picture elements) populate each scan line. The number of pixels varies from set to set. The most recent (and expensive) sets pack in the most pixels per inch. It's the number of scan lines, and the pixel density in each, that determines how realistic a picture looks.

Japan's HDTV system would about double the number of scan lines—to 1125—and increase the width-to-height ratio to 5 to 3. This combination of greater line density and wider image would deliver five times the number of pixels compared to today's TV. The result, says NHK, is an image superior to 35mm motion picture film and approaching that of a 35mm slide.

HDTV's proponents say they arrived at the 5-to-3 screen proportions by studying human vision. For realistic perception, a 30° horizontal angle of view is best. With HDTV, this is possible when you watch from a distance only three times the screen's height: Possible because HDTV's high pixel count would prevent you from seeing grain in the picture. With conventional TV, you'd have to watch from seven times the screen's height to avoid seeing grain. This yields a 10° horizontal angle of view.

The 1125 scan lines in HDTV also derive from human vision studies. When you're sitting three times the screen's height from the set, your natural vertical angle of view is 20°, according to NHK. If you have 20:20 vision, your *minimal* angle of vision (the smallest area your eye can resolve) is 1 minute (1/60th of a degree). To prevent you from seeing the motion of scan lines as they change, about 1100 of them are needed.

Professional movie-making equipment exists for HDTV, and even home VCRs are being developed to handle the immense amount of picture information. But that very quantity of detail poses a problem for the format.

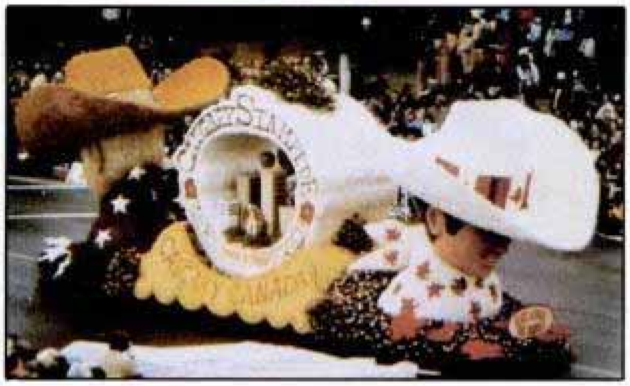
Specifically, the problem is how to transmit the information. There's too much of it for the existing broadcast frequency spectrum to carry. Satellite transmission is the answer, but this poses yet another dilemma.

Getting the picture

As it now stands, HDTV can't be received by current TV sets. An immediate switch to HDTV would make current sets and broadcast facilities obsolete. Most people would agree this isn't practical. So if HDTV happens at all, it will be in addition to terrestrial broadcast TV. Methods of transmitting HDTV and conventional TV simulta-

Flat, wall-mountable TV is still in development. Panasonic/Matsushita prototype (left and below) uses conventional cathode ray tube (CRT). Other experimental flat TVs use liquid-crystal displays to create image.

Panasonic/Matsushita TV (seen here on wall-mount display) has a 10-in. diagonal picture. Overall, it is 15 in. square by 4 in. thick and weighs 31 pounds. Larger screens are possible, though heavier. Flat LCD screens of same size still lack brightness and color complexity of CRT type.



Full-screen photos here show difference in width and picture detail between conventional TV (top) and High-Definition TV (above). The view above was zoomed with recently developed HDTV cameras. Studies say HDTV viewing angle is close to that of human vision. Meanwhile, 1125 horizontal scan-line structure prevents eye from seeing scan-line motion.

neously via existing broadcast equipment are being studied.

There already exists a system that can distribute conventional TV and the new, improved version when it becomes available. It's called B-MAC, developed by a Georgia company—Scientific Atlanta.

B-MAC—for Multiple Analog Components, B-type—is one solution to the dilemma of future programming and current TV obsolescence. It's transmitted by satellite but can be relayed by cable, or even terrestrial broadcast. It can be scrambled for pay TV and even carry teletext and personally addressed electronic mail.

It's possible to fit B-MAC's studio-quality picture and digital Dolby Stereo in the existing broadcast bandwidth because in B-MAC, the large quantity of picture information is compressed before transmission then expanded again at the receiver.

Right now, B-MAC is delivering conventional 4-to-3 ratio screen images, but with all the picture quality that leaves the studio. When TVs with extra scan lines and possibly wider screens become available, the format can transmit the improved images, too—while still serving homes with conventional TVs. According to Scientific Atlanta, B-MAC can even send pure *digital* video when its time comes—possibly in the late 1990s. Today, B-MAC is being used by the Australian public TV.

Transitional improvements

These high-quality TV transmissions won't happen overnight. Meanwhile, there's no lack of improvements in the works for conventional TV. Most of this takes place at the receiver, by reprocessing the incoming signal.

Digital TV sets (not transmissions) can effect substantial improvements (*Hi-Fi For Eyes & Ears*, page 82, Feb. '85). These include artificially doubling the number of horizontal scan lines, correcting color tones and eliminating multipath "ghosts." Digital sets with improved image quality should arrive on the market in the next year or two.

Analog signal processing is already in use, and likely to spread. One system that just made its debut in Kloss Novabeam projection TVs is the Faroudja circuit (named for Yves Faroudja, the inventor). In video, fine details are carried in the highest frequencies. Unfortunately, some of this detail is lost by the time a tape or broadcast program reaches your screen. What Faroudja circuitry does is reconstruct those subtle details to restore the image's original quality.

New displays

All of the foregoing outlines what you might see on your TV in the future. But what kind of display will you see it on?

For 40 years, experts have been predicting that flat, thin, wall-hanging TV is just five years away. You won't read that here—though it's closer than ever. In fact, there has been more progress made in the last five years than in the preceding 35.

Thin TVs of two types are under development now. One is the liquid-crystal display (LCD) similar to pocket calculators and current pocket TVs. The other is the familiar cathode ray tube (CRT)—without its current depth. LCD probably will arrive first, but CRT promises to look better.

In recent months, Japanese manufacturers have demonstrated LCD color screens 10 in. and larger. What they lack is the rainbow of colors now available in CRTs. While they look fine for still color graphics, they need more brightness and color tones to match the CRT. The manufacturers state this is possible—in five years.

Flat CRTs, by Japan's Panasonic/Matsushita and America's Lumitron, have those brightness and color problems licked. Matsushita's 10-in. diagonal color CRT (*Electronics*, page 32, June '85) measures about 4 in. thick and weighs about 30 pounds. Lumitron promises to weigh in the same with a 35-in. diagonal color model just 3 in. thick this year. For the time being, the company will supply military and commercial users—but a home version could be sold for $4000 in the 1990s. It's still a little too soon for these manufacturers to swing into production, but they've got their eye on the ball. **PM**

PM COMPARISON TEST

SPORT BOAT SEXTET

Six multi-mission sterndrives go bow-to-bow in our performance showdown.

BY TIM COLE, Boating/Outdoors Editor; Photos by Skip Gandy

You've got to be vaguely suspicious of a boat design purported to do everything well. But the recent crop of closed-deck, cuddy-cabin sterndrives confirms that some so-called "all-purpose" designs *are* capable of delivering on their somewhat hefty promise. You can haul a pair of waterskiers, probe shallow creeks, camp overnight in sheltered comfort, troll for fish with minor modifications to the lower unit, picnic with friends using molded-in ice chests and stowage, fly across open water at speeds approaching 50

Sterndrives go throttle up (from front to back): Cobia Sportster 197 SCV, Success 191, 4-Winns 195 Horizon, Regal Sebring 195 XL, Mark Twain MTC 195 and Century Palomino LTD.

A lightning-swift top end failed to mask the Regal Sebring's handling flaws.

mph or simply bask in the noonday sun. Indeed, with this batch of sportsters, life becomes a never-ending game of multiple choice.

Still, it's a rather humble design that permits these diverse recreational pursuits. You don't get some tricked-out drag boat with a disproportionate snout and fancy fantail. Nor do you find the acres of unobstructed deck space of a dedicated bass boat or center-console. These closed-deck cuddies are founded on simple, well-balanced hull lines. They possess an elegance and a simplicity that no doubt contribute to their "multi-mission" spirit.

You also get the performance and easy handling of sterndrive power—provided for PM's head-to-head comparison by MerCruiser, the world's largest producer of inboard/outboards. We selected Merc's new Alpha One 205-V6 for its optimal power-to-weight figures. The Alpha One outdrive sports several improvements, including advanced corrosion protection, a redesigned gear case and beefier power trim cylinders. We wanted the most power possible in order to yield hard facts about these boats across a wide performance spectrum—from low-speed maneuverability dockside to trimmed-out, flat-water flying. The Alpha Ones, prepped and broken in by Dave Martin and crew from Mercury's Mercabo Test Base in Placida, Florida, ran with nary a hitch through some hard, and frankly untypical, driving. The boat that came out on top achieved the best balance between comfort and performance.

Mark Twain MTC 195

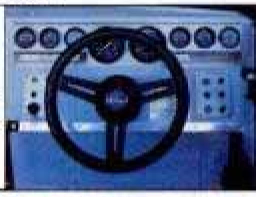
After a while, we started calling it the space machine. Its nicest feature, and there are a lot of nice features, is the incredible amount of sitting headroom in the cuddy cabin compared to its peers. The vee-berth is expansive, with a large rectangular footwell and wrap-around side-pocket stowage. Cuddy access is also improved by a removable

1. MARK TWAIN MTC 195	2. 4-WINNS 195 HORIZON	3. COBIA SPORTSTER 197 SCV
LOA/**18'9"** B/**90"** W/**3050** lbs. Fuel/**32** gal.	LOA/**18'10"** B/**92"** W/**2965** lbs. Fuel/**27** gal.	LOA/**17'7"** B/**94"** W/**2650** lbs. Fuel/**35** gal.
Stowage[1]: CP[2] /**27.04** CD[3] /**14.98**	Stowage: CP/**32.56** CD/**15.14**	Stowage: CP/**17.69** CD/**10.33**
Fewer compartments, but more "usable" stowage	Ample, well-positioned	Accessible but insufficient
Usable Area[4]: CP/**18.29** CD/**11.17**	Usable Area: CP/**23.85** CD/**16.6**	Usable Area: CP/**28.22** CD/**18.22**
Belowdeck spaces are this boat's strong suit	Intelligently balanced, even with box seats	Pedestal seat to starboard saves cockpit
Hull[5]: 4LY WR, 4LY CR, Spr. PU, Wd SS	Hull: 2LY WR[9], 3LY CR, Wd SS, Inj. PU	Hull: HLU 4LY M, 2LY CO, Inj.PU
Top End[6]: **46.8** mph	Top End: **48.6** mph.	Top End: **47** mph.
Acceleration from 0 to 40: **13.45** sec.	Acceleration from 0 to 40: **11.96** sec.	Acceleration from 0 to 40: **14.67** sec.
180° "Quick-Turn" Course: **31.11** sec.	180° "Quick-Turn" Course: **31.17** sec.	180° "Quick-Turn" Course: **33.52** sec.
Performance Course: **1:05.21** sec.	Performance Course: **1:05.58** sec.	Performance Course: **1:10.31** sec.
Handling[7] **1:** Tight steering; tracks well	Handling **2:** Tight tracking and fast	Handling **3:** Acceptable; full-throttle ease
Finish[8] **2:** Excellent glass and detail work	Finish **1:** Clean styling and super detail	Finish **5:** Suffers from inexpensive detailing
Price as tested: **$15,077**	Price as tested:**$17,526**	Price as tested: **$16,990**

The MTC's slow top end is counter-balanced by superb handling and dash. Helm doesn't hide gauges.

4-Winns' spritely performance is complemented by more contemporary instrument layout.

Speed indicator and tach are obscured by the steering wheel in the Cobia. Detailing is off.



1. Stowage is measured in cubic feet. 2. CP=Cockpit. 3. CD=Cuddy Cabin. 4. Usable area is measured in square feet. 5. Hull Construction key: HLU=Hand Layup, LY=Layer, WR=Woven Roving, CR=Chopped Roving, M=Mat, CM=Coremat, CO=Combo, Spr.=Sprayed, Inj.=Injected, FL=Foam Log, PU=Polyurethane, WD=Wood, FG=Fiberglass, SS=Stringer System. 6. Top End is measured through a quarter-mile fixed trap on flat water. 7. Handling is a

smoked-plastic lid that covers the companionway. While the MTC 195 turned in average but respectable performance figures, the boat's tremendous belowdeck space tilted the scales.

In the cockpit, the total usable area is on the meager side compared to the other boats we tested. But the designers have used it well, building in seating appropriate to the space. You get a sense of openness, and an unrivaled freedom of movement.

The MTC's cockpit arrangement necessitates the use of pedestal seating for the driver and navigator, which is not exactly desirable in rough water. But Mark Twain has taken the time and energy to bed them properly to the sole (unlike other makers).

The engine compartment adds an unobtrusive ingredient to the MTC's cockpit layout, and port and starboard seats in the stern are elevated to engine box level, creating an ingenious athwartships bench seat.

The reason the Mark Twain works so well is its slightly higher freeboard vis-a-vis the rest of the fleet we tested, along with a deck raised significantly above the norm. But the boat doesn't look boxy by any means, and the performance impact of these design elements is interesting. A higher helmsman's position and a higher CG translate into a feeling of power and grace in hard turns.

While it was by no means the fastest boat in our test (and speed, while important, is not our ultimate criterion), it carved around the turns with alacrity, leaving a very confident impression. The downside? It liked to pitch spray into the cockpit during *really* hard cornering.

The 4-Winns 195 Horizon earned high marks in layout, detailing and performance.

4-Winns 195 Horizon

In most PM boat performance evaluations, the No. 2-ranked boat usually misses No. 1 by a veritable whisker. And this test was no exception. Maker 4-Winns has produced a well-handling,

4. SUCCESS 191	5. REGAL SEBRING XL 195	6. CENTURY PALOMINO LTD
LOA/**18'9"** B/**90"** W/**2795** lbs. Fuel/**24** gal.	LOA/**18'11"** B/**92"** W/**2825** lbs. Fuel /**26** gal.	LOA/**19'6"** B/**91"** W/**3380** lbs. Fuel/**31** gal.
Stowage: CP/**20.80** CD/**21.52**	Stowage: CP/**20.91** CD/**19.02**	Stowage: CP/**15.09** CD/**15.34**
Triple-tier side pockets along gunwale	Standard fare; under sole space appreciated	Skimpy, particularly in gunwale area
Usable Area: CP/**31.39** CD/**16.59**	Usable Area: CP/**31.74** CD/**16.25**	Usable Area: CP/**21.86** CD/**21.37**
Raised deck offers minor gain in cuddy space	Cockpit space ample; vee-berth average	Extremely crowded cockpit; hard to move
Hull: 3LY WR, 4LY CR, Spr. PU, Wd SS	Hull: 3LY WR, 5L M, FL PU, Wd SS	Hull: 4LY WR, 4LY CR, 1LY CM, Spr. PU
Top End: **50.4** mph.	Top End: **52.3** mph.	Top End: **48.6** mph.
Acceleration from 0 to 40: **10.36** sec.	Acceleration from 0 to 40: **10.25** sec.	Acceleration from 0 to 40: **14.83** sec.
180° "Quick-Turn" Course: **29.09** sec.	180° "Quick-Turn" Course: **31.84** sec.	180° "Quick-Turn" course: **31.46** sec.
Performance Course: **1:02.93** sec.	Performance Course: **1:07.78** sec.	Performance Course: **1:12.58** sec.
Handling **4:** Corners rough; feels top heavy	Handling **5:** Fast but very unresponsive	Handling **6:** Extremely poor acceleration
Finish **3:** In the ballpark	Finish **6:** On the rough side in glass/details	Finish **4:** Adequate
Price as tested: **$14,245**	Price as tested: **$15,429**	Price as tested: **$18,980**

Success's wood steering wheel with finger grip was well received. Offset switches make sense.

The Regal's dash design works nicely. The boat's styling is also a strong point.

Century's steering wheel hides speedometer and tach. Crash pads impinge on panel switches.

subjective ranking, plus comments, of steering ability and speed in a variety of wind and sea states. 8. Finish is a subjective ranking, plus comments, of glasswork and detailing in addition to an evaluation of how well components like snaps, opening ports and stowage access doors work. 9. Woven roving lapped at keel and chine. All performance tests were staged with an MPH K-15 X-band radar gun and a Heuer digital stopwatch.

nicely proportioned boat in the 195 Horizon, but there's no step-through windshield offered standard, and that reduces overall management of this boat substantially. The manufacturer has compensated with an oversize deck hatch (at 2.38 sq. ft., the largest we measured) that one is presumably supposed to use when moving aft. But in a pinch, the first mate hardly cares for a descent through the cuddy cabin after casting off dock lines. And moving over or around the windshield to get to the cockpit is a decidedly precarious proposition.

But on to the positive side. It handles as nicely as the Mark Twain, and it's significantly faster, offering tight, speedy tracking through our convoluted performance course and jumping onto plane with brisk authority.

In addition, 4-Winns' new dash layout is clean, easy to read and innovative, and cockpit sunloungers (which, unlike the Mark Twain's pedestal arrangements, can be converted into sleeping platforms) don't interfere with freedom of movement. There are also enough stowage nooks under the gunwale and in the cockpit sole to satisfy you nautical pack rats.

Cobia Sportster 197 SCV

The notes from our performance course read "similar to the 4-Winns in many ways." The Cobia enjoys the same kind of brisk, consistent handling as the 4-Winns, and moves onto plane with no-nonsense determination. More importantly, a half to a full second is all that separates the Cobia's fastest and slowest runs in our performance courses, which means, in the most objective terms we know, that she's a truly consistent handler.

As with the 4-Winns and the Mark Twain, there are no eccentricities to puzzle out in the tight spots.

Belowdeck space and stowage is adequate, although cuddy cabin headroom is barely sufficient (not to single out Cobia unfairly here; all the boats save the MTC 195 suffered in this category). But Cobia has opened up the cockpit by using a box sunlounger to port and a space-miser pedestal seat for the driver. This arrangement intelligently compromises space and comfort. These laudable fine points notwithstanding, the Cobia suffers in the detailing department. The folding cuddy access doors are rather pedestrian slabs of fiberglass and don't compare well to the louvered teak her peers employ. The sunlounger mechanism broke after 3-minutes' use. We wondered what would be next. We also wondered why one of the lightest boats in the test failed to turn in quicker performance numbers.

Success 191

The Success 191 was one of the big surprises at the PM sterndrive shootout. This well-built, well-proportioned boat is made by Mel-Hart Products of Conway, Arkansas, an up-and-comer in the competitive marine industry. There's plenty to like about their cuddy cabin entry, yet she's dogged by a few subtle imperfections that require closer scrutiny. For instance, the cuddy on the Success 191 is raised higher than most, which looks flashy from the outside, but, strangely, fails to translate into any appreciable increase in headroom on the inside.

Quibbling aside, the Success enjoys some really positive points that can't go unmentioned. Her cockpit space is designed around a very secure box-type pedestal (far superior, we think, to the metal post-type pedestal found on the Mark Twain) with a sunlounger to port. This arrangement (used by the Cobia and the Regal as well) opens up the cockpit dramatically.

Testers scope out MerCruiser's Alpha One sterndrive package.

The Success 191 also turned in some truly astonishing performance figures: in addition to a 50-plus top end, she beat all-comers in our quick-turn and performance courses. But speed *must* be complemented by good handling. The Success 191 felt really skittish in the corners.

Regal Sebring XL 195

We expected a lot from the Regal and the Century, the last two boats in our ranking, and we confess to being very tough on them when they failed to deliver.

The Regal, for starters, registered an impressive top end in the quarter mile, winning this segment of the test with a speed of 52.3 mph. The Sebring also copped the acceleration test, which indicates that this boat is a real champ in a straight line. But the boat's speed through our quick-turn and performance courses was a real disappointment. The Mark Twain, with a signficantly slower top end, beat the Regal easily in these two all-important handling evaluations. Her extremely sloppy steering was no doubt the culprit. The driver's pedestal seat also collapsed through one turn, which helped shade our opinion. In rough seas, the Regal came down hard and unevenly after exiting the water, and too much bouncing produced some rather unseemly vibrations and rattles.

Century Palomino

Here's a case of form interfering with function. The Century Palomino LTD was probably the sexiest boat in our test, with a commodious cuddy cabin (at 21.37 sq. ft., the largest measured) and rakish foredeck, culminating in a plush cockpit. But the dual sunloungers in the cockpit severely restrict movement, butting a paltry knee's width against the two stern jump seats. The sunloungers also impede access to the gunwale stowage port and starboard. You can't even open the liquor cabinet all the way without smashing into a seat.

In addition, we found that all the Century's cuddy cabin space really isn't necessary. The Mark Twain gets by with far less square-footage in the vee-berth, which allows more cockpit room. The Century's added cuddy space results in a longish foredeck, which, when coupled with a very poor time-to-plane figure (see chart), limits visibility out of the hole pretty severely. It takes a full five seconds to move from a standing start to a planing condition—five seconds of hopelessly obstructed vision from the helmsman's position. Add to these deficiencies the slowest acceleration time and the slowest time through our performance course and you wind up with an unexpected disappointment.

But, as with most boats that undergo the PM performance test, the differences we found in our covey of sterndrives were functions of shading, tone and emphasis. With any kind of boat that tries to do a lot of things well, design becomes a balancing act. **PM**

STERNDRIVE MANUFACTURERS

1. Mark Twain Marine Industries, P.O. Box 276, West Frankfort, IL 62896; (618) 932-3148
2. 4-Winns Inc., 925 Frisbie St., Cadillac, MI 49601; (616) 775-1351
3. Cobia Boat Co., P.O. Box 1857, Sanford, FL 32771-1857; (305) 322-3540
4. Success, Mel-Hart Products Inc., 1052 Harrison St., P.O. Box 43, Conway, AR 72032; (501) 327-6501
5. Regal Marine Industries, 2300 Jetport Dr., Orlando, FL 32809; (305) 851-4360
6. Century Boat Co., 1009 Manistee St., Manistee, MI 49660; (616) 723-9975

Goodyear's future blimp will have a fly-by-wire control system, an advanced cockpit and engines that will make it the fastest airship flying.

SILENT RUNNING

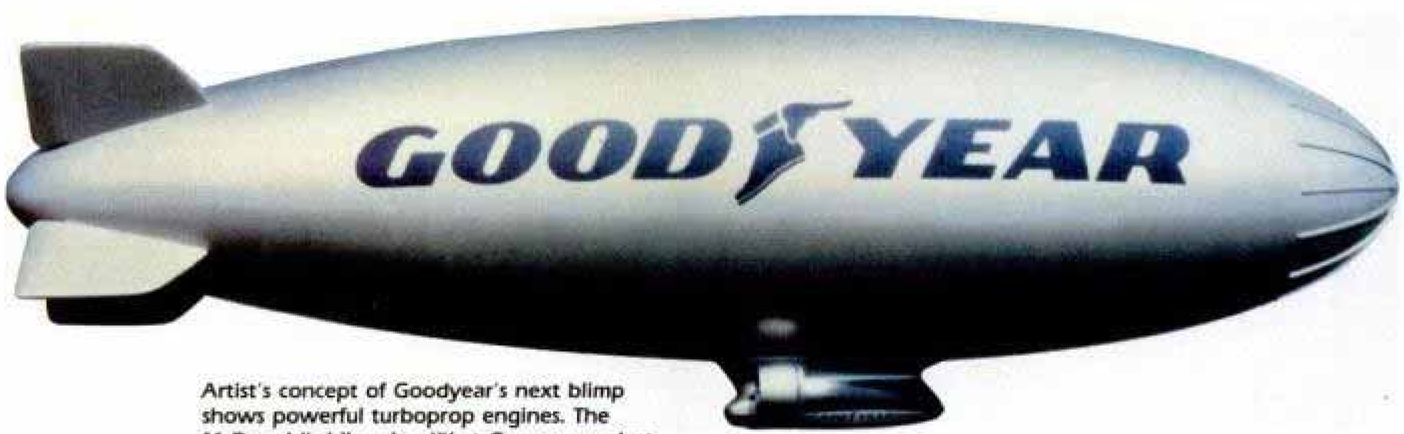
To the military, they're a target that's hard to find. For TV, they're a stable camera platform. Advertisers need them to wave the flag. Airships are back, and they're on high-tech wings.

BY DENNIS ESKOW, Science/Technology Editor; Illustrated By Alan Gutierrez

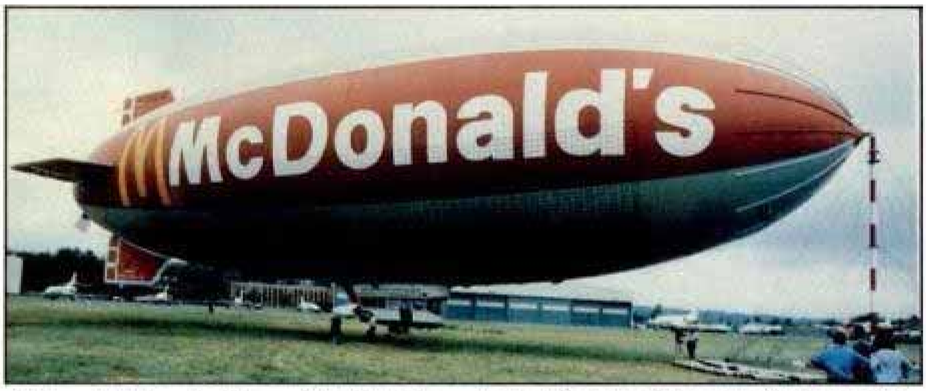
The men on the bridge of the fleet communications ship stood silently, watching for a blip on the screen. There was none. A junior officer exchanged glances with the captain, nodded, then called the vessel's communication center. "We don't have it," he said over the ship's telephone. "Do you have it?" There was a moment of silence. The junior officer heard something he didn't like, then barked: "Well, you keep looking, because there's no way you can hide something that big."

He slammed down the receiver, and before he could catch his breath, he saw the rest of the officers running to a window. There it was, slipping over the horizon. An airship. Flying at just under 1000 ft., the British-made Skyship 500 carried a crew of six and internal radar. Why didn't it show on the radar? Because the Skyship's gondola is made of Kevlar, the envelope is of polyurethane fiber and it's filled with helium. They all have little or no radar register.

The breathtaking demonstration flight, held off the



Artist's concept of Goodyear's next blimp shows powerful turboprop engines. The **McDonald's blimp is a West German product with a high-tech animation board for ads.**



North Carolina coast last summer, confirmed the military value of airships. They will make radar platforms that are practically undetectable. The British and French navies already have ordered airships for their fleets. The U.S. Navy is studying the future of airship coastal patrols, something America relied on in World War II.

After the war, airships fell into obsolescence. Coastal patrols were performed by high-performance aircraft and helicopters. These were picked up on radar more readily than airships. But we weren't at war, and rescue missions required quicker aircraft.

Even before airships came back onto military drawing boards they were beginning to make a comeback commercially. They offer a stable platform for television cameras, and the Goodyear blimp over the past 20 years has become the ever-present symbol of network televised sports.

The blimp has given television a perfect perch from which to shoot the action. And it has given brand-name recognition that is so strong, scores of other big companies have rushed to follow Goodyear's lead. Recognizing the resurgence in airship interest, Goodyear is in the midst of a multimillion-dollar development program for the blimp of the future. And European rivals are cranking out new high-tech airships at a machine-gun rate.

"The new airship will be a state-of-the-art demonstrator of what a lighter-than-air vehicle can be," says Goodyear Vice President Fred Nebiker. When it starts flying next year, the high-tech blimp will be lifted by a 2-ply, rubber-coated, polyester bag filled with 248,000 cubic feet of helium. It will be the first airship powered by turbine engines—a pair of 420-hp Allison turboprops. Its fly-by-wire control system uses electrical (wire) connections instead of mechanical and hydraulic linkages. Put all the elements together, and the next Goodyear blimp will be the fastest (70-knot top speed) and highest flying (12,000-ft. operational ceiling) of all the airships in the world. But the Goodyear blimp will hardly be alone in the skies of America. Take Airship Fuji, a Skyship 500. The 164-ft.-long Fuji blimp, which speeds along at 55 knots, will be seen all summer around major-league baseball parks. The Fuji ship is the official videotaping sky platform of baseball this year.

Carrying a crew of 10, the Fuji airship is equipped with three camera booms and cabin computers to help point both the ship and the cameras electronically. It is powered by twin Porsche 911 6-cylinder engines. The ducted propellers, while providing less power than the planned Goodyear turboprops, remain part of the most fuel-efficient powerplant in the airship business. The Fuji airship usually operates at 1000 to 5000 ft., but it can squeeze up to 10,000 ft.

The makers of the Skyship 500—Airship Industries—have spun out a bigger and slightly faster vessel in the Skyship 600. The 600 has a top speed of 60 knots and can carry a load of almost 3 tons, bigger than any other airship in service today. Pan Am and others have been using the Skyship 600 to carry up to 18 passengers on short trips around London and other European cities. Tourists take the short hops mostly for the view. Airships are still a long way from becoming fast enough to be used as passenger transports.

The British firm by next year will begin testing a prototype of its Skyship 9000, a vessel that may open a new market in the air transportation field.

The Skyship 9000, with its planned 900,000-cu.-ft. airbag, will be able to carry more than 30 tons. Early concept drawings suggest the ship will go with a scaled-up model of its present ducted fans. Its speed is expected to match the futuristic Goodyear blimp, but there are unanswered questions about its feasibility. The largest concerns the size of the airbag. Will a ship of such great dimensions be able to maneuver safely? Will its large surface area put so much strain on the powerplant that speed projections will fall through? Only building the prototype will tell.

The Skyship 9000 is being offered to the British navy as a super radar platform. Officials of the Royal Navy have withheld comment pending testing.

A West German airship builder has thrown everything into its entry. Airship International has come to America with the McBlimp, a 193-ft. behemoth flying the colors of the McDonald's hamburger chain. Lofting to 10,000 ft. with a 211,888-cu.-ft. airbag, the McBlimp has twin Rolls-Royce Continental engines. It cruises at 35 mph, but can get up to 60 mph in a favorable wind. Like Goodyear, it uses rubber-coated polyester fiber for the bag.

Most of the features of the McBlimp are from established technology. But Airship International has thrown in a super graphics computer that runs the blimp's sign. The 118- by 29-ft. McBlimp sign uses 8500 blue, green, red and yellow lamps to depict mes-

sages and animated cartoons. It's all in fun. But it's big business, too, and McDonald's, which used the McBlimp for the first time last summer, is reported shopping for a second airship.

So far, the biggest customers have been companies wanting a mobile billboard. But one good push from a military contract may launch airships into a new generation of technologies.

France, earlier this year, may have fired the starting gun in the airship technology race by announcing that its coast guard would use airships in rescue operations—not just as radar platforms, but for the rescues themselves. The Skyship is equipped with a lightweight speedboat tucked under its gondola. In a rescue, the airship moves in on the search area and comes down to just above the surface. The speedboat is dropped with a 2-man rescue crew. Up to six passengers can be taken aboard and delivered to shore or a rescue ship. The French are reported working on a recovery system that would allow them to hoist the boat back into the gondola of the airship.

On an even more serious note, the U.S. Navy has contracted with Goodyear Aerospace, Sperry and Litton to come up with retrofits for mothballed airships or new systems for futuristic vessels. The primary use of future airships would be to detect the launching of cruise-type missiles from submarines. Such missiles, launched into very low altitude trajectories, would be almost impossible to detect.

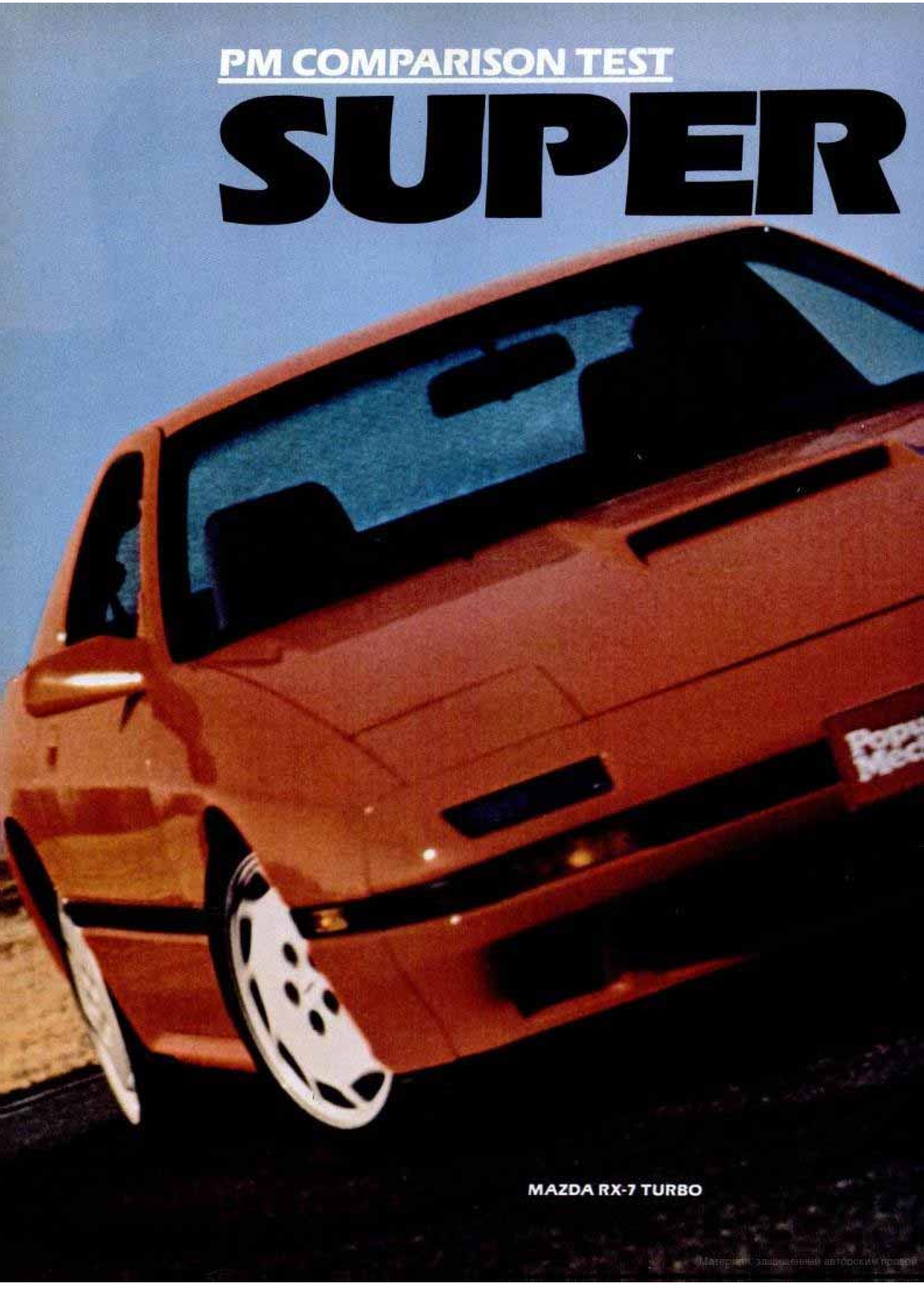
"The Navy needs to spot them soon enough to react," says Don Marco, Navy airship program director at Goodyear Aerospace. With advanced turboprop engines, the future airships of the Navy could develop speeds exceeding 80 mph. But the next-generation ships would sip fuel. And they would stay operational for months at a time.

As these are developed for military use, it is not too farfetched to predict that airships of the next decade may even be used for trans-Atlantic passenger service. PM

The Fuji airship (top) is a British-made vessel designed as a camera platform. Pan Am and others have used the Skyship 600 (above) with ducted-fan engines. It carries passengers on tours over European cities. Gondola (left) is of Kevlar. Another artist's concept (below) shows an airship as a radar platform. Goodyear is working on an antisubmarine blimp.

PM COMPARISON TEST

SUPER



MAZDA RX-7 TURBO

COUPES

TOYOTA SUPRA

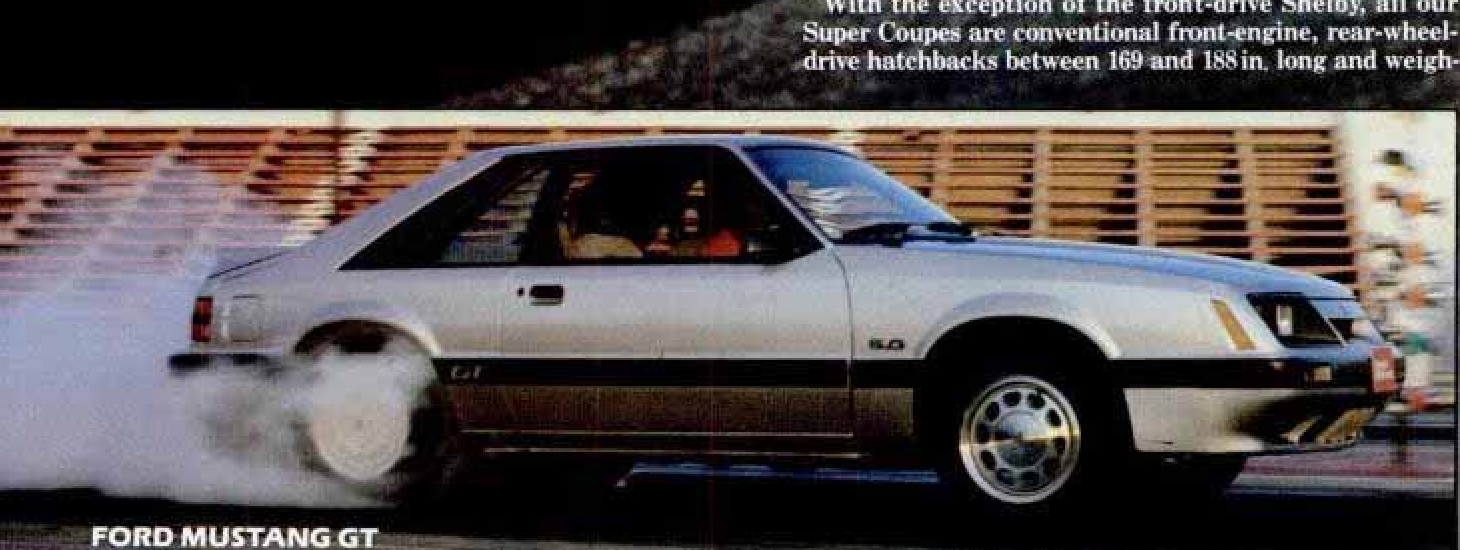
We check out nine sports coupes to see who's hot and who's not.

You want excitement? We'll give you *excitement!* Driving even the worst Super Coupe in this test is like driving a miniature Ferrari. And the best of them? Well, the winner is one of the most competent automobiles you can buy in America in 1986, judged by any standard you care to name. It's so good, there's nothing you could do to improve it.

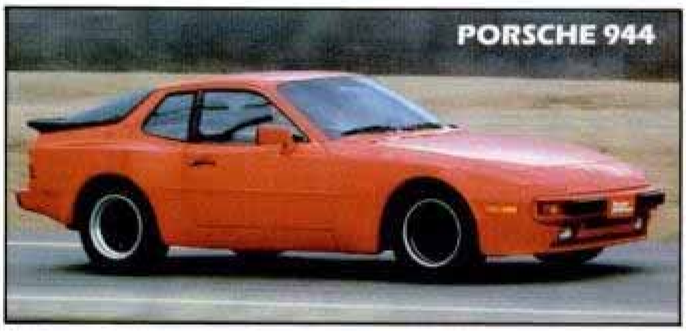
These Super Coupes absolutely tore up the track. As a group, they posted the highest performance averages we've ever seen, and the winners set records for PM testing. We haven't turned a low 14-second quarter-mile since musclecars died 15 years ago, while .90 G cornering has previously been uncharted territory for a street machine.

There are two all-new cars in this group (Mazda's RX-7 Turbo and Toyota's Supra), a few partly new cars (Mitsubishi's Starion ESI-R, Chevrolet's 350 Camaro, Nissan's 300ZX Turbo and Ford's fuel-injected Mustang GT) and three cars that have become automotive icons by remaining the same year after year (Porsche's 944, Alfa's GTV6 and Dodge's Shelby Charger).

With the exception of the front-drive Shelby, all our Super Coupes are conventional front-engine, rear-wheel-drive hatchbacks between 169 and 188 in. long and weigh-



FORD MUSTANG GT



ing 2800 to 3600 pounds. Under the hood is where they differ. Virtually every popular engine type is represented in this group, including two different V6s, two V8s, a dohc Six, turbo and nonturbo 4-cylinders and even the first turbocharged Wankel rotary. The only feature these engines share is tire-shredding horsepower.

As usual, we did our track testing at Raceway Park in Englishtown, New Jersey, followed by two days of back-to-back driving around our standard road loop near Princeton, New Jersey. Every tester drove every car, then ranked them in order of preference, price no object. The average of their rankings was averaged with the track results to produce our Overall Rating.

All of these cars are good, but some clearly are better than others. Those are the ones that, because of their combination of performance, styling, status and panache, truly deserve to be called Super Coupes.

Mazda RX-7 Turbo

There's not a single thing wrong with the RX-7 Turbo. Everything is right. We predict it will handily displace Porsche's 944 as the "target car" for other manufacturers in the Super Coupe market.

To the basic RX-7, the Turbo adds 36 hp plus heavy-duty suspension parts and Eagle GT tires on 16×7-in. alloy rims. Mazda's unusual intercooled turbo, with dual-scroll passages, comes on line at a low 2000 rpm, so the extra power is available at just about all speeds, right up to the Wankel's impressive 7000-rpm redline. There's no discernible turbo lag, and the rotary is still uncannily smooth.

The Turbo is a beast when you push the pedal to the metal. A 14.97-second quarter-mile at over 93 mph is nothing to sneeze at for an engine that nominally displaces 1308 cc. There are quicker cars—two of them are in this test—but none with the Turbo's combination of brute force and sophistication. The RX-7 Turbo is equally sweet to corner. Its 63.60-mph slalom speed is one of the fastest we've ever seen, and the Turbo's .90-G skidpad performance is the best we've ever recorded on OEM street tires.

The RX-7 also set a new 60 to 0 stopping record at 107 feet. Even when we factored in the Turbo's miserable 13-mpg fuel consumption—the thirstiest in this group of thirsty cars—it was still the dominant winner in our track testing.

Unlike some winners at the track, the Turbo is also a winner on the street. All too often, high performance comes at the expense of comfort, function and everyday usefulness. The RX-7 Turbo is not a "narrow focus" racer, but a "broad focus" street machine. As our track test driver put it, "It's an animal on the track, but the Turbo is also a well-balanced car that would be fun to drive every day at any speed."

The RX-7 interior is a cross between the austere functionalism of the 944 and the baroque technology of the Supra. You can find all the electronic gizmos you could want, but Mazda's engineers have clearly put more energy into the ergonomics of the seats, steering and instruments than they have into the cleverness of the radio knobs. The little RX-7 also swallowed more grocery bags than any of its competitors, thanks partly to its lack of rear seats. The normal RX-7 is available with a pair of 2+2 seats in the back, which we think should be optional on the Turbo as well.

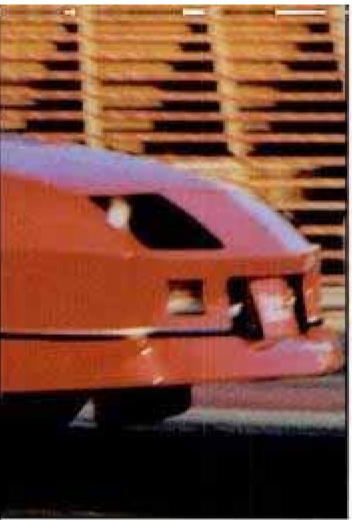
Ford Mustang GT H.O.

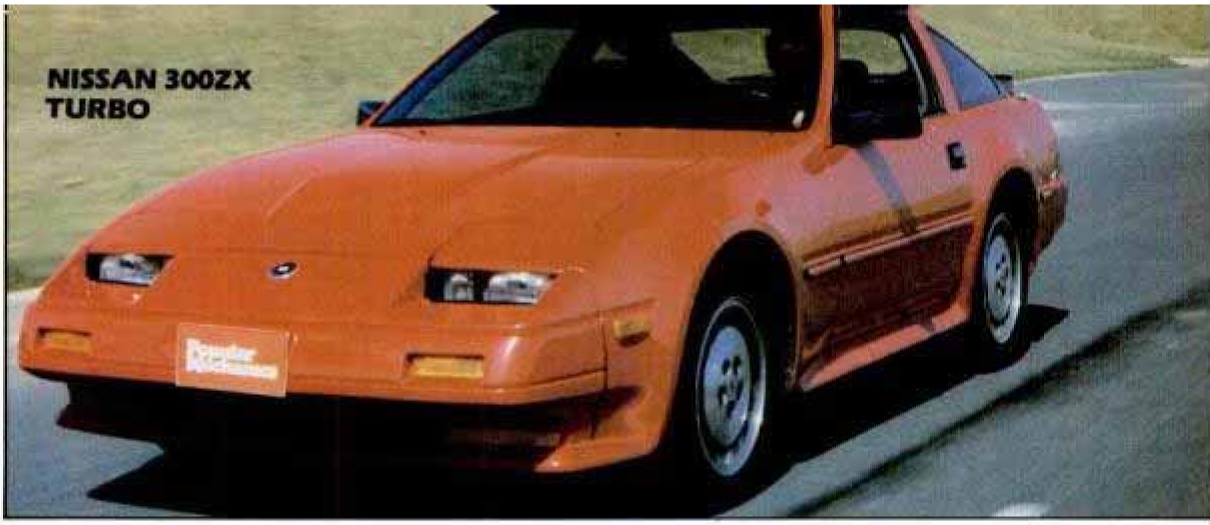
Ford's inexpensive Mustang GT—as rock-simple a car as has ever been built—decisively outperformed some much more expensive and pretentious machinery to finish a close second behind the sophisticated RX-7 Turbo. As one of our enthusiastic testers put it, "The Mustang is crude, rude, lewd—and I love it! This car just wants to be *bad*." To pick another word, it's *fun*. There is nothing you can buy for under $15,000 that offers the Mustang's adolescent blend of performance and tail-wagging enjoyment. If this car won't put a smile on your face, you need to have your cheeks lifted.

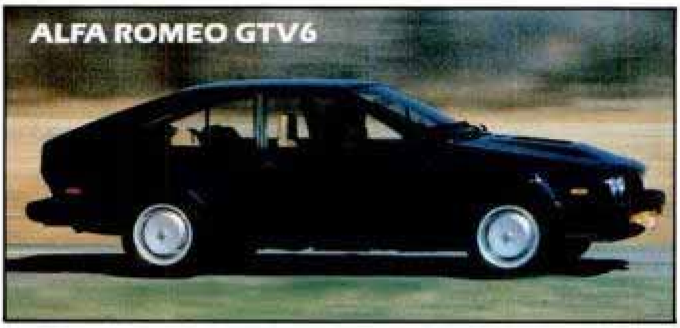
Our Mustang turned in an excellent 14.84 seconds at 91.74 mph in the quarter-mile. The time-honored 302 V8 now has fuel injection, which drops the horsepower from 210 to 200, but adds mid-range torque. Any carburetion hesitation is gone, replaced by an easy-revving surge of power transmitted through a slick-shifting 5-speed. As one tester said, "This is the kind of power that made America famous."

The Mustang shows its age in the corners (remember, this chassis started out 10 years ago as the Fairmont). It ambled through the slalom at 58.72 mph, and slid around the skidpad at an average of .80 G. Braking distances, too, were mediocre. A few years ago, such performance would have

PRODUCED BY THE PM AUTO DEPT.; TEXT BY RICH TAYLOR; PHOTOS BY HUMPHREY SUTTON







been world-class. Nowadays, it's merely okay. Still, the Mustang feels solid and stable at almost any speed, and it fairly begs to be thrown around like a car half its size.

The all-gray GT interior is identical to that in the ill-fated SVO Mustang, which means it's surprisingly European in ambience. White-on-black instruments live in a black plastic dash, and the softly sculpted black steering wheel might have come right out of the Merkur. The Mustang is all-American right down to its roller cam and dual exhausts, but the interior speaks a foreign language.

Unlike the perfect RX-7 Turbo, there are some things we'd improve on the Mustang GT. The "too light, too little feel" steering is especially annoying when you're trying to drive fast. And everyone criticized the shallow, unsupportive bucket seats.

Our testers were willing to put up with the Mustang's minor discomforts in order to enjoy its performance. There's more fun per dollar than any car you can buy. It's reliable and easy to fix and has a nice image and a great V8. The old-time hot-rod is refined for the '80s. The Mustang GT is the best performance bargain in America.

Toyota Supra

Toyota's all-new Supra is just a turbo and stiffer suspension away from being one of the great all-time Gran Turismos. As our track test driver put it, "This car reminds me of Jaguar's XJ-S V12. It feels big and soft, but it's capable of phenomenal over-the-road performance. It's a handful on a racetrack, but the perfect car for commuting from New York to Florida."

On the spec page, the Supra is one of the most advanced cars in production. The double-overhead-cam Six has been enlarged to 3 liters. With fuel injection and four valves per cylinder, it produces horsepower like an electric motor—from idle right up to redline without a pause. The chassis is a very model of a modern Super Coupe, with a really excellent 5-speed gearbox, all-independent suspension, 4-wheel disc brakes and electronically adjustable suspension.

Unfortunately, all this adds weight. At 3600 pounds, the Supra weighs 350 pounds more than the V8 Mustang. This extra weight hampers performance and gives the car a ponderous feel at low speeds. The Supra has more dials and gadgets than a 747, but once you've gone through the ground school, they mostly make sense. *Everything* inside is either electrically powered, adjustable, automatic—or all of the above. Even the radio equalizer is preprogrammed with curves for jazz, classical and rock.

"Anyone from Quasimodo to Arnold Schwarzenegger could get comfortable in these seats," said one tester. "Infinitely adjustable and lots of headroom." The rest of the controls are equally well planned, with excellent steering, shifting and ergonomics.

Toyota has already announced a forthcoming turbocharged version of the Supra, which should answer our testers' cry for more power. We recommend at the same time that they scrap the complicated TEMS adjustable suspension and replace it with one that's at least as stiff as the current SPORT setting. As one tester put it, "Why bother with TEMS when the SPORT setting is what you want 100 percent of the time?"

The Supra is superbly built, beautifully finished, surely reliable and extremely competent. All it lacks is verve.

Chevrolet Camaro IROC-Z 350

Driving this Camaro makes a trip to the grocery store an adventure, and a cross-country drive sets your heart aflame. What we're talking about here is engine. This fall, Chevrolet will offer '87 Camaros with the 5.7-liter V8 from the Corvette. In theory, the engine loses 15 hp because of a more restrictive exhaust system, and the Camaro weighs nearly 200 pounds more than the Vette. Our test car was a pre-production prototype supplied by Chevrolet, and it was 0.4 seconds quicker and 2 mph faster in the quarter-mile than the best Corvette we've tested. Its 14.44 seconds at 95.44 mph is the best quarter-mile run we've seen in years. We'd say the car you buy will be doing well to run 15 seconds at 93 mph.

The Camaro 350 is fitted with P245/50VR16 Eagle VR50 tires and a front sway bar as big around as your wrist. This combination makes for a stiff ride even on relatively smooth pavement. On a back road, the whole car skips from bump to bump. At the track, the Camaro is magnificent. It averaged .87 G on the skidpad and got through the slalom only a hair slower than the Porsche 944.

The big V8 is only available with an automatic transmission, which we think suits the Camaro perfectly. This is not a precision driving instrument. It's more like a chain saw, chopping and hacking its way down the road with a rather appealing viciousness.

In the succinct phrase of one tester: "Seats stink." Otherwise, the Camaro interior is quite nice, with a full set of real instruments. Our biggest complaint with the Camaro applies equally well to the Corvette. The interior is cramped and compromised, yet the exterior is huge. It's like opening the door of a giant bank vault, which the Camaro's long, heavy doors resemble, only to find a piggybank inside.

One of our testers summed up the IROC 350 as, "Great fun for a half-hour blast on a deserted road, but not a car you'd want to drive very far. It's wonderful for what it is, but has too narrow a focus for every day."

Porsche 944

No doubt fanatics all over the country are revving up their $150 Porsche Design pens to ask how *could* we rank the 944 behind a Chevrolet and a Ford, not to mention two *Japanese* cars. All we can say is, "Have you driven a Ford/Chevy/Japanese car lately?" Porsche has stood still for years—the 944 is really a modified 1976 924—while the Japanese and Americans have taken aim at a stationary target.

At $27,000 as tested, the 944 has already priced itself out of this market, while the excellent 944 Turbo costs well over $35,000. At that point, you're no longer selling an automobile, but a status symbol.

This is not to say that the 944 is a bad car; it's been the standard of excellence in this class ever since it came out. In acceleration, the 944 tied for last with our sick Alfa. It was fourth in the slalom, third on the skidpad and fourth in braking. In other words, the chassis is quicker than the engine. The 944 Turbo solves this problem—for a price.

On the road, the 944 feels a lot happier. Our testers found it excellent in every way. All the controls are simple but easy to use. The ergonomics are superb, and the driving is wonderful. The car works with you, not against you, and it's beautifully balanced.

The 944's styling is a bit cobbled up since Porsche added spoilers, air dams, driving lights and fender flares to the original 924 body. But it still looks tough and "right," particularly in Porsche's vivid Guards Red. The interior is functional and somber by comparison. One tester called it industrial. And the race-type seats, with huge side-support wings, make entry and exit an acrobatic exercise.

As one tester wrote, "People buy these cars for all the wrong reasons. You shouldn't buy a Porsche for cosmetic reasons—it doesn't look that good. You shouldn't buy it for luxury, because it's not very comfortable and driving it around town is a chore. You should buy it only for driving very fast on secondary roads. There aren't many places you can do that in the U.S., so you end up buying the 944 to impress your neighbors."

Dodge Shelby Charger Turbo

The Shelby is probably in the wrong test. It costs half as much as most of the cars in this group. On the other hand, it's a feisty little overachiever that you can't help but like. The Charger is the Omni chassis taken about as far as it can go and fitted with Chrysler's 146-hp 2.2-liter turbo Four. Our test car ripped off a 15.73-second quarter-mile at 86.04 mph—quicker than the Porsche and Mitsubishi and within a heartbeat of the Supra and 300ZX.

The Shelby was second in the slalom and rang up a solid .81 G on the skidpad. The brakes are good, and the interior is by far the largest of any car in this test. It swallowed as many groceries as the RX-7, but in addition to four passengers, not two. The Shelby even won in fuel economy. All of this was enough to make it second overall in our track testing. You can't ask for a better combination of all-around performance, utility and economy.

But make no mistake, the Shelby is a cheap car. Chrysler has jazzed it up with really infantile, tacky tape stripes and plastic add-ons. The interior is equally awful and old-fashioned. The whole seat/steering wheel/controls relationship is a disaster, the shifter is balky, the gauges are cheap and the interior trim is substandard. It's obvious that all the money in a Shelby goes into the engine and suspension, with none left over for sound deadening or civilizing influences.

"The Shelby Charger Turbo is harsh, noisy, crude and unrefined," summed up one tester. "It's cheap and ugly, yet it obviously gives great performance. If this test were a singles bar, it'd have to be awfully late before I'd go home with the Shelby. But it'd probably be a night to remember, one way or another."

Nissan 300ZX Turbo

For 1986, the 300ZX Turbo was given stiffer springs and sway bars, 225/50VR16 Bridgestone Potenzas under newly flared fenders and a revamped air intake to eliminate the awkward hood scoop. With 200 hp the 300ZX should be the hottest car in this class. Unfortunately, it's just not. The 300ZX has been overtaken by a new generation of Super

SPECIFICATIONS AND DIMENSIONS

CAR[1]	BASE PRICE	PRICE AS TESTED	ENGINE	TRANSMISSION	WHEELBASE (in.)	LENGTH (in.)	WEIGHT (lb.)
Alfa Romeo GTV6	$16,500	$18,095	170-hp SOHC 2.5-liter V6	5-speed manual	94.5	171.2	2850
Chevrolet Camaro IROC-Z 350	$12,561	$15,889	215-hp OHV 5.7-liter V8	4-speed automatic	101.0	188.0	3400
Dodge Shelby Charger Turbo	$9,361	$11,039	146-hp SOHC 2.2-liter Inline-4 Turbo	5-speed manual	96.6	174.8	2550
Ford Mustang GT H.O.	$11,065	$13,145	200-hp OHV 5.0-liter V8	5-speed manual	100.5	179.3	3250
Mazda RX-7 Turbo	$20,195	$20,195	182-hp port-induction 1.3-liter Inline-2 Rotary Turbo	5-speed manual	95.7	168.9	2850
Mitsubishi Starion ESI-R	$17,479	$18,054	176-hp SOHC 2.6-liter Inline-4 Turbo	5-speed manual	95.9	173.2	2950
Nissan 300ZX Turbo	$20,999	$23,559	200-hp SOHC 3.0-liter V6 Turbo	5-speed manual	91.3	170.7	3250
Porsche 944	$24,500	$27,216	150-hp SOHC 2.4-liter Inline-4	5-speed manual	94.5	168.9	2850
Toyota Supra	$17,990	$18,810	161-hp DOHC 2.8-liter Inline-6	5-speed manual	102.2	181.9	3600

1. All are 2+2 hatchbacks, except for the Nissan and Mazda, which are 2-seat hatchbacks. All are front-engine, rear drive, except for the front-drive Dodge.
2. Best speed achieved while weaving through seven cones placed 100 feet apart; the higher the speed, the better the transient handling.
3. G-forces generated during steady-state cornering around a 200-foot-diameter circle; cw=clockwise, ccw=counterclockwise.
4. The number of standard-size grocery bags that will stand upright (1-inch crush space permitted) in hatchback cargo area with folding rear seatbacks (if any) upright.

Coupes, while the increasing value of the yen has raised its price to $24,000 and counting. We think it's time for Nissan to take the superb turbo V6 and install it in a lightweight, up-to-the-minute sports car that can successfully compete with the new RX-7 and Supra.

At the track, the 300ZX did finish second in braking behind the RX-7, but overall it ended up seventh in a field of nine. Our track test driver complained that the shifter is notchy, the steering vague with too much feedback and the ride bouncy.

On the road, our group found the 300ZX equally off the pace. Among the most frequent complaints were the "loony" dashboard with unreadable digital instruments. Lamented one tester, "This seems like a car that's been committeed to death by Marketing, Engineering, Design and R&D—an automotive camel. It feels heavy and ponderous, no matter what the track numbers are."

Mitsubishi Starion ESI-R

Years ago, when the Starion first came out, it was an inexpensive, pleasant little car with a terrific reputation for reliability. Over the years, Mitsubishi has turbocharged the 2.6-liter Four and dolled up the clean Starion bodywork with an increasingly heavy hand.

For 1986, the Starion has been given an intercooler to raise its power to 176 hp. The fenders have been flared *a la* Porsche 944 to leave room for Yokohama 225/50VR16 radials at the rear, 205/55VR16 on the front. Inside, Mitsubishi has gone wild with electronic accessories, in the modern Japanese fashion. All this costs money, of course, and the Starion ESI-R is now an $18,000 Super Coupe that is also sold by Dodge dealers as the Conquest.

The interior is perfectly nice. The dashboard is very straightforward, the driving position is excellent and, as you'd expect, the Mitsubishi sound system is as good as any you'll find in a new car. The only change we'd make is to replace the lush-looking "loose cushion" seats with buckets that give better support.

At the track, the Starion is a midfield performer in everything except braking. The brakes faded immediately, and if there'd been something to hit, we would have hit it. Try to throw a quick shift and the rear axle thunks like it's about to come loose.

Despite its lackluster performance, the ESI-R guzzled gas faster than anything except the RX-7. As one driver summed it up: "Taken as a generic Japanese sports coupe, it's not bad. But it certainly doesn't compare with any of the serious Super Coupes in this group, especially at the price."

Alfa Romeo GTV6

Driving the GTV6 is just like driving a half-scale V12 Ferrari. Let the revs drop under 4000 rpm and it vibrates, stumbles and otherwise signals its displeasure. Drive it like a homicidal Italian racing driver, flat-out *all* the time, and the Alfa is nirvana. The performance levels are not all that high, so any road can become part of the Mille Miglia. The brakes are good, the handling predictable and the steering spot-on.

Still, you have to be a pretty die-hard *Alfisti* to buy one of these cars. Our test car had less than 200 miles on the odometer, and there was a serious driveline vibration *before* we started our test. Alfa's mechanics are still investigating. The upholstery was coming apart, the hood latch refused to open and the electric window worked intermittently.

We'd say Alfa has two serious problems. One, quality control. Two, poor detail design on things like controls, gauges and interior appointments. The interior looks like it was designed by five different guys who weren't talking to one another.

The basic GTV6 is a nice package. The styling is still distinctive after all these years, and the 2.5-liter V6 is willing and able. But the car was designed before ergonomics were invented, and the arms-out driving position gets real old, real fast. As one of our testers summed up, "The GTV6 has an undeniable charm, like my vintage race car. I can see why there are Alfa enthusiasts in the world. This car has *character*."

Conclusion

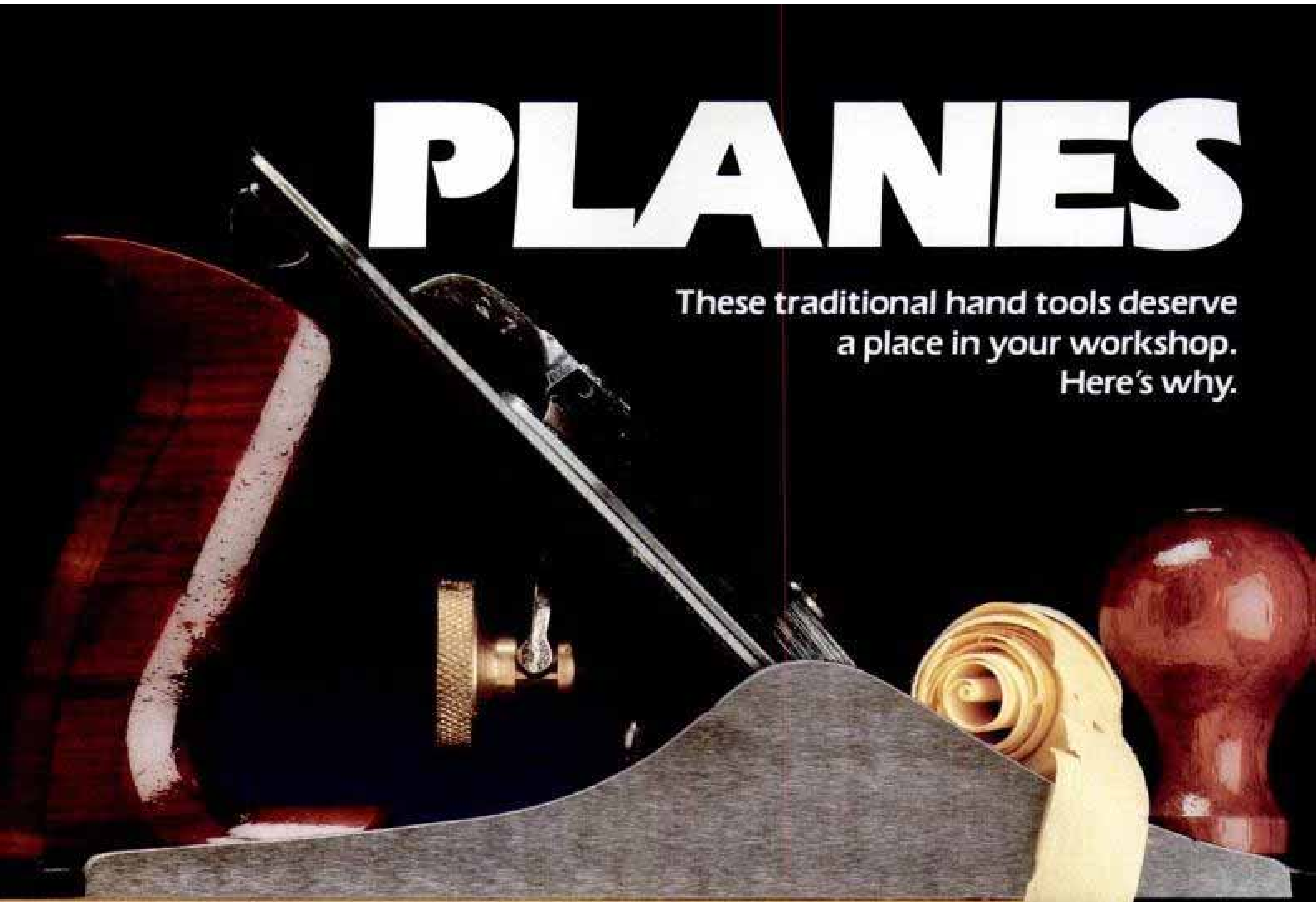
This has to be the hottest market segment in the automobile industry, filled with really superior automobiles. Highly regarded classics like the Porsche 944, Alfa GTV6 and Nissan 300ZX are merely also-rans compared to the all-new Japanese competition. And through the application of what they do best—raw horsepower—Ford, Chrysler and General Motors have turned their aging sporty cars into enviable Super Coupes.

All in all, these Super Coupes are the best group of cars we've tested in years. It's not often you'll hear us describing a $20,000 car as a bargain, but we'd say the RX-7 Turbo, Toyota Supra, Mustang GT and Camaro IROC-Z can all be legitimately compared to cars costing $15,000 to $25,000 more. If that's not a bargain, what is? **PM**

TEST RESULTS

GAS MILEAGE (EPA city/PM test)	¼-MILE (sec. @ mph)	SLALOM[2] (mph)	SKIDPAD[3] (cw/ccw)	BRAKING (ft.) (60-0 mph)	TRUNK CAP. INDEX[4]	INTERIOR SPACE INDEX[5]	TEST TRACK RANKING[6]	ROAD TEST RANKING[7]	OVERALL RATING[8]
19/16.6	16.86 @ 84.50	51.70	.76/.80	129	5	106.33	8	9	9
16/14.9	**14.44 @ 95.44**	59.91	.86/.88	124	4	103.16	3	5	4
20/18.0	15.73 @ 86.04	60.60	.80/.83	130	14	103.28	2	8	6
17/15.4	14.84 @ 91.74	58.72	.79/.81	148	6	**113.96**	5	2	2
17/13.0	14.97 @ 93.16	**63.60**	**.86/.90**	**107**	**15**	67.20	1	1	1
19/13.9	15.79 @ 85.47	60.51	.81/.81	156	7	92.54	9	6	8
17/15.1	15.32 @ 89.19	58.23	.81/.83	111	11	69.70	7	7	7
19/16.6	16.15 @ 84.42	60.10	.85/.87	121	6	96.94	6	3	5
18/17.5	15.63 @ 87.54	57.32	.81/.84	112	5	102.36	4	4	3

5. Front-seat width × headroom × legroom + rear-seat width × headroom × legroom ÷ 1000.
6. Points are awarded from best (1) to worst (9) in each category. The car with the fewest total points ranks first, next lowest second, and so on.
7. Subjective ranking on the road by a team of testers; cars are graded by "feel," independent of test track results.
8. Average of Test Track and Road Test ratings. Ties are decided in favor of Road Test score. Bold numbers indicate best performance.



PLANES

These traditional hand tools deserve a place in your workshop. Here's why.

BY JOSEPH TRUINI
Shop and Tools Editor
Photos by Brian Kosoff

The hand plane, more than any other tool, evokes strong images of handcrafted woodworking. In fact the plane, unlike many other tools found in the workshop, is strictly a *wood*working tool. It's the one tool that provides today's woodworkers with the strongest link to the Old World craftsmen.

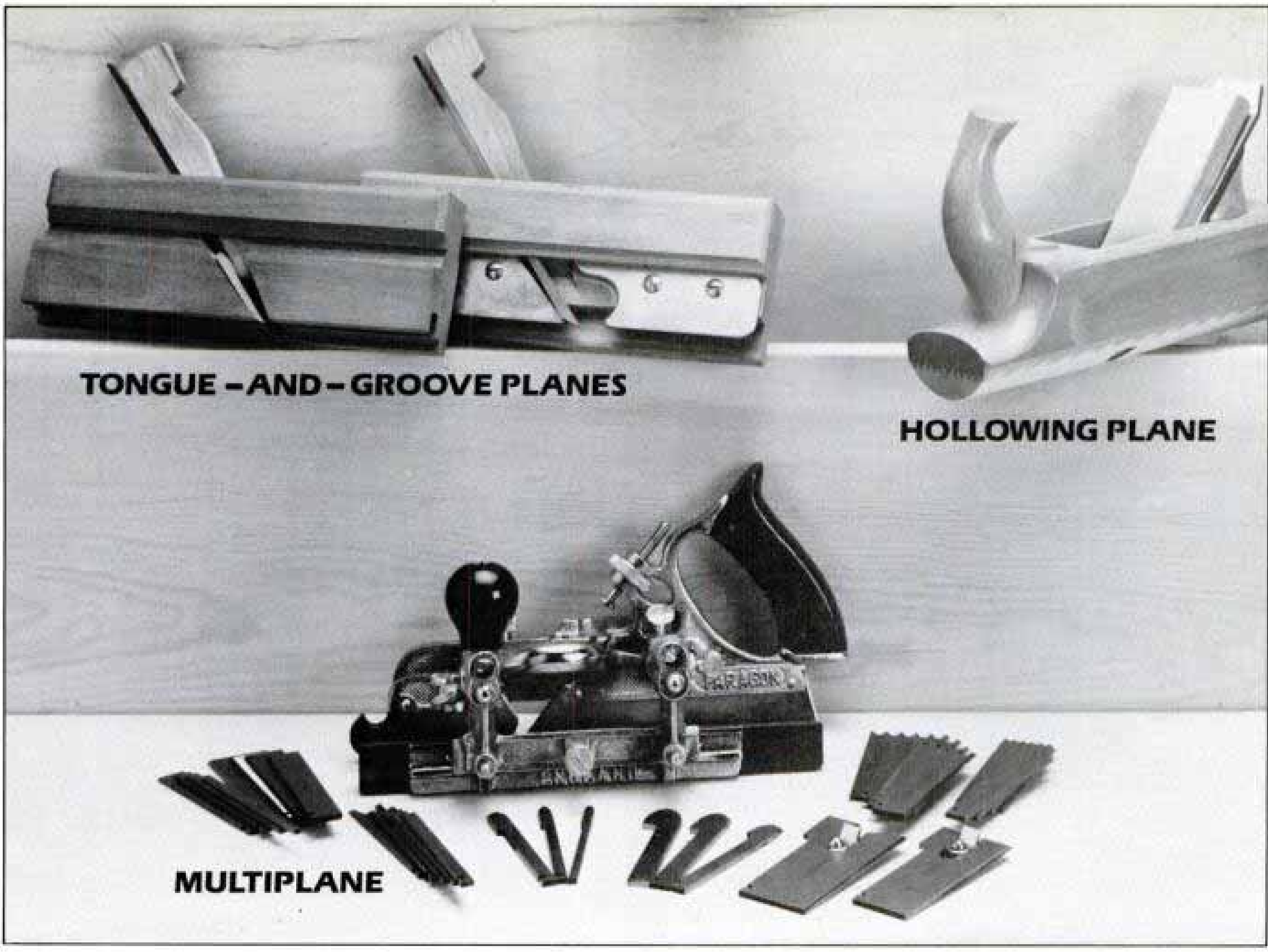
The hand plane is one of the world's original woodworking tools, dating back more than 2000 years. The tool's original design and principle, however, are relatively unchanged today.

And, as shown on the following pages, planes come in a variety of sizes and shapes, with wood or steel bodies.

Planes can be divided into two basic groups: bench planes and specialty planes. Generally, bench planes are used to flatten and smooth large wood surfaces and long edges. They characteristically have large, flat soles and straight, square blades. Bench planes are commonly available in lengths from 8½ to 24 in.

When using bench planes to smooth the rough surface of a board, start with a jack plane followed by a smoothing plane. Use the larger planes, such as a trying plane, to smooth long, uneven edges.

Specialty planes are designed for making specific cuts, such as shaping various molding profiles and cutting rabbets, tongues, grooves, dadoes and other woodworking joints. Some



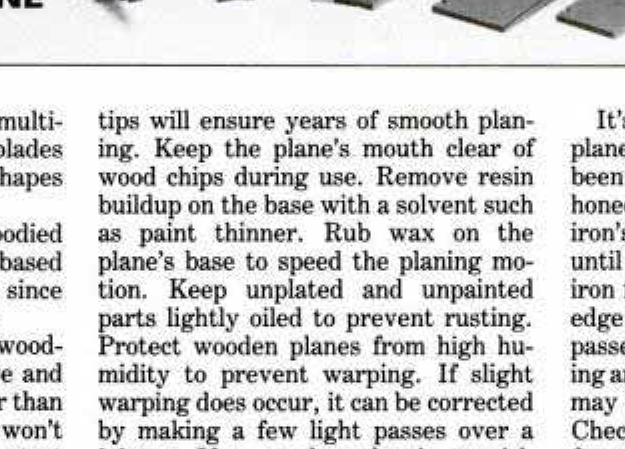
specialty planes, such as the multiplane, feature interchangeable blades that are available in a variety of shapes and sizes.

The choice between a wood-bodied plane and an all-steel plane is based largely on personal preference, since both types perform equally well.

Many woodworkers find that wood-bodied planes are more attractive and easier to use since they are lighter than steel planes. Also, the wood soles won't mar the workpiece. The two greatest advantages of steel-bodied planes are that they're available in a much greater variety than wooden planes and that steel planes offer more precise control and adjustment of the blade, known as the plane iron. Many wooden planes use a wood wedge arrangement to secure the plane iron. Note that some planes, like the reform smooth plane and trying plane shown, combine the best features of both tools—a wood body with a precise steel adjustment mechanism.

Proper care

Careful handling and occasional maintenance are all that's required to keep your planes in great condition for generations to come. The following tips will ensure years of smooth planing. Keep the plane's mouth clear of wood chips during use. Remove resin buildup on the base with a solvent such as paint thinner. Rub wax on the plane's base to speed the planing motion. Keep unplated and unpainted parts lightly oiled to prevent rusting. Protect wooden planes from high humidity to prevent warping. If slight warping does occur, it can be corrected by making a few light passes over a jointer. If a wooden plane's varnish finish wears off, apply an occasional coat of linseed oil to prevent it from drying out and cracking. Also, you should completely disassemble a plane at least once a year to clean each part thoroughly. Apply a light coat of oil to all metal parts before reassembly.



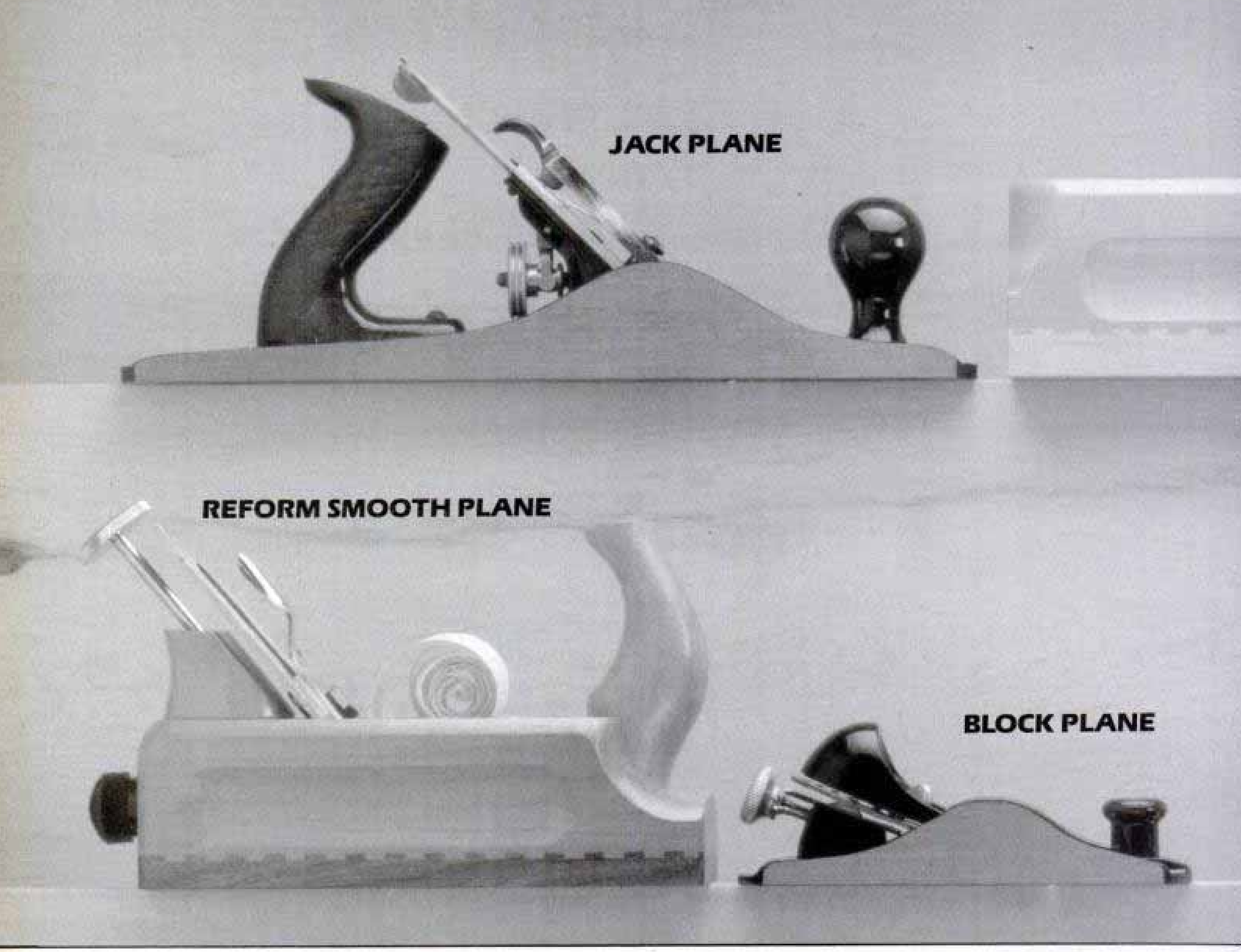
It's worth noting that many new planes come with plane irons that have been ground—usually to 25°—but not honed. Before use, you must hone the iron's edge to 30° on a flat, oiled stone until a burr is formed. Then, lay the iron flat on the stone, with its beveled edge facing up, and make a few light passes to remove the burr. The grinding and honing procedure for your plane may differ from the above technique. Check with the plane's manufacturer for specific instructions. Now let's take a close look at the planes shown.

Tongue-and-groove planes—This matching pair of planes ($59.95) is used to mill tight-fitting tongue-and-groove joints onto the edges of ¾-in.-thick boards. The 1⅜ x 9⅝-in.-long red beech planes employ a wood wedge to secure the plane irons.

Matching pairs of tongue and groove planes are also available for use on ⅝-, 13/16- and ⅞-in.-thick boards. Contact Frog Tool, 700 West Jackson Blvd., Chicago, IL 60606.

Hollowing plane—The unique convex-shaped sole of this tool identifies it as a hollowing, or rounding, plane. The 9½-in.-long plane features a red beech body with a hornbeam sole. The 1⅞-in.-

PLANES



wide plane iron is rounded to match the convex sole. Use this plane to cut hollows with or across the wood's grain. It's available for $66.90 from Frog Tool, 700 West Jackson Blvd., Chicago, IL 60606.

Multiplane—Here's a fine example of a classic hand tool. Offered as a successor to the now-discontinued Stanley No. 55 and the Record No. 405, this superversatile plane comes with 24 cutters ($345.80). An optional 16-cutter set is also available.

Use the multiplane to handle a variety of jobs, including cutting grooves, tongues, ovolos, fillisters, beading, flutes, hollows and rounds, and milling sash work. The 24 standard cutters include 13 plough and dado, five beading, two tongue, two ovolo, one slitting and one fillister cutter. For more details, contact Garrett Wade, 161 Ave. of the Americas, New York, NY 10013.

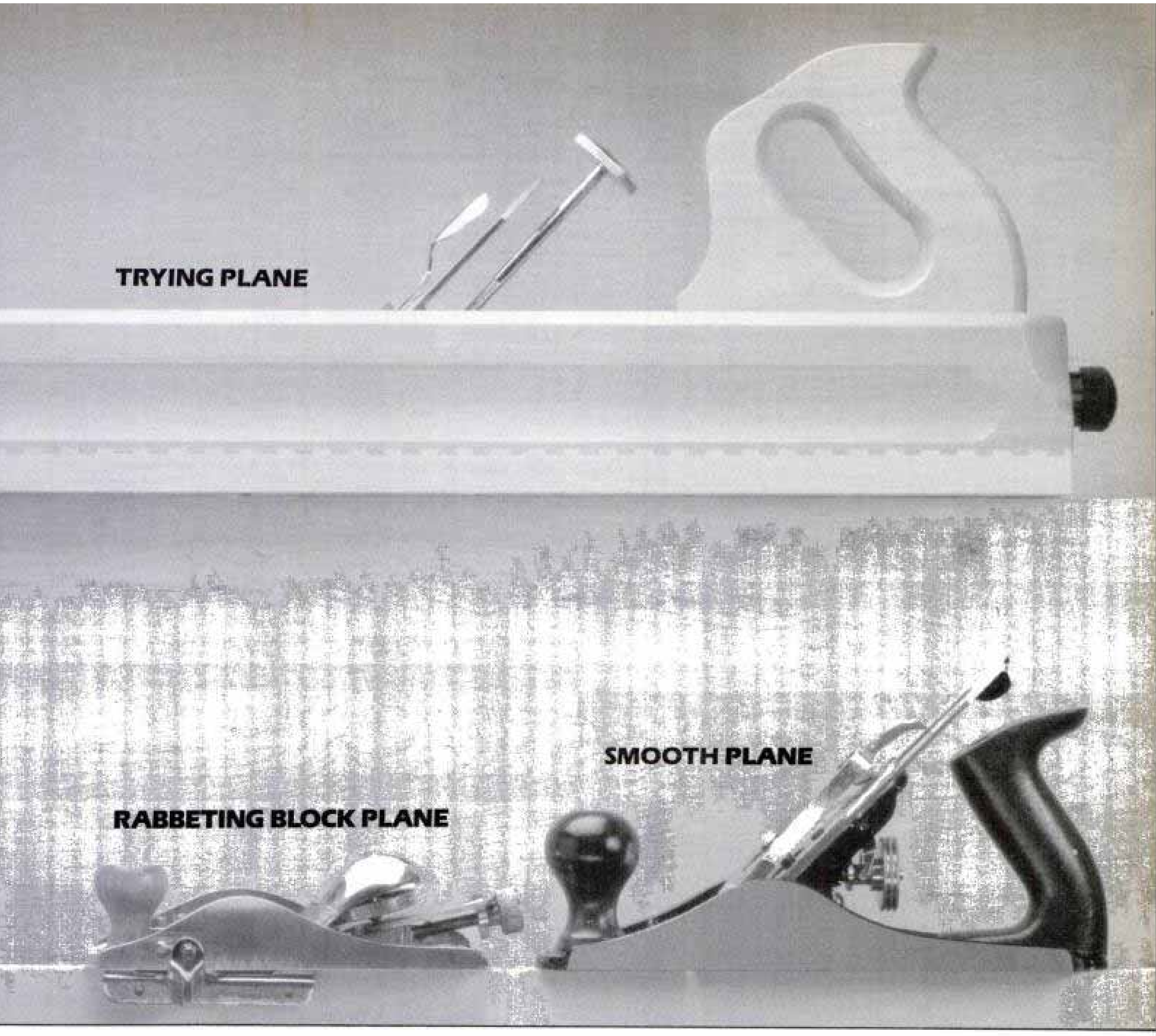
Violinmaker's planes—Don't be fooled by the Lilliputian dimensions of these planes. They are superbly designed and highly precise. Cast from silicon bronze, the planes are used for ultrafine finishing work. The set of three ($94.50) includes a ¾ x 1⅜-in. plane with a ½-in.-wide iron, a ⅝ x 1⅛-in. plane with a ⅜-in.-wide iron and a ½ x 1-in. plane fitted with a $^{5}/_{16}$-in.-wide iron. Contact Woodcraft, 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

Jack plane—The all-purpose jack plane is considered to be the most useful of all bench planes. Use it for smoothing rough boards and to flatten uneven surfaces.

This top-quality Record No. 05 jack plane has long grooves machined in its sole that are designed to make the tool slide easier—especially on resinous woods—by breaking the suction between the sole and the wood. The British-made plane has a 2½ x 14-in.-long sole and two hardwood handles. It comes with a 2-in.-wide tungsten vanadium steel plane iron. The Record No. 05 jack plane is available for $67.10 from Garrett Wade, 161 Ave. of the Americas, New York, NY 10013.

Reform smooth plane—Feature for feature, this is clearly the finest plane I've ever used. Made by the reputable German firm E.C. Emmerich, this smooth plane features a patented blade adjustment mechanism that provides you with supersensitive control of the plane iron. A spring-tensioned rod pulls the plane iron back tightly against the body to eliminate chatter which, in turn, promotes smooth planing.

This handsome tool features a lacquered pearwood body with sole of



lignum vitae—a superhard, self-lubricating wood that secretes natural oils to make planing easier. It also has an adjustable shoe cut into the sole that allows you to narrow or widen the space in front of the protruding iron. Generally, the harder the wood, the narrower the mouth setting.

The 2½ x 8½-in.-long plane comes with a 1⅞-in.-wide iron. It's available at larger Sears stores for about $80. Contact Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684.

Block plane—The block plane is designed for trimming end grain. Also, use it to smooth small wood pieces and for edge-planing plywood, particleboard and even plastic laminate. The block plane's major differences from a bench plane are that the iron is held at a low angle—21° on this Stanley model—and it's installed with the bevel facing *up*. The Stanley block plane ($17) has a 2 x 7-in.-long sole with a 1⅝-in.-wide iron. Contact Stanley Tools, 600 Myrtle St., New Britain, CT 06050.

Trying plane—The great length of this plane, nearly 24 in., makes it ideal for planing long, straight edges and for leveling broad, uneven surfaces. Made by E.C. Emmerich, it features the same patented blade adjustment mechanism described for the reform smooth plane. The 3-in.-wide red beech body has a white beech sole. It comes with a 2⅝-in.-wide chrome vanadium steel plane iron. The trying plane costs about $100 at larger Sears stores. Contact Sears, Sears Tower, Dept. 703-PM, Chicago, IL 60684.

Rabbeting block plane—Garrett Wade now offers a replica of the famous Stanley model No. 140 skew-blade rabbeting block plane that was discontinued in the 1930s. As compared to a standard block plane, this tool cuts much easier and cleaner due to the plane iron's superlow 12° skewed angle. The plane's right side is removable for use as a rabbeting plane. It comes with an adjustable fence and a 1½-in.-wide iron. The 1⅞ x 6⅞-in.-long plane is made of cast manganese bronze.

This professional-quality tool costs $156.85 from Garrett Wade, 161 Ave. of the Americas, New York, NY 10013.

Smooth plane—Designed for general-purpose planing, the smooth plane is often used after the jack plane for final finishing. This popular, easy-to-handle Stanley No. 4 plane features a 2½ x 9¾-in. cast-iron body with an adjustable mouth opening. It's sold at hardware stores for about $49. For details, contact Stanley Tools, 600 Myrtle St., New Britain, CT 06050. **PM**

1987 DETROIT

Our ace spy photographer pops out of the weeds to bring you an advance look at next year's cars

BY JIM DUNNE, Detroit Editor

CHEVROLET CORSICA

For car buffs, the New Year starts when the old year is only half over. 1987 is here! Starting this fall, look for completely new compact sedans and coupes from GM, heavy facelifting of Ford's spectacularly successful Thunderbird and Cougar, a front-drive successor to Chrysler's Cordoba, and the first all-new civilian Jeep since the original CJ's introduction in 1945.

Corsica/Beretta

Corsica is the 4-door successor to the Citation II, the compact sedan that Chevy dropped from production last summer. Its running mate is the Beretta coupe. There is little similarity in the styling of the two models, even though they will share 2.5-liter 4-cylinder and 2.8-liter V6 engines and front-wheel-drive hardware. Their appearance features an *au courant* aerodynamic look that's combined with traditional GM attention to mass appeal. Sheetmetal lines are crisp to the point of being sharp, hoodlines curve deeply downward, and glass surfaces are unusually large.

Allante

The muscular appearance of this 2-seat convertible from Cadillac is unlike anything in the current or past luxury-car lineup at GM, and that's as it was planned. Designed by styling whiz Pininfarina in Italy, the body will be built and outfitted in Turin—in 7000-per-year lots—then air-freighted to Detroit, where running gear and suspensions will be installed. Its target: highly profitable sales now going to Mercedes' $50,000 560SL convertible.

Allante's aluminum roof can be removed by one strong person and stored at home, so true convertible motoring is possible. Powered by Cadillac's effete 4.1-liter aluminum V8 engine, the Allante will not compete with the Mercedes, or any other 2-seater, in performance. But Cadillac officials are banking on "super ride, handling, quietness and elegance" to entice customers to this $40,000-plus beauty and away from the European exotics. Goodies will include leather interiors, anti-skid braking, multipoint fuel injection with a new tunnel ram induction system and a choice of just five colors—white, gold, blue, red or silver.

CADILLAC ALLANTE

Shadow/Sundance

Based on the ubiquitous K-car drivetrain and a chassis much like the Laser/Daytona, these 5-passenger subcompact twins fill the market slot between the low-priced Omni/Horizon and the mid-sized Aries/Reliant. A 97-hp 2.2-liter Four is standard, with a 146-hp turbo version of the same engine optional. Chrysler's familiar 3-speed automatic transaxle or 5-speed manual are the transmission choices. The cars should be on sale by the time you read this, with prices starting in the $7000 range. Two body styles are available—a 3-door and 5-door hatchback.

Chrysler LeBaron GTC

A miniature Imperial shows up in Chrysler's line for 1987. This 4-seat personal luxury coupe will not be a high-price model, but will compete in the Thunderbird class filling in for the now defunct Cordoba as Chrysler's mid-price model. No big surprises under the hood. Look for the Chrysler 2.5-liter 4-cylinder engine to be the base powerplant, with a new, Chrysler-built, 3.2-liter V6 to be added late next year. Price for the GTC should be in the middle teens.

Reatta

This 2-seater, equipped with Buick's vigorous 3.8-liter V6 and automatic overdrive transmission, will definitely offer high performance to luxury 2-seat

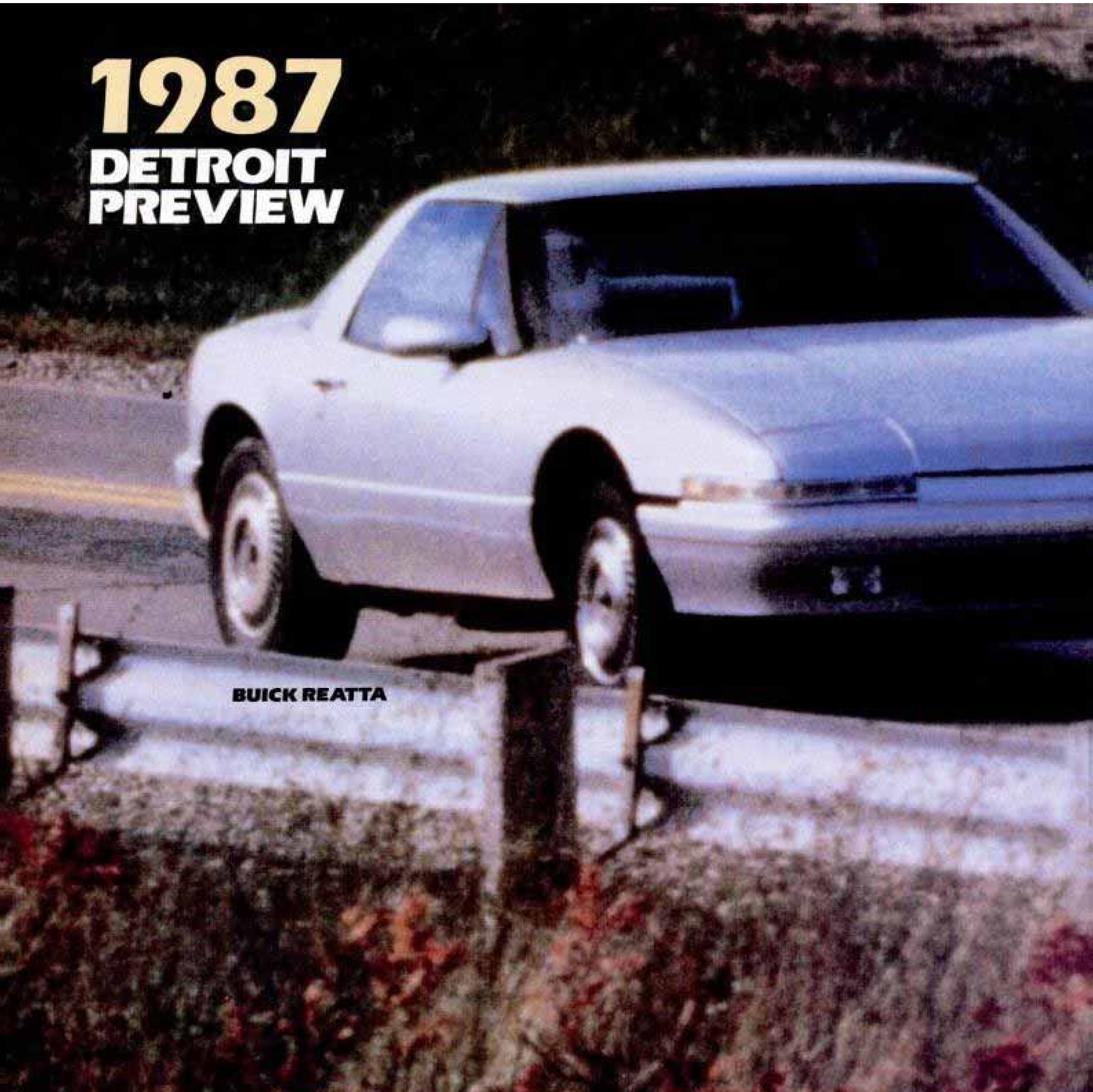
PREVIEW

CHEVROLET BERETTA

DODGE SHADOW

CHRYSLER LE BARON GTC

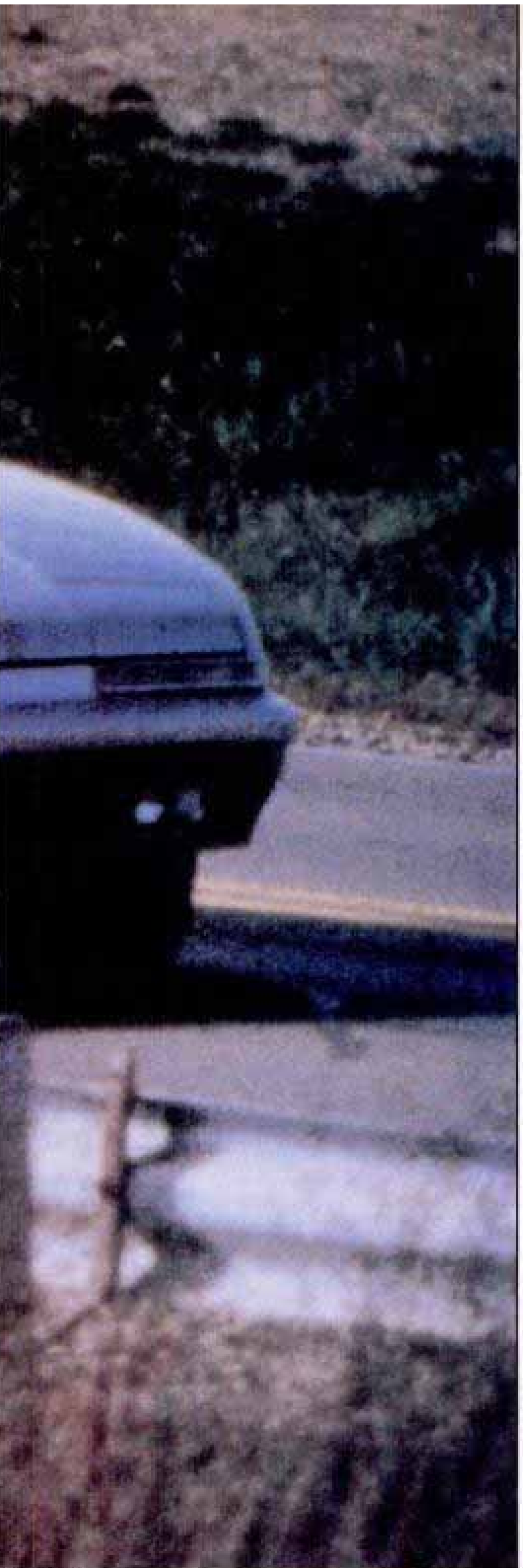
1987 DETROIT PREVIEW



BUICK REATTA

FORD MUSTANG

MERCURY COUGAR



coupe buyers. Unlike Allante, the Reatta will be an all-American. Its body and running gear will bear the U.S.A. logo, and it will be assembled in Lansing. A hardtop that looks a bit like a Corvette variant, the Reatta differs from the Chevy musclecar in using front-wheel drive and a steel body.

Due out in the spring of '87 with a price that may push $30,000, the Reatta will weigh in about 400 pounds less than a Corvette. Essentially, the car will use a shortened Riviera chassis on a 4-in. shorter wheelbase. A major problem may be too much power for the chassis to handle, especially if Buick's most powerful 235-hp V6 with turbocharger and intercooler is added to the option list. If it can put all that power to the ground, a turbo Reatta could outperform a Corvette!

Mustang

Reigning king of the affordable musclecars, the Mustang gets minor freshening on the outside while keeping its traditional body lines for 1987. Up front, the grille opening is slightly different, but the main change is the aero headlights. Just so you won't make a mistake, the Mustang name is molded into the bumper face in front. Taillights are slightly altered, too, but still recognizable as Mustang.

Thunderbird

No pulling back now. This aero style, now three years old, is hot and has catapulted Ford ahead of GM's strong G-cars (Regal, Monte Carlo, Bonneville and Grand Prix) in the mid-price personal coupe market. Ford intends to keep that lead by making major changes in the 1987 models. Most visible are the shape of the C-post and rear roof, and the grille design. Overall, the new 'Bird has a smoother, more finished look, one that enhances its aerodynamic shape. Mercury Cougar, Thunderbird's running mate, has similar changes—more radical rear quarter window outline and an enclosed grille with aero headlights.

In '88 the T-Bird will get new fastback rear glass, and in '89 an even more rounded, aerodynamic nose, all of which will help to keep it the hot setup on NASCAR speedways.

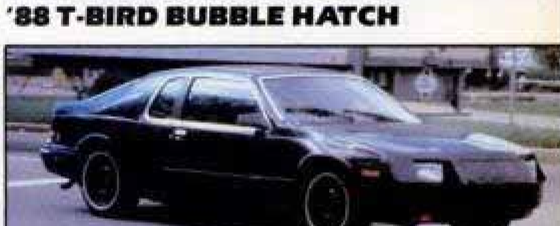
Jeep YJ

Appearances can be deceiving. Wrangler, the 1987 version of the 4-wheel-drive pioneer, is radically new, both in styling and chassis design, even though it may not look much different from what you've seen in the past. But the body floor pan is taken from the new Cherokee. Wheel track is wider front and rear to make the new Jeep more stable and less susceptible to rollover. The instrument panel is no longer a primitive design, but crafted as carefully as those in the Cherokee. Still rugged? Yes, if those leaf springs all around and rigid axles are any indication. And the windshield still can be folded down on top of the hood. AMC's in-line Six will be revived for '87. **PM**

JEEP WRANGLER "YJ"

1987 FORD THUNDERBIRD

'88 T-BIRD BUBBLE HATCH



'89 T-BIRD AERO NOSE

BACK TO RATTAN

A guide to fabricating furniture with this versatile building material.

BY NEAL BARRETT

You may have seen furniture like this in old books or movies about the elegant life in Palm Beach. Or you may have seen examples of it in old hotels throughout the deep South, with palm trees growing close by and a slow-moving fan overhead. Or you may have seen it in the last few years at forward-looking furniture stores where the style and grace of rattan have been making quite a comeback.

This recent interest caught our eye, so we decided to do some research and come up with original designs that could be built by any shop enthusiast. This material is very workable—in a somewhat unorthodox way—and easily yields the classic sweeping curves that are so much a part of the furniture's appeal. We hope you enjoy the process and results as much as we did.

What is rattan?

Rattan is the stem (or trunk) of a climbing palm tree that grows in the tropical jungles of Southeast Asia, Malaysia, Indonesia and the Philippines. In its natural state, the stems are covered with a tough, thorny bark, but during harvesting, this is removed, leaving a hard outer layer of silicone resin on the poles. In this form the rattan is called unskinned. For some uses, this hard layer is also scraped off, resulting in a more porous, softer outer surface. This is called skinned rattan, and is often used in commercial rattan furniture.

Since the skinned type is more porous, the process of bending the poles using moisture and heat is easier. With some hand sanding, the poles can be made smooth and regular. However, the unskinned poles have a series of slightly ragged ridges that reflect the growth of leaves along the stem. This creates the classic rattan *look*, so we chose the unskinned poles for our loveseat and chair. Keep in mind that these poles are solid, not hollow like bamboo.

Before you begin

Building with rattan instead of conventional wood requires different construction methods and a different mind-set as well. The need to work to extremely close tolerance cannot apply to rattan the way it does to traditional cabinetmaking. The exact diameter of the rattan poles is not specified when sold. Instead, they come in bundles that can range in size from 10 to 12 mm, 18 to 25 mm and 40 to 45 mm. Also, the poles will vary in diameter from one end to the other. So keep in mind that although you can frequently accommodate this material to your design, there will be times when your design will have to be adjusted to suit the material. We've provided exact dimensions in the drawing on page 97. But you will surely have to depart from these occasionally.

Before beginning the actual construction, examine the poles. Most will average 9 to 10 ft. in length and will have a series of bends and crooks in them. You should straighten each pole as much as possible to make construction easier.

Thin poles—up to ½ in. dia.—respond well to simple hand pressure. A certain amount of overbending is required because the rattan will spring back a little. The amount of overbending will become apparent after a few attempts.

Thicker poles require a combination of heat and moisture. To bend these, clamp each pole in a strong vise, dampen the bend and then heat with a heat gun as shown in photo No. 3. At the same time, begin applying pressure to the pole in the direction opposite to the existing bend. Several applications of water and heat may be required before the pole softens sufficiently. Again, a certain amount of overbending is necessary. Proceed along the length of the pole until it seems reasonably straight.

Bending the poles

Prepare all the parts for both the chair and loveseat at the same time. Aside from the difference in length, the only additional parts are the center legs and cross braces in the loveseat.

Next, make a full-size drawing of each different member. Then bend the first copy of each and check against its drawing until it matches. When satisfied, construct a jig for each by tack-nailing scrap lumber to a plywood panel as shown in photo 4. Make sure that the ensuing poles for each bend fit precisely into the jig. Leave each pole full length until after bending. It's easier to make accurate measurements this way.

Clamp each pole in the vise about 2 in. from the start of the bend. Make sure it's parallel to the tabletop so you'll have a plane of reference for the bend. Use the same techniques to bend the pole as

Color photos: J.R. Rost; **Black and white photos:** Neal Barrett
Technical art: Dyck Fledderus; **Fabric:** Waverly Confetti

you did to straighten it. After several applications of water and heat you will feel the pole soften and resistance lessen. Overbend as mentioned before, then apply water to cool the bend. When cool to the touch, slowly release the pressure. Keep in mind that the hottest part of the pole will be the most flexible. Also remember that larger radius bends require heating a longer section of the pole.

Joinery

After all the required bends have been made, clamp a board to the edge of the workbench and butt each pole to the board. This provides an easy *and* accurate way to measure the finished lengths of the bent poles. Then cut the poles using either a hacksaw or a Japanese ryoba saw. Keep the saw square to the length of the pole. In the loveseat, the back poles require a splice joint because one pole is too short to span the entire distance. A splice joint is also required on the inner pole of the chair back for ease of fitting and measurement. To form these, cut half of the joint first as shown in photo 7. Then use the cut pole as the template to mark the other pole. After the splice joints are cut, use carpenter's glue and screws to assemble. Drill pilot holes and countersink the screwheads.

Next, cut the 1½-in.-dia. poles to length for the seat rails and upper back rails. Note that the ends of these parts are shaped to a slight hollow with a coarse rasp to form a better joint.

Then cut 1-in.-dia. poles to length for the back spindles, and using a sharp chisel, trim the ends of each spindle to form ¾-in.-dia. × ⅝-in.-long tenons.

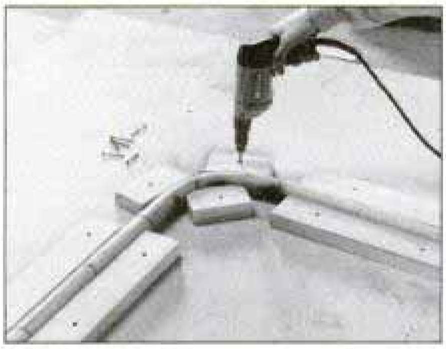
Temporarily clamp the upper back rail to the inner back pole and mark the position of the spindles on both. Then clamp the assembly to the table and, using the angled back pole as a guide, drill ¾-in.-dia. × ⅝-in.-deep holes for the spindles in both parts. Unclamp the rail and apply glue to each hole. Fit the spindles into the rail first and then into the back pole. Use clamps to draw the parts together. Drive two 2½-in. × No. 8 fh screws through the back pole into each rail end to fasten the joint. Install the back seat rail in the same manner. Then attach the outer back pole to the inner pole with the same size screws spaced 10 to 12 in. apart. Countersink all screwheads so they can be filled later with wood putty.

Clamp each armrest pole in the vise

1 To straighten pole, clamp in vise then brush water onto bent section. Let water soak in, then apply heat with heat gun.

2 Use workbench to check progress when straightening poles. Pole should align with surface and be parallel to edge.

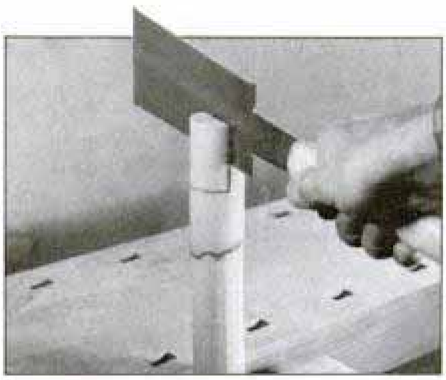
3 To bend pole, clamp in vise 2 in. from point of bend. Apply water and heat until pole softens, then bend to shape.



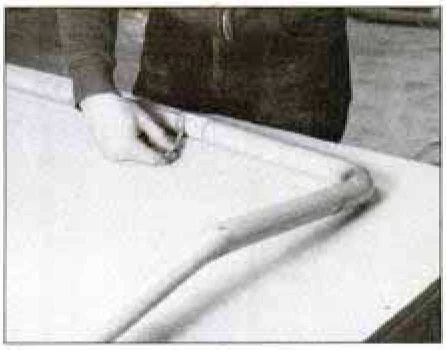
4 After first pole of given profile is bent, screw blocks around edges to create jig for testing other poles of same shape.

5 Clamp board on edge of work surface, then butt bent pole against it. This gives accurate surface for measuring length.

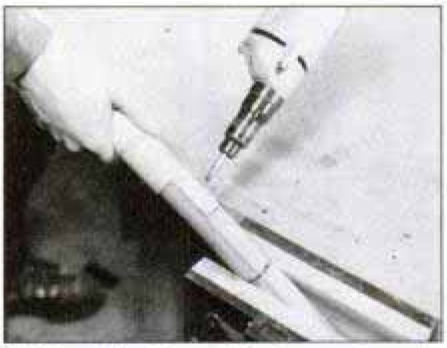
6 After bending top corner in back pole, clamp pole in vise so it's square to bench top. Then make sideways bend.



7 Cut 2-in.-deep splice joint in end of one pole using hacksaw or fine-toothed Japanese ryoba saw. Keep cut square to end.



8 Use splice joint cut on first pole as template for marking joint cut on end of mating pole. Cut joint on second pole.



9 Join splice joint with glue and screws. Countersink heads so they can be covered with wood filler later.

and use the rasp to shape the joint with the rear leg. Then join them to the back. Fasten the side and front seat rails in place, being careful when positioning the screws to avoid hitting the screws holding the adjacent rail.

Cut to length ¾-in.-dia. poles for the side and front stretchers and the front seat sub rails. Use 1-in. brads to join the poles in pairs to form the stretchers. Keep the brads back at least 2 in. from either end of the stretcher.

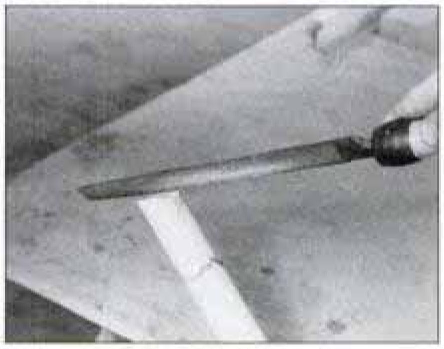
For the armchair, fasten the front stretcher between the two inner legs. But for the loveseat, fasten one center leg to each stretcher and then attach the stretchers. Screw the two center legs together and attach the front sub rail to the seat rail using 1½-in. brads.

Place the outer armrest pole into position and fasten to the rear leg and inner armrest. Then install the side stretchers between the front and rear legs and install the armrest trim strip with 4d finish nails. Finally, cut the cross braces for the loveseat and screw them in place between the front and rear center legs.

Fabricate the front spindles by joining two ½-in.-dia. poles with ¾-in. brads. Mark the position of the spindles, and use 1-in. brads to fasten the spindles to the back side of the front stretcher and sub rail. Fill all screw holes, let dry and sand flush to the surface.

In traditional rattan furniture all joints were wrapped with cane, but with the use of screws, the structural value of the wrapping is seldom required. In fact, in most contemporary rattan furniture, the wrapping is omitted entirely. In our design, we wrapped selected joints to reinforce the traditional feel. The cane is 6 mm wide and is usually called wide binder. To prepare the cane for wrapping, soak it in water for at least 20 minutes prior to use to soften the material.

We approached the wrapping in two different ways. The splice joints are wrapped in a straight line. First bore a ⅛-in.-dia. by ½-in.-deep hole in the bottom edge of the pole at one end of the wrap. Fold the end of the cane and force it into the hole. Cover the area to be wrapped with white glue, then circle the joint with cane until it's covered. Tie it off by pushing the end under the last two or three wraps, pulling tight and trimming the end flush with the surface. Finish up by wiping off excess glue with a damp cloth.



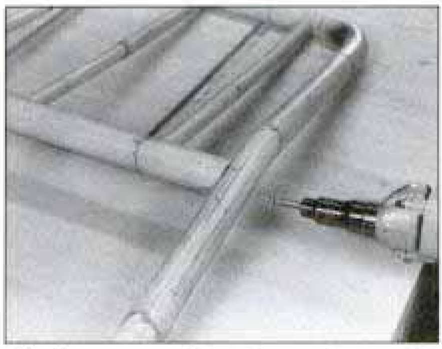
10 On butt joints, create tight fit by filing end of one pole to slight hollow using wood rasp. Keep tool square to pole end.

11 Test-fit butt joints then apply glue and attach parts with fh screws. Bore pilot holes and stagger screws.

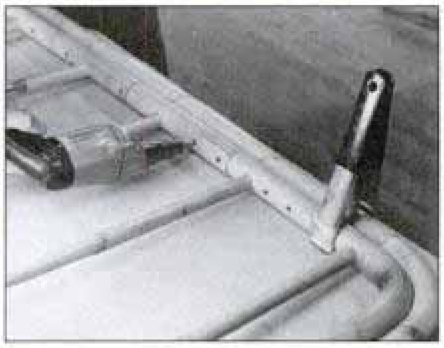
12 Temporarily clamp back rail between rear legs and bore spindle holes in rail. Angle drill same amount as bend in legs.

13 Cut spindles, then pare ends to ¾ in. dia. with sharp chisel. Test-fit in scrap rattan that has ¾-in. hole bored in middle.

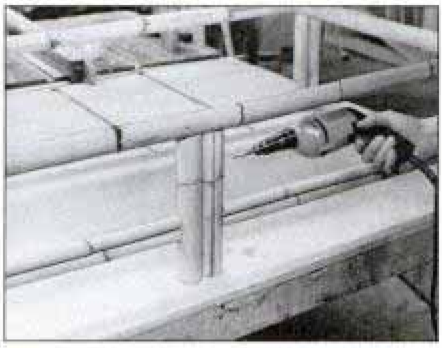
14 Apply glue to spindle holes in back rail, then slide spindles in place. Glue this assembly into holes in inner crest rail.



15 Clamp rear rail and crest pole together. Then join the end of the rail to the pole with glue and screws.



16 Clamp inner crest pole and back rail assembly to outer crest pole. Bore clearance holes and attach with screws.



17 Center leg on loveseat is made of two assemblies. Stretchers must be attached to single legs *before* legs are joined.

18 Scribe loveseat cross braces in place between front and rear center legs. Attach with screws driven at a slight angle.

The second type of wrapped joint is the T joint. Begin by attaching the cane to the inside surface of one member about ¾ in. below the joint. This can be done by either using 20-ga. × ½-in. wire nails or by drilling a ⅛-in.-dia. hole and pushing the end of the cane into it. Fold the cane over the joint and fasten the other end with a wire nail. Repeat with more strands of cane until the entire joint is covered. Then bore a hole just below the ends of the cane strips. Spread glue and push the end of one cane strand into the hole. Wrap the cane around the joint, tie off the end and trim flush.

Lay out the position of the upholstery webbing on the seat rails. Cut the pieces to approximate length leaving at least 12 in. extra per piece. Nail one end on one side seat rail as shown in photo 26. Be sure to use a support block under the rail as you nail to keep it from bouncing. Then use a webbing stretcher to pull the webbing across the seat. For this job it's helpful to have someone tack the webbing as you pull. Repeat for each length of webbing.

Attach the side spindles using 1-in. brads. Then cut the ½-in.-dia. trim strips and use 1-in. brads to install them over the ends of the webbing.

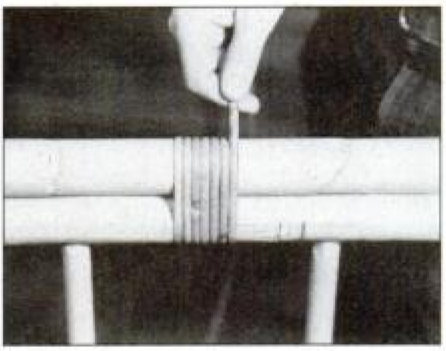
Finishing

Lightly sand both pieces using 120-grit sandpaper. Brush off all dust and paint using a spray enamel or lacquer. We used Sherwin-Williams spray enamel—Gloss Green No. 140076. Let the first coat dry for about one hour and recoat. No sanding between coats is required unless drips occur in the first coat.

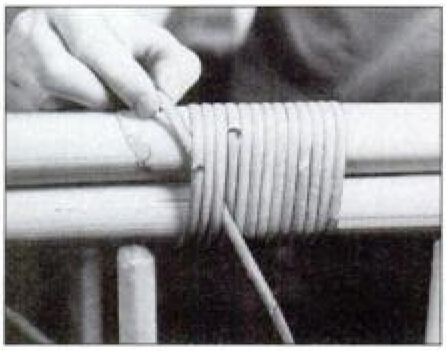
To make the seat cushions, wrap 5-in.-thick, high-density foam with one layer of polyester batting. Stitch the batting together to hold it in place and to keep the proper shape. To achieve the soft overstuffed look of the back cushions, wrap 2-in.-thick, high-density foam with three layers of polyester batting. Apply one layer of batting at a time, stitching each in place as you go. When all cushions are formed, test-fit and make any necessary adjustments, then sew the covers for the cushions—we used a Waverly fabric called Confetti—and the pieces are done. PM

SOURCES OF RATTAN

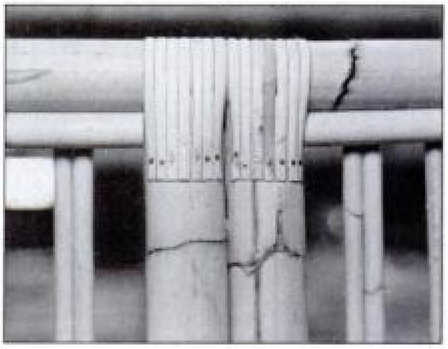
- Rainbow Trading Co., 5-05 48th Ave., Long Island City, NY 11101; full bundles only
- Frank's Cane & Redd Supply, 7252 Heil Ave., Huntington Beach, CA 92647
- Peerless Rattan, 222 Lake Ave., Box 636, Yonkers, NY 10702



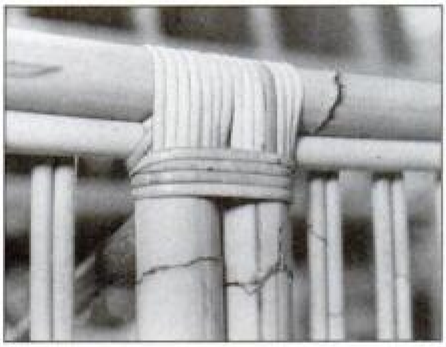
19 Join parallel poles with cane wrapping. Insert lead end into prebored hole, then cover joint area with glue and wrap.



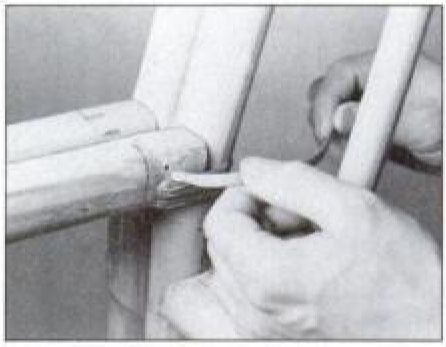
20 Continue wrapping until joint is complete, pulling cane tight as you go. Slide end underneath, pull tight and cut off.



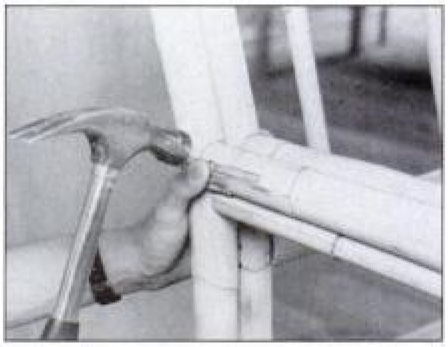
21 Reinforce butt joints with cane strips as shown. Cover joint with glue, then attach ends of strips with brads.



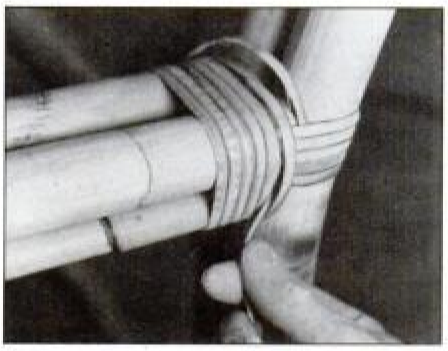
22 Apply glue to bottom edge of strips, then cover with continuous piece of cane. Wrap until all ends are hidden.



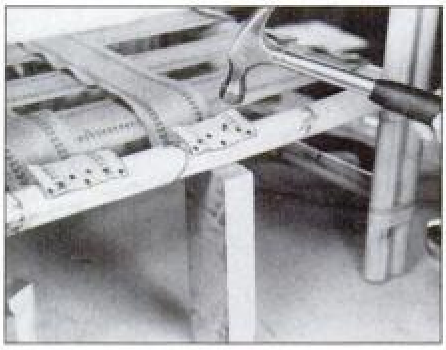
23 For extra strength at armrest and leg joint, bore holes for each strand of cane. Glue ends into holes, then pull tight.



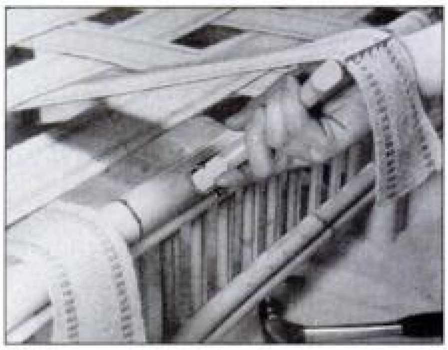
24 Cover joint with glue then bring cane around back leg and nail to other side of armrest with brads. Cut off excess.



25 Tie off cane at armrest and leg by sliding end under whole row of cane strips *and* last turn of finish wrap. Cut end flush.

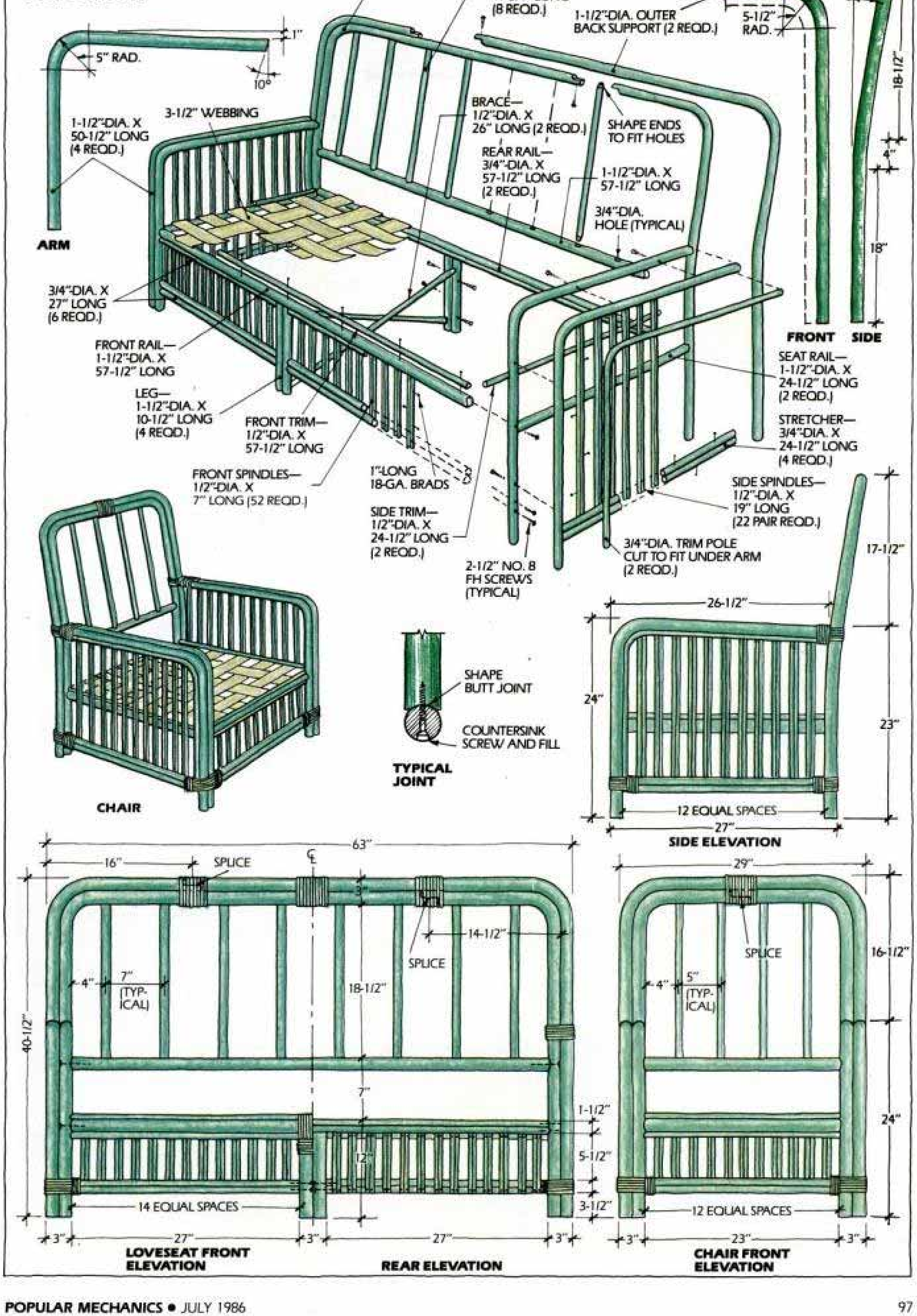


26 Attach ends of webbing to seat rails with tacks. Double-over end and support rail with block when hammering.



27 Use stretcher to pull webbing tight, then have helper tack in place. Cut to length, double-over and tack again.

RATTAN LOVESEAT AND CHAIR



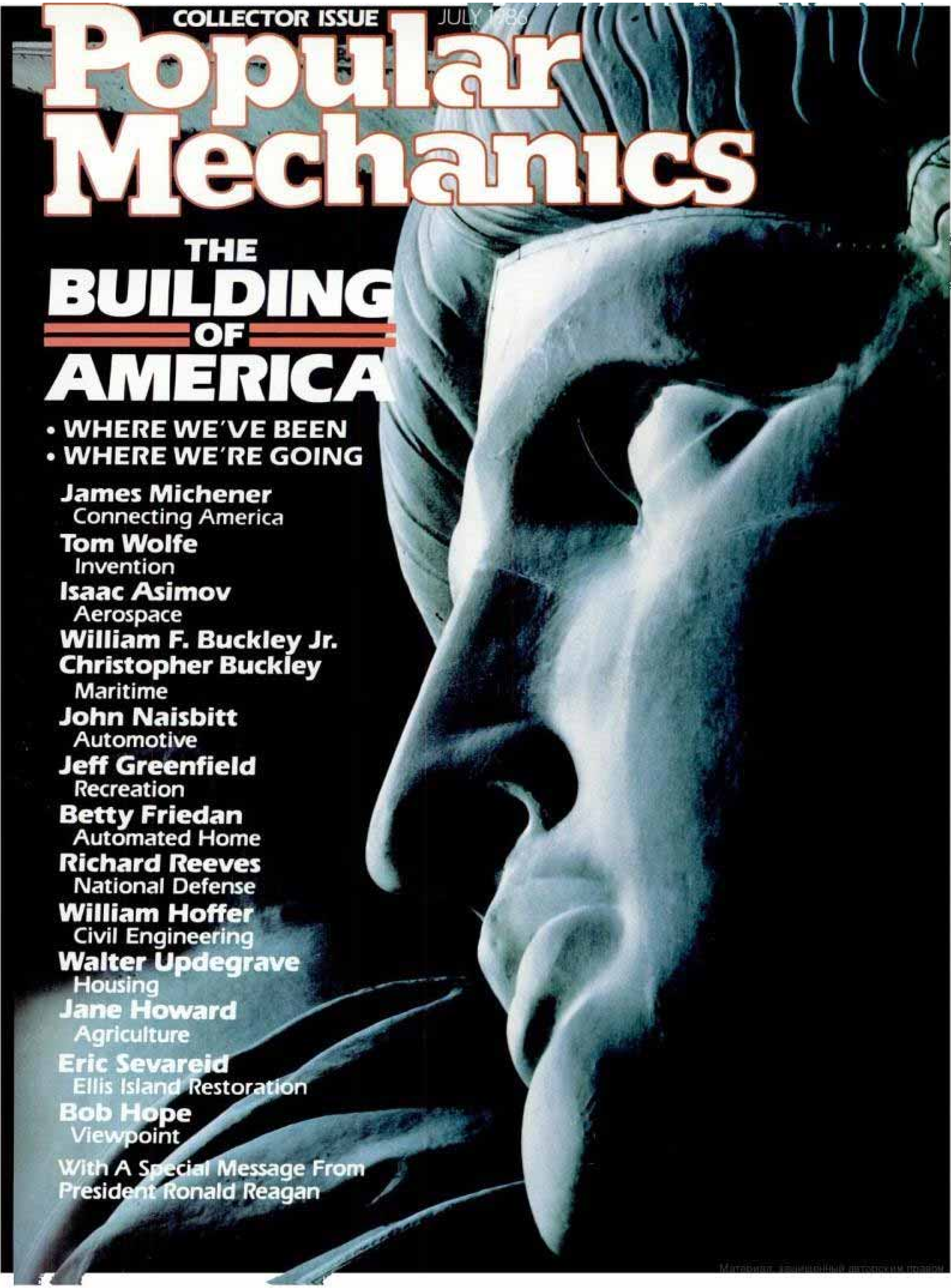
Recommended by Ford, Chrysler, GM for all new 4 cylinder and small 6 cylinder engines: 10W-30 or 5W-30.

Recommended for quality: The Big Q.

Quaker State quality should be your first choice whatever the viscosity. It's a one-of-a-kind performance oil. Quaker State 10W-30 or 5W-30. The factory recommended viscosities to protect 4 cylinder and small 6 cylinder engines.

Check your new car owner's manual.

Quaker State.
The Big Q stands for Quality.
Always has. Always will.



COLLECTOR ISSUE JULY 1986

Popular Mechanics

THE BUILDING OF AMERICA

- WHERE WE'VE BEEN
- WHERE WE'RE GOING

James Michener
Connecting America

Tom Wolfe
Invention

Isaac Asimov
Aerospace

William F. Buckley Jr.
Christopher Buckley
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Ellis Island Restoration

Bob Hope
Viewpoint

With A Special Message From President Ronald Reagan

Ford Bronco II


tough tradition...
Ford F-Series
Ford Bronco
Ford Ranger

...Ford's tough 4-wheelers.

(It's our middle name!)

Ford Ranger

Ford introduces Ranger SuperCab. It gives you over 22 cu. ft. of space behind the front seat. Or, add optional center-facing jump seats for seating up to five.

Sporty Ranger STX.

The 4x4 with everything on it...to go! The exuberant Ranger STX has over a dozen extra features, from unique paint to bucket seats, at a special package price. STX won the West, now it's offered nationwide.

New 2.9L V-6 Power.

The STX boasts Ranger's new bigger, more powerful 2.9L V-6. Electronically fuel injected, it hands you the reins to 140 horses.* (Ranger standard trim models also offer 2.3L EFI Four.)

New "Touch-Drive" System.

Presto! Just touch a button in the overhead console to shift from 2WD to 4WD high at any speed. Shift back to 2WD the same way. Ford's new "Touch-Drive" is that simple! (Manual locking hubs are still standard for you traditional off-roaders.)

Ford Bronco II

This tough number shares most of Ranger's good news. Like slick "Touch-Drive." Ford's remarkable new option brings push-button ease to 4-wheeling. You never have to wrestle a reluctant 2WD/4WD shift lever. You always have the assurance of 4-wheel drive high instantly.

New Powerhouse V-6.

Bronco II has the dash and drive of Ford's new fuel-injected 2.9L V-6. It's the one for power. For bashing through the brush with tighter turns than S-10 Blazer or Jeep CJ's. And for turning heads in town, too.

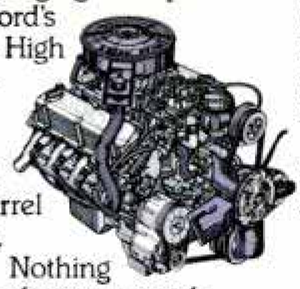
Eddie Bauer Broncos.

Both Bronco II and Bronco are offered in luxurious Eddie Bauer editions. They feature unique paint and special trim. High-styled interiors with Captain's Chairs. Plus Eddie Bauer tote and garment bags. And Ford's Extended Maintenance and Limited Warranty coverage. Ask to see this warranty when you visit your dealer.

Ford Bronco

Bronco's a winner... the strapping 4-wheeler that outsells every other full-size sport utility.**

Bronco starts with Ford's husky 4.9L Six, standard. And you go up from there, with the 5.0L V-8 with multiport electronic fuel injection – and 185 surging horsepower.* Or Ford's 5.8L High Output V-8 with 4-barrel carb.



Nothing in its class can match Bronco for power!

Unique Suspension.

Of all the big 4-wheelers, only Bronco has independent front suspension. To smooth your on-road ride. And to help keep wheels glued to the ground for maximum traction off the road. Your choice: manual front hubs or optional automatic front locking hubs.

Tow almost 4 tons!

The strong, powerful Ford Bronco can be equipped to tow 7,900 lbs. That's nearly a ton more than competitors– giving Bronco extra value and versatility nobody else offers!

Ford F-Series

They're too tough to top: America's best sellers 8 years straight.†

This year, Ford 4x4's pour on the power. With the biggest standard Six, plus the most powerful lineup of V-8's–big as 7.5L and 245 horsepower.*

They're the only big 4x4's with independent front suspension (Mono-Beam on F-350). The only ones with your pick of three cab sizes.

With Ford's rugged 4-wheelers, even the choice is tough!

Best-Built American Trucks.

At Ford, Quality is Job 1. A 1985 survey established that Ford makes the best-built American trucks. This is based on an average of problems reported by owners in the prior six months on 1981-1984 models designed and built in the U.S.

Lifetime Service Guarantee.

Participating Ford Dealers stand behind their work, in writing, with a free Lifetime Service Guarantee for as long as you own your Ford car or light truck. Ask to see this guarantee when you visit your participating Ford Dealer.

Buckle up–together we can save lives.

*Horsepower based on SAE Standard J1349 7.5L engine horsepower lower in California.

**Based on 1985 model year manufacturers' reported retail deliveries through July, 1985.

†Based on 1978 through July 1985 model year manufacturers' reported retail deliveries.

BEST-BUILT Built Ford Tough **AMERICAN TRUCKS**

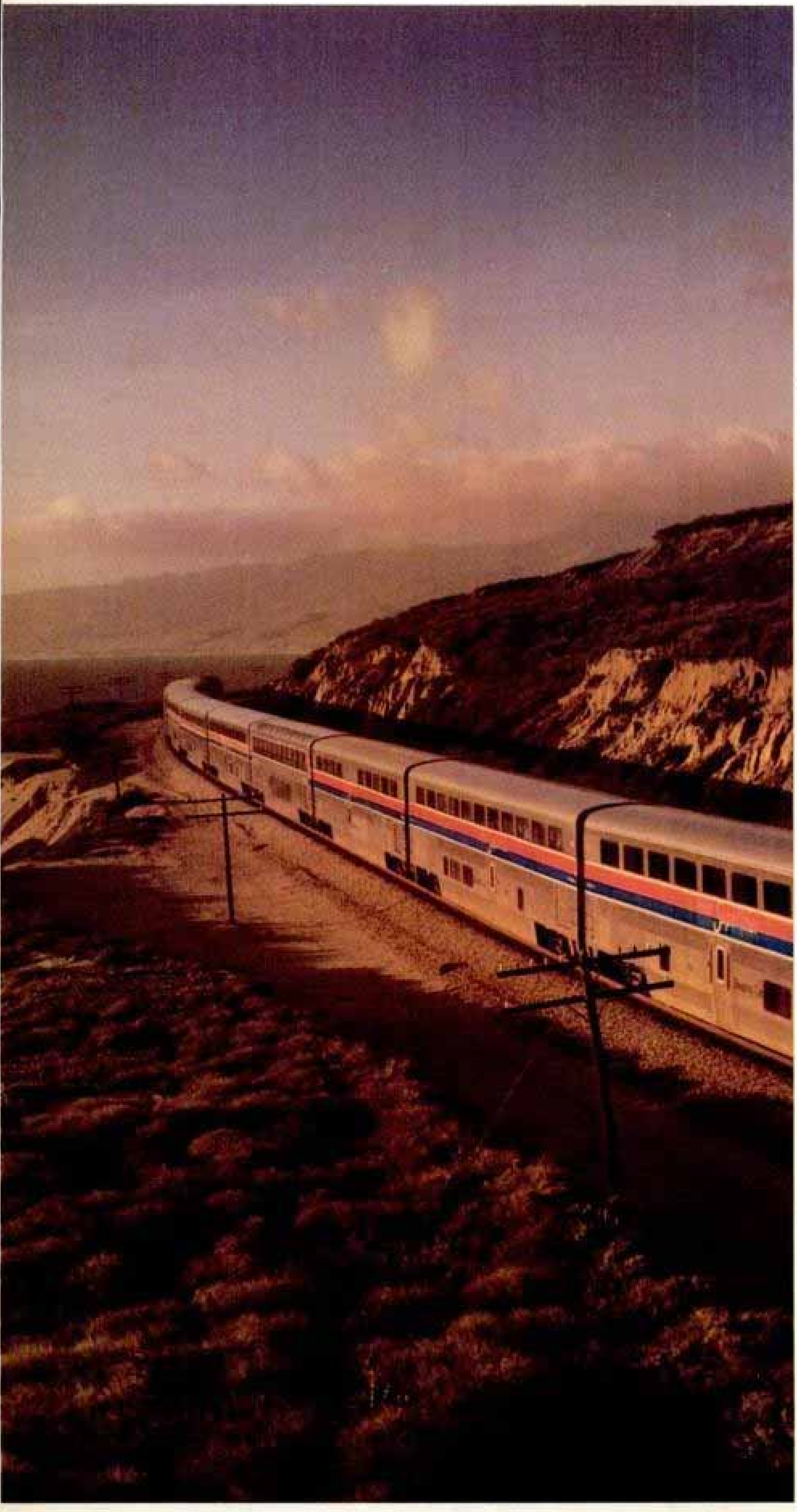

Ford F-Series


Ford Bronco


Ford Ranger

Ford Bronco II

"I THINK THIS IS A PERFECT PLACE TO HAVE A COCKTAIL."



America isn't just a country, it's a world.

But you won't experience the endless diversity and awesome beauty of it from 35,000 feet.

To unlock the magic of America you have to take the scenic route aboard Amtrak.

We'll whisk you in relaxed comfort to just about anywhere you want to go. Pampering you all the way with friendly service, first-rate meals and unlimited views.

Take Amtrak and you'll also find some of the newest, most modern equipment in the travel industry.

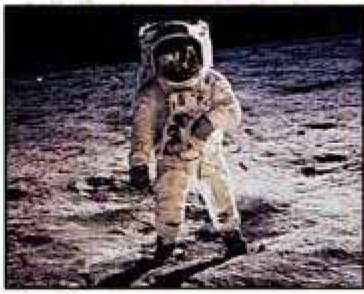
For more information, including our very affordable fares, call your travel agent. Or call Amtrak at 1-800-USA RAIL. Our staff of full-service professionals can also help arrange package tours, car rentals, even hotel accommodations in many of our nearly 500 destinations all across the USA.

Go for the magic and go for the train. Because on Amtrak, it's not just the destination, it's the journey. Cheers!

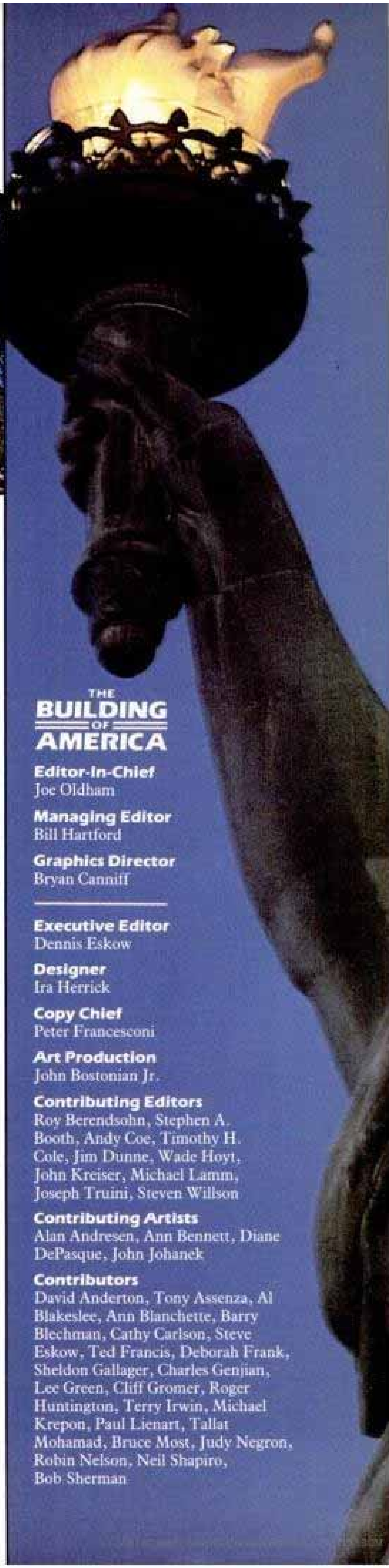
ALL ABOARD AMTRAK

Popular Mechanics

THE BUILDING OF AMERICA



TOP LEFT PHOTO FROM NASA/HASSELBLAD; TOP RIGHT PHOTO BY SKIP GANDY; MIDDLE AND FAR RIGHT PHOTOS BY JAKE RAJS
COVER PHOTO © 1983: PETER B. KAPLAN



THE BUILDING OF AMERICA

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The Building Of America

'We have rediscovered and reapplied a few basic truths about what government can and cannot do.'

BY RONALD REAGAN

Miss Liberty, the grand lady in New York Harbor, has borne witness to many great events during her first hundred years. She has welcomed millions of new Americans, and bid farewell to American servicemen and women who went abroad in wars of freedom and democracy. Indeed, she has been our sentinel, to mark progress on many fronts as we, a diverse people, have joined together to build America.

Under Liberty's gaze, fleets of commerce were transformed from wood and wind to steel and steam. Out from the corner of her eye, the world's most famous skyline grew, and the ports of New York and New Jersey became conduits for growth and prosperity for all of America.

In May 1927, she may have caught a glimpse of the Spirit of St. Louis before it departed Roosevelt Field for Paris. Today, she watches as jumbo jets make that same trip out of Newark and Kennedy airports as a matter of routine.

One hundred years ago, when the Statue of Liberty was first dedicated, your neighborhood was either emerging from an American wilderness or turning from simple farming to other industries. In the 1880s, most of America's beauty lay in forests, waters and range lands, left much the way God had created them. A century later, "America the Beautiful" is a nation of communities that, while caring for our natural beauty and resources, has succeeded in building a society that is the most prosperous and technologically advanced ever known.

As I've traveled this great land, I've heard a clear and consistent message from the people of America: Americans want the building to continue. They expect and deserve a government that will allow that to happen.

In the past few years, we have begun to shed the failed notions that government can provide all the answers or guarantee true prosperity. We have rediscovered and reapplied a few basic truths about what government can and cannot do.

Our government must provide equal justice under law and a sound economic policy; ensure our public health, safety and environmental quality; and, most importantly, guarantee our national security. The task of creating and building belongs to the working people of America. Often, the best thing that government can do to promote growth and prosperity is simply to get out of the way.

Less government, and a less costly government wherever it operates, allows our resources to be used more efficiently in private-sector initiatives. That ultimately translates into greater economic growth and more jobs.

Less regulation—less red tape—unfetters ingenuity and promotes the creation of more new enterprises. We've cut Federal paperwork for Americans—applications, reports and the like—by 350 million man-hours since 1981. That's the equivalent of every man, woman and child in Little Rock, Arkansas, working full time for a year filling out government forms. I think everyone, particularly the

citizens of Little Rock, would agree that there are much better uses for one's time than filling out government forms.

Lower tax rates have meant higher incentives for work and investment. The experience of the past few years—millions of new jobs and new business incorporations at record rates—proves a simple truth: If you tax something, you get less of it. In the 1970s, repressive taxes on growth and earnings were retarding growth and productivity. Our lower tax rates have cleared the decks for more innovation and greater prosperity.

That all suggests that the best view of government is in the rear-view mirror as you're driving away from it. But there are times when government can play a direct and appropriate role in building for our nation's future. Opportunities arise that are simply too enormous for individuals or businesses alone to tackle. The best example is suggested in one word: space.

In the years before I was born, commentators declared the American frontier closed. Once Arizona and Oklahoma became states, they said, the heartland was tamed. No more land grabs, no more gold rushes.

But Americans need frontiers; close one down and we open up another. We're doing that now. We are going to build a Space Station in the 1990s.

It will be the 20th-century equivalent of a frontier outpost on the fringe of the American wilderness, and a springboard to the development of new technologies and deeper exploration of space. The possibilities are as endless as space itself, and should keep us building for a long time to come.

SPACE WILL ALWAYS BE the final frontier. But frontiers still exist in our own communities—methods to obtain better, less costly housing, a cleaner environment, lower cost health care, more jobs.

Federal Enterprise Zones, if passed by Congress, will provide opportunities for new jobs and businesses where there are now only cityscapes of despair. Businesses using the Job Training Partnership Act are training the jobless to work where there are real opportunities. And Federal block grants will continue to provide resources to local communities to tend to our human and environmental needs. The Federal government will play a role in attacking these frontiers, but private citizens and businesses in their own communities, working as partners with local governments, hold most of the best solutions. Yes, here too, in our communities, we will continue to build.

Fifty years ago, driving a car to an airport had become routine, but flying across the country remained an adventure. In the same way, the Space Station will become another one of mankind's can-do miracles, an invention that will in time become commonplace as it opens up even greater opportunities.

We must continue to build for our future and that of our children. What now exists only in our imagination will someday become a tool for greater prosperity.

I envy Miss Liberty for what she will be able to witness during her next hundred years. PM

PHOTO: THE WHITE HOUSE

James A. Michener's U.S.A.

The Statue of Liberty, a lovely gift from France, has symbolized the fact that except for the first Americans, the Indians, the rest of us began by belonging somewhere else. America is the melting pot, the land of immigrants. We *are* the huddled masses.

If America has been shaped by any one essential force, it has been that of movement. Speed and transiency and the call of the open road seem always to have been part of America's destiny. From beyond the city limits the land called to us, drawing us ever farther toward new frontiers. As America looks forward to the 1990s, we have many more hundreds of miles to travel down the road Dos Passos described.

I have been asked why I traveled so much as a young boy. At 14, I would leave home with maybe 15, 25 or 35 cents in my pocket and hitch to Florida or some other distant place. It never occurred to me I wouldn't make it. Those were easy days for a hitchhiker. I think that before I was 15, I had been from Canada to Key West. Why did I do it? Life at home was not very pleasant. We were a very poor family. Things on the road were just about as good as at home. I think I traveled because I had an innate love of seeing what was around the bend. I've never lost that sense of curiosity.

For me, the most natural place to look at the country called the United States of America is my hometown, Doylestown, Pennsylvania. I was born there in 1907, and to this day I call it my home. Its streets, its institutions, its joys, its sorrows are familiar to me. But perhaps because I have never known who my parents were, I am also a child not so much of this particular place but of a larger place, a place of language and national identity: the whole United States. The psychology of this country is infused into who I am. Though I have lived and written in many countries of this world, when someone who does not know me asks what I do, my answer is constant—I am an American writer.

I have thought a good deal about our society, but I am not a philosopher. I have written a good deal of history, but I am not a historian. In the past, I've even taught sociology, but I am not a sociologist. And although I love politics, and even ran for Congress from the Doylestown area, I cannot be considered a political theorist.

I have had, however, one set of experiences that partly qualifies me for the task of taking a fresh look at our nation: As much as I have worked and written

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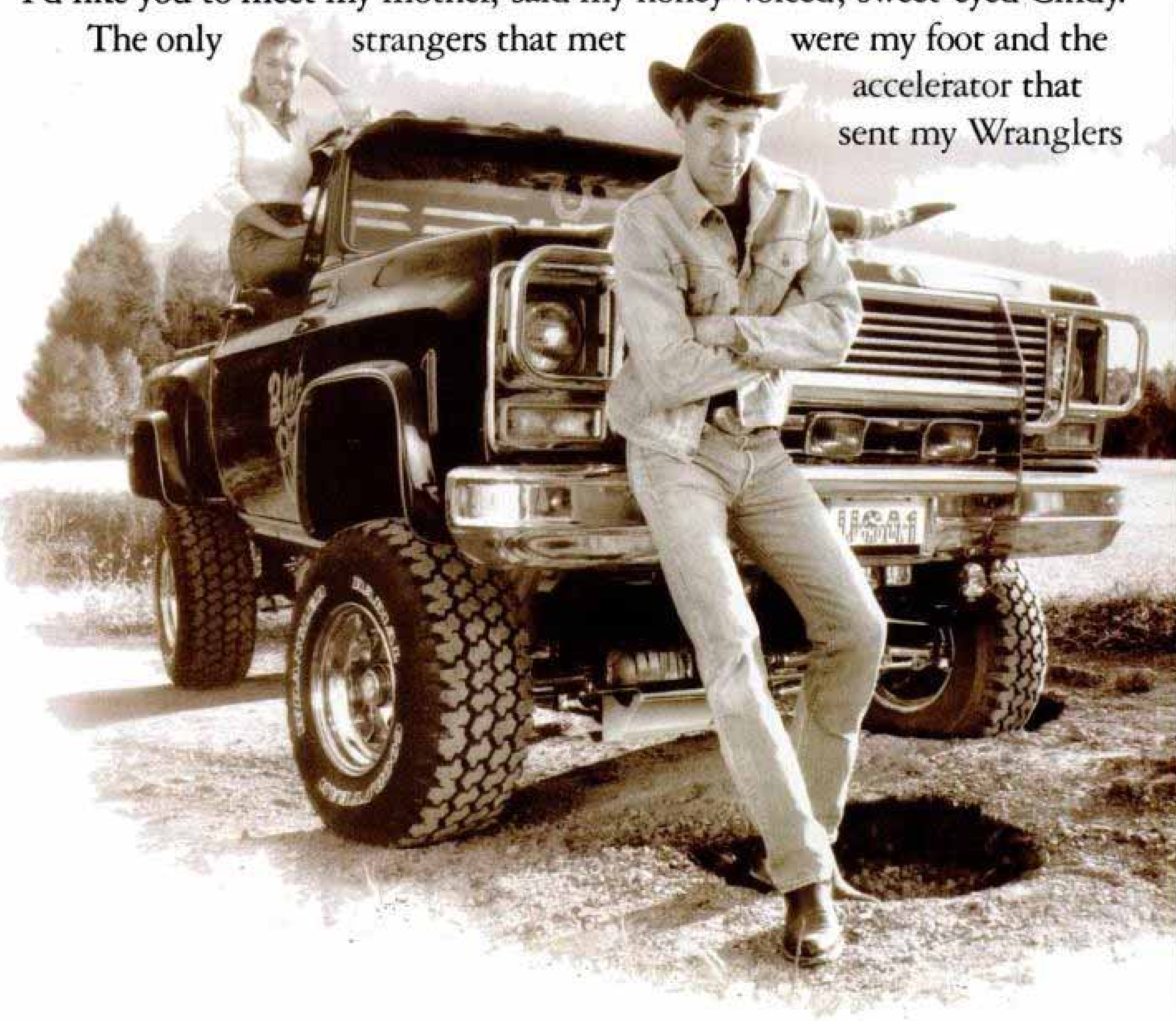
ALASKA HIGHWAY/PHOTO BY INDEX STOCK

"THE REARVIEW BEING CHASED BY A PLEATED SKIRT.

I pulled the 4-by into her driveway, turned the lights down low and let the Wrangler Radials purr to a stop. The only thing between Cindy's lips and mine were her good looks, when I heard a safety kick back like the last nail in the coffin. Suddenly my eyes were crawling up the barrel of a .357 Magnum attached to a 200-pound drill sergeant wearing a hair net.

'I'd like you to meet my mother,' said my honey-voiced, sweet-eyed Cindy.

The only strangers that met were my foot and the accelerator that sent my Wranglers

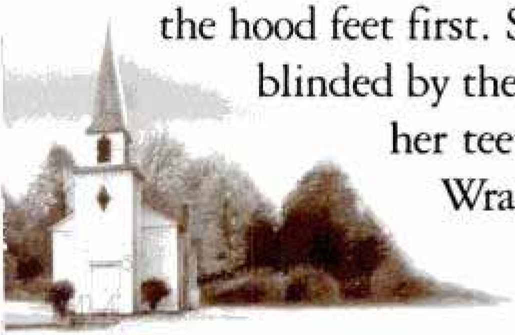


TOLD ME THAT I WAS
TAIL GUNNER IN A

into a spin and gravel into orbit. We were heading west doing fifty when my rearview picked up a speeding four-wheeler with a bazooka on the roll bar. The shell hit the white line about twenty feet ahead turning Hudson Street into a smouldering black hole with a welcome mat that said, 'Goodbye.'

My Wranglers didn't stop to take pictures and neither did her mother's. They chewed the crater's edge and spit us out like bad coffee.

There I was, just starting to pull ahead when I heard a thud that was second cousin to a baseball bat hitting a home run with a cantaloupe. Cindy's mother landed on the hood feet first. She was taking aim when we were blinded by the gleam of the bowie knife she held clamped between her teeth. Cindy screamed, I hit the brakes and my Wranglers bit the church parking lot with a foul-mouthed roar that sent the preacher halfway to heaven.



Now some skeptics will tell you my sweet little mother-in-law wouldn't know a bazooka if it asked her to dance, and the only crater on Hudson Street is a pothole that thinks it's a pinhead. But, if you buy that one, you might want to buy some Wranglers before your date with Cindy's little sister. ”

GOODYEAR

You either have Goodyear Wranglers. Or you need them.

at home, I have also worked extensively abroad. I have had an opportunity to see the United States from a distance; to see it whole; to see it through the eyes of others.

When I look at my country, I take pride in its stable system. I think of the United States as experienced and tested.

From this vantage point, it is significant and exciting to take stock of the U.S.A.—where we are and where we are likely to go.

The Northeast

THE HEART OF NEW England is still, as it has always been, the small town. Built around a village green—itself bordered by churches, a library, the town hall, a few small stores and perhaps an inn or a school—the New England village has long since entered the American consciousness as everyone's hometown. To millions of Americans, many of whom have never visited a Center Sandwich in New Hampshire or a Newfane in Vermont, the very thought of such places is sustaining. Even to imagine oneself in such a setting seems to bring visions of dappled sunlight filtering through the brilliantly colored foliage of a New England October.

In the not so distant past, New England was also the workshop and the educational heart of America. Its towns were the market centers for the ocean-borne commerce and the agricultural and manufactured products that once helped to sustain the nation. But the great days of world-traveling merchant ships out of Rhode Island, Massachusetts and Maine ports have entered the realm of history and legend. The textile and shoe industries, to which New England gave birth, fled decades ago to regions of cheaper labor. Even today, a quick tour of rural Vermont or New Hampshire can turn up hundreds of traces of once well-tended farms now abandoned. And certainly there are few more depressing examples of urban decay than once-prosperous mill towns such as Bellows Falls, Vermont, or North Adams, Massachusetts.

But today, one feels a sense of movement, of new wealth, of better times. A visitor to New England is aware of a new optimism at the bustling Faneuil Hall marketplace in Boston or in the workshops on the Maine coast. It is also evident along Boston's Route 128, an American center for high technology where scores of computer and communications firms work with scientists from such neighboring institutions as Harvard, the Massachusetts Institute of Technology, Boston University and Brandeis University. Hartford, Connecticut's capital city, has a revitalized downtown that is another testimony to the region's new prosperity.

New York

Despite its fiscal problems and deteriorating services, its graffiti and crime-ridden subways, and its prices, New York City remains the focal point of America's commerce, communications and culture. Within a short walk of the X-rated tawdriness of Times Square are the theater district's Broadway theaters. A 20-block stroll up Broadway brings a visitor to Lincoln Center, home of the Metropolitan Opera, the City Opera, the New York Philharmonic and the incomparable New York City Ballet. To the east and south, small movie houses, one after another, show films from just about every country in the world.

And everywhere, *everywhere*, there are restaurants. Do you fancy a kabob from Armenia? New York can accommodate you at a score or more eateries. Or how about raw fish from Japan? There's probably a place serving such delicacies within four blocks of any spot in Midtown. Or pasta, or haute cuisine, or a corned beef on rye—it's all there for the asking and the paying.

NEW YORK CITY/PHOTO BY JAKE RAJS

New York City remains the focal point of America's commerce, communications and culture.

New York is everything to everyman. It is bleak and shabby. It is bright and blooming. It's an impossible place to live and the *only* place to live. It's the human condition spelled out in neon. As the song says, "It's a helluva town!"

Boston

It has been said that the Northeast is made up of one big city stretching from Washington, D.C., to Boston, Massachusetts. And it has been given a label: megalopolis. Oliver Wendell Holmes called Boston "the hub of the solar system." Today, Bostonians call their city "the hub of the universe."

I'd like to take a look at Boston as an example of where our older cities are going. The city proper has almost 700,000 people, but Boston is really a ring of about a hundred cities and towns comprising a metropolitan area of more than 3 million residents.

Boston is also the home of one of the most talked about and admired pieces of urban development in America: the rebuilt Faneuil Hall marketplace. It is at this place, amid jugglers and pushcarts, old brick walls and tree-lined paths, that delighted visitors are able to sample a cornucopia of food and drink and shop in a dazzling variety of attractive stores, while their dollars provide jobs for 2000 Bostonians and at the same time swell the city and state tax bases.

Washington, D.C.

If someone familiar with the Washington of a decade or two ago were to return to the city today, he would undoubtedly be struck by the extent to which the capital has changed. Each day, as in years past, tourists pour in to gaze at the monuments and visit such magnificent museums as Air and Space, History and Technology, and the Hirshhorn Gallery. But now, instead of locking themselves into their hotel rooms at night, they join the city's residents and suburbanites for dinner at 3-star restaurants or an evening at the theater—perhaps the splendid John F. Kennedy Center for the Performing Arts. On warm evenings, on streets that but a few years ago were deserted after sunset, café patrons sip coffee while they watch the city strolling by.

Still, the old, intractable problems—poverty, crime, unemployment—remain. But hope has replaced despair, and the possibility exists that this city is on its way to becoming worthy of its title as capital of the world's greatest democracy.

Philadelphia

Philadelphia's heritage is a glorious one. In the 18th century, it was the American colonies' leading city, the second-largest English-speaking city (after London) in the world. It was here that Quaker founder William Penn hoped to establish a model community where peace, justice, religious liberty and contentment would reign supreme under the watchful eye of a merciful God. It was Ben Franklin's city, the nursery of American science and art, and the cradle of liberty. Here Franklin, Thomas Jefferson and John Adams met to hammer out the Declaration of Independence in 1776. A decade later, "we the people of the United States" converged upon Philadelphia once more "in order to form a more perfect union" through the Constitution. From 1790 to 1800, Philadelphia was the nation's capital. And because of the harbor that made it America's principal port, it was the commercial capital as well.

Today, new restaurants, theaters, art galleries, markets and commercial buildings form an exciting backdrop to the quiet of the restored 18th- and 19th-century neighborhoods. When *New Jersey Magazine*, whose readers live in the shadows of two great metropolises, compared the amenities of Philadelphia and New York City, "Surprising Philadelphia" held its own.

The South

HOW MANY PEOPLE IN America have the option of returning to the style of an earlier day? In much of America, we erase the past with each rebuilding.

And yet, as the South moves ever more quickly toward an industrialized future, Southerners continue to honor and preserve those traditions that are particularly their own. The great Southern writer Eudora Welty describes her country kinsmen as born reciters, great memory retainers and great talkers—above all, great talkers. Storytelling is an art that has always been much loved in the South. And, as a storyteller myself, I love the Southern verbal tradition.

The South has a special atmosphere, one where language is as vital an element as air and where the fine art of conversation comes as naturally as breathing.

Atlanta

Atlanta has been called the Cinderella City because of the vast amount of building here in the 1960s. And now, dressed for the ball, Atlanta claims its place as the Southeast's leading urban center.

Yet, some people ask, is Atlanta really the South at all?

The city's gleaming skyscrapers, busy freeways and modern rapid-transit system present an urban landscape as futuristic as any in the nation. There seems to be little evidence of the sleepier days of antebellum charm.

From the time that Gen. William Tecumseh Sherman burned Atlanta to the ground in the Civil War, successive generations have rebuilt her. She is a phoenix of the South, rising again and again. Today, the city is an international center of industry and commerce. About 440 of the biggest industrial firms among the Fortune 500 have offices here. The world is discovering this city, and through Atlanta the entire American South.

An ironic proof of Atlanta's successful growth is the air pollution that threatens the central city. Most of the air pollution comes from automobile fumes, and new auto registrations have risen twice as fast as the population. The city's hope for dealing with this familiar problem is MARTA—the Metropolitan Atlanta Rapid Transit Authority—a 53-mile urban rail line integrated with nearly 1500 miles of bus lines. Experts consider MARTA a model urban-transportation system, one that will be copied by many other American cities.

Gleaming skyscrapers help to mark Atlanta as a modernistic center of commerce.

TVA and growth

In 1933, Congress authorized the creation of the Tennessee Valley Authority, charged with coordinating and extending flood control, navigation and hydroelectrical services along the Tennessee River and its tributaries. In the intervening decades, the dams, reservoirs and power plants that the TVA has built and operated have changed the face of some 40,000 square miles of land in seven states. By eliminating annual floods, the TVA brought tens of thousands of acres into productive agricultural use. By providing relatively inexpensive electrical power to a vast area, it created not only the means to improve farming but also offered a great pool of energy for industry. Finally, by deepening channels along the Tennessee River system and encouraging the building of ports, it made the river a major artery of commerce.

Orlando

Although almost every area of Florida has felt the effects of encroaching populations, central Florida has been particularly hard hit. Not too long ago, central Florida was where tourist cars tanked up before making the final dash south to the glittering Gold Coast—Miami Beach and its satellites.

Beaches highlight Florida's Gold Coast.

The orange groves and the cattle ranches of central Florida still exist, although their number has shrunk visibly. Orlando has experienced explosive growth, with all the problems attending it.

What happened? First, the federal government decided to transform Cape Canaveral—about 65 miles east of Orlando—into a major aerospace research and development facility. Cape Canaveral's influence, though, was only a modest prelude to the effect of the opening of Walt Disney World in 1971.

Other amusement parks soon sprang up in the area, hoping to cash in on Disney World's pulling power.

In the immediate vicinity, there are Sea World and Circus World, Reptile World and Alligatorland Safari, and Gatorland Zoo. Slightly farther away, Silver Springs, Cypress Gardens and The Dark Continent beckon.

Miami

Why would a mayor of New York City travel a thousand miles to Miami, Florida, just to "press the flesh"? The answer is simple enough. New York Mayor Edward Koch was greeting his constituents. At any one moment, thousands of New York residents can be found in the Miami area, and tens of thousands of retired folks from New York now live there permanently. True, members of this last group no longer vote in Gotham, but they maintain strong family ties with the city. Many of their sons, daughters, cousins, nephews and nieces still cast their ballots in the Big Apple. According to some wags, Miami and its metropolitan area are, in reality, nothing more than New York City's sixth borough.

Of course, Miami is a great deal more than that. It is a major port for Latin American trade. It remains, in spite of the Caribbean Islands, America's vacation paradise. Miami Beach alone boasts almost 400 hotels with more than 30,000 rooms. In recent years, Miami has become a center of light industry, with thousands of small manufacturing plants, and has achieved a reputation as a scientific center, particularly in the field of oceanography.

Physically close to the geriatric communities and lush tourist hotels of Miami Beach—but light-years away in spirit—is another Miami: the world of Cuban refugees, escapees from the Castro dictatorship, who have established on the Florida shore a vital, prosperous Latin enclave. These are new Americans. Their success repeats—and in many cases far surpasses—that of earlier immigrant groups.

What they have accomplished is truly remarkable. They have revitalized whole sections of the city, and transformed once-decaying neighborhoods into healthy communities. They have lent a sense of solidity to a city that otherwise seems almost always in the throes of change. And they have endowed Miami with true charm, a grace that becomes quite obvious when compared with the gaudy pleasures and expensive honky-tonk of the resort strips nearby.

New Orleans

Though New Orleans boasts one of the busiest ports in the nation, though petrochemical plants make the metropolitan region one of the world's great oil centers, though the massive Superdome proclaims the ascendancy of big-time sports, it all seems quite alien. Houston to the west and Atlanta to the east are the real money-making centers of the region, and New Orleanians look upon them with both envy and disdain.

Here in the Delta, there is a softer message carried on each breeze. It says, "Don't hurry, don't rush. Come, sit on a café terrace. Breathe deep. Relax. Have an aperitif. Watch the world go by."

Nashville

They call it, with the hyperbole typical of the region, the Athens of the South, and

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The French Quarter of New Orleans: a favorite of tourists drawn to the Delta.

not only because it boasts a built-to-scale replica of the Parthenon. (It was erected in 1897 to commemorate Tennessee's statehood and the elevation of Nashville itself to the state's capital city.) Nashville also can claim a number of fine old Greek-Revival buildings, and 14 universities and colleges, including the top-ranked Vanderbilt and Fisk.

Nashville's recording industry generates billions of dollars. The city has nearly 100 recording studios that operate day and night, six record-pressing companies, 250 music publishers, 3000 union musicians and 34 talent agencies—not to mention the Grand Ole Opry House, the Opryland U.S.A. theme park or the Opryland Hotel, Tennessee's largest. For many of the more than 7 million tourists a year, Nashville is as exciting a place to visit as Hollywood is for movie fans. You can see Roy Acuff and Loretta Lynn in the flesh, catch a glimpse of Dolly Parton emerging from her limousine or pick out from the throng of would-be country music stars—who come by the thousands to this mecca of the electric guitar—the next Elvis Presley.

The Midwest

IF THE 12 STATES THAT comprise the American Midwest—Ohio, Indiana, Michigan, Wisconsin, Illinois, Missouri, Minnesota, Iowa, Kansas, North Dakota, South Dakota and Nebraska—were an independent country, it would be a colossus among nations.

Taken together, these states are home to 60 million Americans—one-quarter of the population of the United States—and cover 763,500 square miles, an area larger than continental Western Europe minus Scandinavia.

However, it is not just size and population that make the region a giant. It is the fact that here, in the American heartland, is America's muscle. These states, with their prairie and plains farms, form not only America's breadbasket but the food reservoir for the entire world.

For all its agricultural diversity and abundance, the Midwest is pre-eminently industrial. Detroit and its surrounding metropolitan area may be seen as the linchpin of America's entire manufacturing complex. When the automobile industry thrives, America booms; when it falters, America staggers. So many basic industries—steel, rubber, mining, glass, to mention a few—depend upon the health of the auto industry that the ripple effect of a downturn in car and truck production and sales is felt throughout the nation. But it is felt most disastrously in the Midwest, where millions of workers are directly or indirectly dependent upon this one industry.

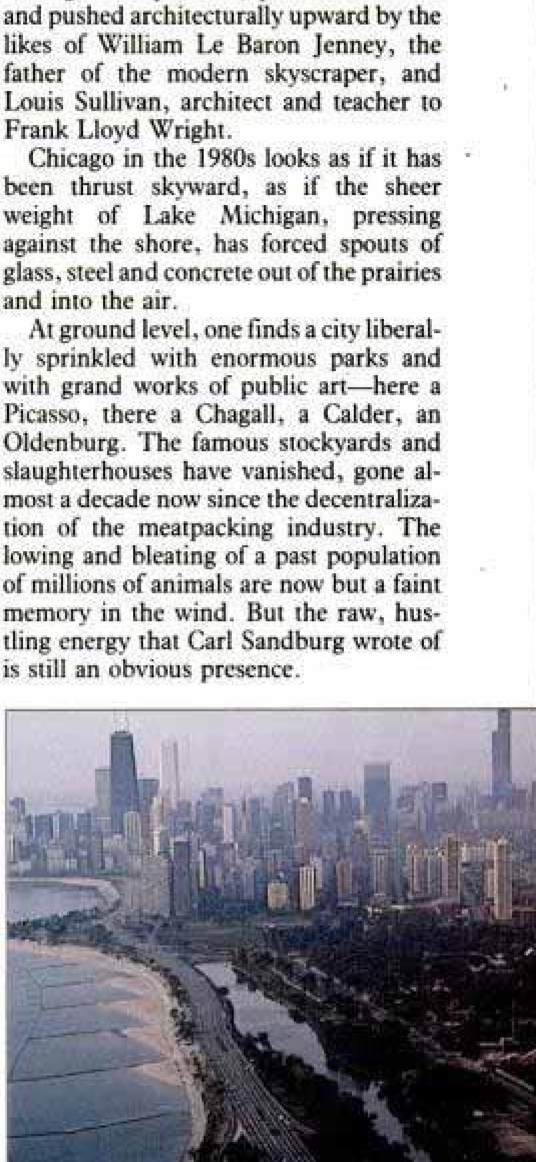
Chicago

In the Midwest, all roads lead to Chicago. It was here, in 1902, that H.H. Windsor founded POPULAR MECHANICS. It is the heart of the American heartland. The trucks and the cars come funneling through this major city on the prairie at the rate of hundreds of thousands each day. The railroads, which first put the city of Chicago on the map, are today but a minor factor in the city's wealth, their place having been taken by the airplane. Chicago's major airport, O'Hare International, is the world's busiest: About 2000 aircraft a day, in and out, alternately soak up and disgorge the more than 50 million travelers who pass through this terminus each year.

Chicagoans also exult in the world's tallest building, the Sears Tower; the biggest single steelmaking plant on Earth, Inland Steel; the largest hotel in the nation, the Conrad Hilton; the biggest sewage-treatment system anywhere; America's largest volume of manufactured goods shipped; and the tallest apartment building. In fact, a condominium owner on the 92nd floor of the John Hancock Center—which soars above Chicago's "Magnificent Mile" and incorporates both offices and dwelling places—raised his floors by 6 inches just so he could claim ownership of the most elevated apartment in the world. The city of Chicago was planned, prodded onward and pushed architecturally upward by the likes of William Le Baron Jenney, the father of the modern skyscraper, and Louis Sullivan, architect and teacher to Frank Lloyd Wright.

Chicago in the 1980s looks as if it has been thrust skyward, as if the sheer weight of Lake Michigan, pressing against the shore, has forced spouts of glass, steel and concrete out of the prairies and into the air.

At ground level, one finds a city liberally sprinkled with enormous parks and with grand works of public art—here a Picasso, there a Chagall, a Calder, an Oldenburg. The famous stockyards and slaughterhouses have vanished, gone almost a decade now since the decentralization of the meatpacking industry. The lowing and bleating of a past population of millions of animals are now but a faint memory in the wind. But the raw, hustling energy that Carl Sandburg wrote of is still an obvious presence.



Chicago: a city reaching for the sky.

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Detroit

Under the best of circumstances, Detroit would be a city in trouble. Most of its neighborhoods are old and dilapidated. The middle class long ago fled to the suburbs, reducing the city's tax base and increasing its need for expensive social services. But like other cities that experienced hard times in the late 1970s and early 1980s, Detroit is on its way back—and then some.

Back in 1977, Detroit completed a magnificent complex of new buildings, the Renaissance Center, which includes four skyscraper office buildings surrounding a 73-story hotel. The Renaissance Center is the symbol of a city's restoration to greatness, the symbol of a new day. That new day has already come.

The downtown area is experiencing a revitalization that would astound you if you remember what Detroit was like. With the Renaissance Center as the hub, scores of new hotels, restaurants, nightclubs and shops have opened to handle the needs of visitors to Cobo Hall, the Joe Louis Arena and other convention and cultural facilities.

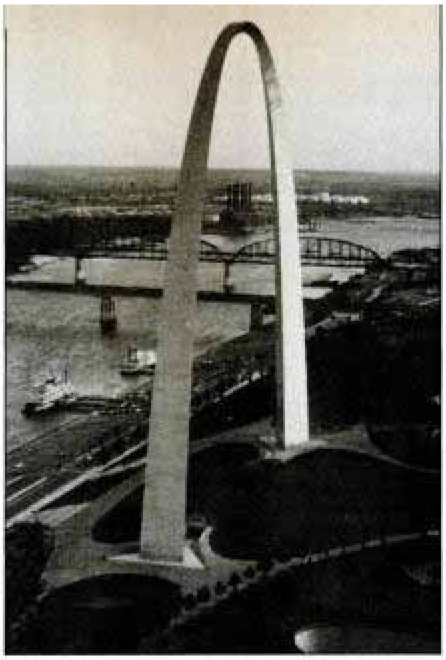
With the car companies experiencing a sales boom and with record profits straining the coffers of Detroit, it's no wonder things are looking up in Motown.

Minneapolis/St. Paul

On almost everyone's list of America's 10 most livable urban areas, the Twin Cities of Minnesota—Minneapolis and St. Paul—rank high.

Hints of bone-crunching cold may come to the Twin Cities as early as October, and a distinct chill may remain in the air well into May. Given a climate much like that of Scandinavia—whence the ancestors of a great many Minnesotans came—Twin Cities dwellers take a particular delight in flowers, in color, in sunlight, in anything that enhances the glory of the all too brief summer and lightens the gloom of the long winter night. Minneapolis alone boasts no fewer than 153 parks, lovingly landscaped, and 22 lakes open to community recreation. In the downtown areas of both cities, a network of enclosed pedestrian bridges, one story above street level, connects scores of office buildings, shopping malls, restaurants and entertainment areas so that in winter workers and those seeking the amenities of urban life need not bundle themselves up and face the peril of the slush-covered streets.

This ability to stay indoors while shopping or while rushing from dinner to the theater has played a considerable role in the Twin Cities' successful efforts to maintain their downtown areas as both economically and culturally viable.



Gateway Arch: symbol of St. Louis and the limitless possibilities beyond.

St. Louis

The city of St. Louis rises where the mightiest of waterways joins the muddiest (described by those who know her as "too thick to drink and too thin to plough")—where the Mississippi meets the Missouri.

French trader Pierre Laclède selected this site back in 1764 to establish a post from which he could trade with the Indians who lived upriver. He wrote, "I have found a situation where I intend to establish a settlement which, in the future, shall become one of the most beautiful cities in the world."

St. Louis's Gateway Arch is as beautiful, certainly, as Laclède's vision must have been. This soaring structure of stainless steel, designed by the great Eero Saarinen, has become a famous symbol not only of the city but, even more, of the limitless lands that lie to the west.

The Southwest

WHEN BRIGHAM Young and his band of Mormons arrived in Utah in 1847, they soon found that there was not enough rainfall to water their crops. So they dug irrigation ditches—among the first such structures built by white men in America (the southwestern Indians had been irrigating for centuries)—to carry water from a nearby river to their fields. By 1865, the Mormons had more than 150,000 acres under irrigation and had constructed 277 canals.

Since then, hundreds of dams have been built along the Colorado River and its tributaries. Many were erected by the Army Corps of Engineers to control floods or permit navigation. Utility companies built others to dam water for power generation.

More than half the Colorado dams are multipurpose: They are used to store water for irrigation, to control it during periods of flood and to harness it for hydroelectric turbines. The storage dams are connected to the fields and faucets of the Southwest by networks of canals, pumps, pipelines and tunnels. These systems supply water to farms, factories and cities often many miles distant.

To irrigate the fields of northeastern Colorado, the Colorado-Big Thompson Diversion System actually shifts water to the eastern slopes of the Rockies that would, if left to itself, flow down the western slopes. The system accomplishes this immense diversion by pumping millions of gallons up-slope and through the 13-mile-long Alva B. Adams Tunnel, a conduit that slices through a mountain.

Two enormous water carriers, the All American Canal and the Colorado River Aqueduct, feed Southern California. Of all the consumers of Colorado River water—and they include the states of Wyoming, Utah, Colorado, Nevada, New Mexico and Arizona and the nation of Mexico—California absorbs by far the most: 1.61 trillion gallons in 1975. New Mexico, the smallest user, took .094 trillion gallons. Mexico, using water diverted to it along the Alamo Canal, got only .54 trillion gallons.

The Colorado is in a sense bankrupt, since it owes far more water to its users than it takes in. Nevertheless, a vast new water supply scheme is in the works to keep Arizona's major cities, Tucson and Phoenix, water-solvent in the coming years of higher population growth and diminishing ground-water tables.

Water has always been a central political issue in the Southwest, and its battles have been fought hard both in the southwestern states and in Washington. In 1935, when the first of the great dams, the Hoover Dam, was built to stem the devastating annual floods of the Colorado River, the state of Arizona sent its National Guard to the dam site in a futile effort to halt—by force of arms, if necessary—the diversion of Colorado River water from its natural course through Arizona into the parched but populated regions of Southern California.

Arizona lost that particular battle, and for more than half a century now the Hoover Dam has stood, hailed as thing of beauty and a miracle of engineering. Its benefits are manifold, and its power is awesome. It holds a 2-year supply of the

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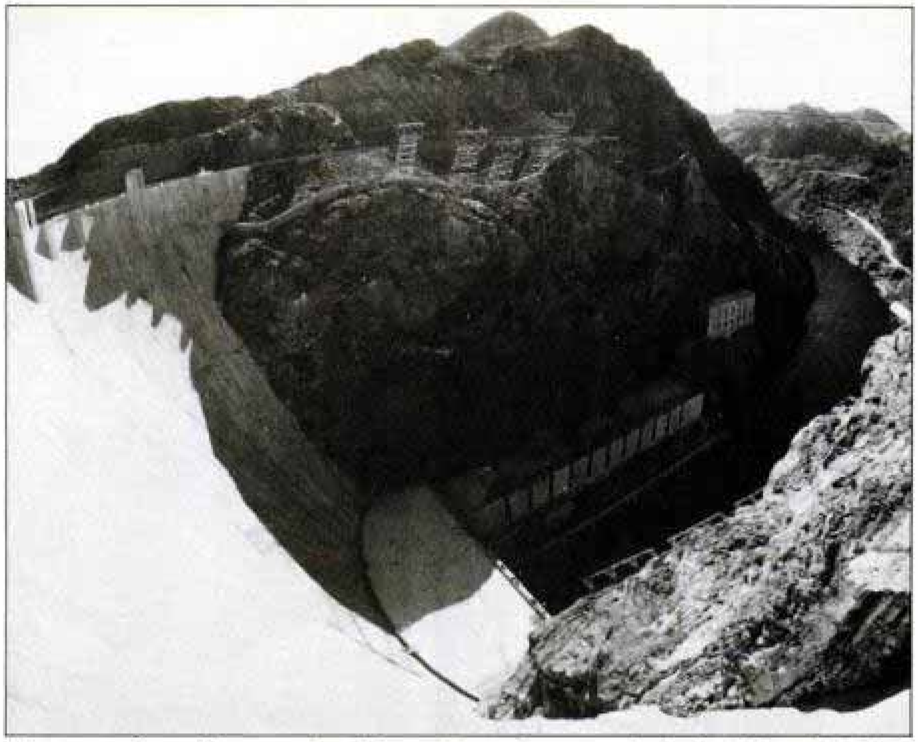

For more than 50 years, the Hoover Dam has restrained the Colorado River, stemming its annual floods and turning it into a source of water and power.

great Colorado River in check. As impressive and important as the Hoover Dam may be, the construction of six more large dams on the Colorado has raised serious questions. Some observers feel that these dams pose a fundamental threat to the environment, that man is altering nature in such a way that he may destroy important natural resources.

One vision of the future Southwest pictures the Colorado River turned into a vast network of lakes and channels spread through the mountains, its waters funneled to far-off cities and agricultural operators miles and miles away.

Houston

When the Trailriders come to town to take part in the Livestock and Rodeo Show, Houston, Texas, reverts, if only for a moment, to its pioneer beginnings. To hunker down with the performers as they camp in the middle of downtown Houston's Memorial Park, to listen to the twanging guitars and quiet voices humming old cowboy ballads, is to be taken on a nostalgic journey of the mind back to the Southwest of a century ago. Yet these are 20th-century Trailriders, and when they open their 2-week shows, it will not be in some dusty corral but in Houston's plush Astrodome, the very model of an up-to-date stadium that only the modern American technological mind could conceive of, much less build.

Dallas

Nothing illustrates Texas's bigness better than the Dallas/Fort Worth Airport, which lies midway between the two cities. Approximately the size of Manhattan Island, this agglomeration of runways, terminals, hangars, parking lots, looping roads and the like is larger than all three of the New York City area's commercial airports put together, with room left over for a fourth landing field of prodigious expanse. Local talk has it that innumerable passengers changing planes at Dallas/Fort Worth have landed there with all of their faculties perfectly intact only to be driven absolutely mad by the sheer bafflement involved in finding their way from one terminal to another. Be that as it may, the airport is certainly a symbol of the astonishing growth of the Sunbelt in general and the Dallas/Fort Worth area in particular. Today, the two cities, which are some 30 miles apart, and the many suburbs they dominate boast a combined population of more than 2.5 million—and among these residents are many of the wealthiest people in the United States.

Dallas, with more than 900,000 citizens, is the seventh-largest city in the nation and the second largest in Texas. If Houston is bigger and growing somewhat faster, citizens of Dallas take comfort in their firmly held belief that in terms of wealth, culture, commerce and the amenities of urban life, their city far outclasses any other in the entire Southwest. Indeed, Dallas is the state's and region's major insurance and banking center, and it boasts thriving aerospace and computer industries as well as a major symphony orchestra, an acclaimed local theater group, an impressive summer opera program and that perennial National Football League power, the Dallas Cowboys.

Yet, despite its patina of culture, there is much about Dallas that bespeaks the open, raw and brutal competition for money. It is this aspect of the city's life that has made it fascinating to Americans from every region and every walk of life.

Las Vegas

Las Vegas hurls its neon glow into the night where once there was only sand and the occasional lizard or rattlesnake. Here even the Mormons, a people of incredible tenacity, couldn't make a go of it. They arrived in 1855 and tried to farm the "meadowland" (Las Vegas means "The Meadows" in Spanish)—a small patch of green watered by artesian springs in the middle of the great western desert. After two years they gave up, abandoned their homesteads and returned to greener pastures in Utah.

The town would have remained a small desert community like its widely scattered neighbors in the dusty reaches of southeastern Nevada but for two events: the construction of the Hoover Dam 25 miles south of Las Vegas, which began in 1931; and the legalization of gambling—by local option—legislation that was passed in the same year.

Reno remained the casino gambling center of Nevada until just after World War II. By then, air conditioning had made it feasible to build huge hotels in the desert, and they began going up all over Las Vegas—at first in the city's downtown section (now renowned as Glitter Gulch), later in an area along the highway called The Strip. The huge profits to be made in casino ownership soon brought in the mob. "Bugsy" Siegel built his Flamingo Hotel in 1946; in 1947, when he was flamboyantly assassinated gangland style, investigators began to look into the extent of mob control of the gambling industry, and the state of Nevada decided to require the licensing of casino owners.

The West

THE WEST. FOR LONGer than we have been a nation, the very words have been a symbol, a metaphor for unlimited possibilities. From the rapidly developing urban centers and farmlands of the eastern states, settlers moved ever farther west, at first leapfrogging the high plains beyond the Missouri to put down roots along the Pacific Coast and then finally filling in the grasslands. The pioneers moved west seeking furs, seeking gold, seeking land. They wanted new lives, free from constraint, rich in opportunity.

Many never saw their promised land. But in spite of the high risks, the settlers

PHOTO BY MORTON BEEBE, IMAGE BANK

Air conditioning and casino gambling have helped make Las Vegas a tourist jackpot.

kept coming, pushing ever westward to the fertile Oregon farmlands and those veins of California gold.

The fertile farmlands and grazing pastures of the West cover coal reserves estimated at 1.3 trillion tons in Wyoming, Montana, Colorado and Utah alone. In addition to coal, there is more oil in the shale deposits of these states than in the entire Middle East, plus enormous deposits of other vital minerals, such as uranium and copper.

Development of the West's vast resources will have tremendous impact on the lives of the people who live here. The energy needs of the nation are being pitted against the human needs of the region. To extract these subterranean riches requires mining operations on an unheard-of scale. Converting the most accessible mineral, coal, into electric power has already produced air pollution in the once-pristine places where these coal-fired plants operate—at the Four Corners Plant, for example, or the plants at Colstrip, Montana.

Land, which we once thought limitless here, can be used for only one purpose at a time: You can ranch it, you can live on it or you can mine it—but you can't do all three.

San Francisco

It was a tiny port on the California coast, a small town of barely 300 people that, along with the rest of California, had only recently transferred its allegiance from Mexico to the United States. Those rare travelers—mostly seamen—who chanced upon this village often remarked on the beauty of the natural setting, and a few even predicted a great future for this place known as San Francisco. Hardly anyone, however, could have foreseen that within a few years the sleepy port would be transformed into a raucous, burgeoning city, the boomingest boom town in the entire world. The cause of this sudden change in San Francisco's fortunes was that most precious of metals for which men have fought, murdered, suffered and died: gold.

By the end of the 1850s, the California gold rush had run its course, and the hectic boom days in San Francisco were over. Yet the city did not revert to its former somnolent self. Its climate, its splendid port and the establishment of a financial elite within its borders combined to maintain its status as the premier city of the golden West. Many of those who had come—not just from the eastern United States but also from such distant realms as England, France, Germany, China and Australia—to seek their fortunes as '49ers remained in San Francisco to impose on the city a cosmopolitan atmosphere unrivaled by any other American metropolis save possibly New York. By the turn of the century, San Francisco had become a magnet for both bohemians and capitalists. The dining room of the Palace Hotel was the place where these two worlds met, rubbed shoulders and discussed the latest production at the opera house. Not even the disastrous earthquake and fire of 1906 could do more than momentarily slow San Francisco's rise to pre-eminence.

Chinatown, North Beach, Haight-Ashbury, the 40-odd hills with their antique cable cars, the "Top of the Mark" and Fisherman's Wharf all have special meanings to the millions who have visited the city, and even to the millions more who merely dream of doing so.

As one writer once put it, "It is still the . . . city . . . where a walker can experience a nostalgia for the place while he is still there—a little, even a lot, like the *nostalgie de Paris*."

Los Angeles

Millions have thronged westward to California over the years to settle in the far-flung reaches of the city of Los Angeles. And millions more—the stay-at-homes—wonder why. It is common knowledge that the Los Angeles area is doomed to fall into the sea one day; it sits right on top of the famous San Andreas fault, a geologic fracture that causes frequent tremors of the earth and an occasional earthquake. It's hot and dry in the city, and the aggressive Santa Ana winds periodically fan fierce fires that eat up vegetation and buildings alike. Drought is often succeeded by heavy winter rains that make a muddy soup of the soil, loosening foundations to such a degree that homes built on the slopes frequently slide off their perches. Los Angeles smog, a specialty of the region, can sit for days on the city, and people move in its murk watery-eyed and sneezing.

Today, the city covers 464 square miles of mostly single-family houses on tiny plots. The housing tracts abut one another and surround the original city, now known as "Downtown," in dense agglomerations. So huge is Los Angeles that it has engulfed other, smaller cities in its enormous spread, and the influx of population has transformed Los Angeles' once-rural Orange County into the nation's second-largest metropolitan area.

After World War II, affluence permitted almost everyone to buy a car, and the city junked what had been the finest American mass-transport system and built, instead, a vast network of highways—"freeways" to Angelenos.

The freeway system, which would eventually reach a total length of 600 miles, allowed for the urbanization of the farmlands in the San Fernando Valley and in other previously inaccessible areas. It made Los Angeles, more than any other American city, dependent on the automobile. Cruising the freeways became a favorite L.A. recreation.

Hollywood

Americans have always moved west to seek their fortunes. During the last half-century or so, a not insignificant portion—in talent, if not in overall numbers—of this westering breed has been coming to Los Angeles with the specific ambition of making it big in that city's most famous industry: the movies.

But sometime around 1949 or 1950, the movies' monopoly began to fade. Another kind of screen—the television screen—was entering the nation's consciousness. Families for whom "going to the movies" had been an automatic response to the coming of the weekend suddenly began

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Los Angeles is a testament to Americans' love affair with the automobile. With 600 miles of freeways, getting anywhere is easy—as long as traffic is moving.

staying home to watch Uncle Miltie's vaudeville antics, Ed Sullivan's dour displays of show-biz dyspepsia or Sid Caesar's comic routines on the little electronic marvel in their living rooms.

Hollywood fought back with every weapon at its command. It attempted to deny television stations access to old films. It launched nationwide publicity campaigns that proclaimed "Movies Are Better Than Ever." It dabbled in new technologies—the wide screen, the wider screen, the 3-dimensional film.

Yet today, Hollywood thrives. Customized Mercedes autos in multitudes cruise Rodeo Drive in Beverly Hills, where intimate boutiques do a brisk business in thousand-dollar suits and hundred-dollar shirts. Writers, actors, directors, agents, money men and women still flock to Hollywood in search of glamour, status and, most of all, profits.

Seattle

It is now over two decades since hundreds of thousands of visitors flocked to Seattle for the World's Fair of 1962. Yet for the citizens of Washington's Puget Sound region, the memory of those glory days lingers on. A constant reminder, of course, is the graceful 606-foot-high Space Needle—symbol of the Fair—that still towers over the city.

Atop this monument, and reached from ground level by an elevator that zooms to the summit in a mere 41 seconds, is a glassed-in revolving disc housing a restaurant. Visitors and Seattle residents flock here, as much for the view as for the food. The vista here is one of the most spectacular in all the world. Directly below are the deep blue waters of Puget Sound; to the east is the great Cascade Range, topped by the snow-covered summit of Mount Rainier; and to the west is the equally impressive Olympic Range. And everywhere, *everywhere*, there are lakes and forests.

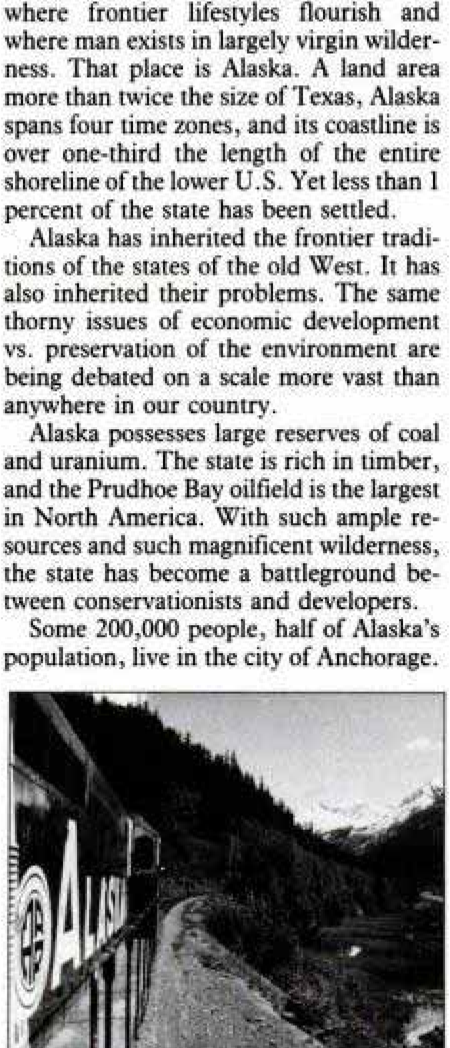
Alaska and Hawaii

Although the frontier may be fast disappearing in the West, there is still a place where frontier lifestyles flourish and where man exists in largely virgin wilderness. That place is Alaska. A land area more than twice the size of Texas, Alaska spans four time zones, and its coastline is over one-third the length of the entire shoreline of the lower U.S. Yet less than 1 percent of the state has been settled.

Alaska has inherited the frontier traditions of the states of the old West. It has also inherited their problems. The same thorny issues of economic development vs. preservation of the environment are being debated on a scale more vast than anywhere in our country.

Alaska possesses large reserves of coal and uranium. The state is rich in timber, and the Prudhoe Bay oilfield is the largest in North America. With such ample resources and such magnificent wilderness, the state has become a battleground between conservationists and developers.

Some 200,000 people, half of Alaska's population, live in the city of Anchorage.



Alaska: development vs. conservation.

The two Anchorage newspapers are potent forces; they help shape the attitudes of the state and, at the same time, reflect the hopes and fears of Alaska's people.

Hawaii is called the state of the "aloha spirit," and to the hundreds of thousands of Americans who live there and the additional millions who have visited these lovely islands in the middle of the Pacific, the appellation is well chosen. To residents and visitors alike, the aloha spirit is a mixture of racial harmony, a burgeoning economy and a sense of well-being that is expressed in a welcoming attitude toward all who come to the islands.

Hawaiians have always gloried in their reputation of living in a place where racial distinctions are of small concern. In my historical novel *Hawaii* (Random House, 1959), I explored the process through which these islands came to be a melting pot for all of the races of Asia and America. Today, approximately 25 percent of the islands' population is of Japanese heritage; 26 percent is Caucasian; about 29 percent is of Filipino, Chinese or Korean background; and some 20 percent is Hawaiian or part Hawaiian.

Looking At Today And Tomorrow

AS WE COME TO THE close of this highly personalized and most selective look at the U.S., it seems to me to be a good idea to take an overall view of where we've been recently and where we're likely, at least in my opinion, to be going. Perhaps I have no particular credentials as a prophet, yet I am a writer and as such it is my obligation to make guesses about the future.

There are plenty of optimistic signs for the future. Our political system, for one thing. We have presidential elections every four years, and they are always orderly. Somebody is elected and it goes without saying that the loser accepts the decision of his fellow citizens. There's no need to bring tanks onto the streets to enforce the mandate of the people. The Supreme Court is going to go on. The Congress is going to continue. I think that all this is a miracle in itself—one that I greatly prize. We have one of the most orderly political systems in the world.

No matter where I travel, people come to me at my hotel late at night, begging me for assistance in getting into America. They want to be here—they want to share in the American dream. **PM**

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Land Of Wizards

BY TOM WOLFE

The threat was delivered to Lemelson's lawyer. "Tell your client we're gonna bury him under a ton of paper." Lemelson wasn't too worried. He thought it was a figure of speech.

So the next day, Lemelson is in the courtroom sitting at the plaintiff's table with his lawyer, waiting for the proceedings to begin. Lemelson is an inventor. He invented the automated warehouse, the automated machine shop, one of the first two industrial robots, several robot-vision machines, the drive mechanism of the audio cassette player and 380 other things. He holds more patents than anybody except the great Edison himself and Edwin Land, inventor of the Polaroid camera. This causes him to be in courtrooms a great deal.

Many corporations manufacture his inventions, but not many mention it to him beforehand.

So it is that on this particular day Jerome H. Lemelson is in a court of law under the usual circumstances, charging a manufacturer with patent infringement. The lawyers for the manufacturer are right across from him at the defendant's table. Between the two tables and the judge's bench is a 15-foot stretch of floor.

The next thing Lemelson knows, the door to the courtroom opens, and here comes a trucker's helper pushing a hand truck with archive boxes piled from the fender on the bottom to the curve of the handles at the top.

An archive box is a box made of heavy cardboard with oak-grain patterns printed on it to make it look like wood. On one end of the box is a little metal frame that holds a card describing the contents. The box has a lid, like a shoe box. Inside, there is room for a dozen reams of documents, usually arranged in

From electric lamp to laser, American inventions have lighted the world. Edison's carbon-filament lamp first glowed in 1879. Three years earlier, Bell's telephone was recognized by the U.S. Patent Office. Our century opened with the Wright Brothers' flight in 1903. Incredibly, in the same decade Goddard began static-testing small rockets. Before his idea of the factory assembly line, Ford patented a transmission and other automotive mechanisms. In 1929, Zworykin demonstrated his kinescope, forerunner of modern TV cathode-ray tubes. Instant photographs became a reality with Land's Polaroid at mid-century. Gould's laser, one of the miracles of our modern age, would seem more wondrous than a bolt of lightning to America's patriarch of invention, Benjamin Franklin.

PM ILLUSTRATION BY NORMAN WALKER


SONY
A
B
DOUBLE

'All successful inventors know about depositions. They learn to live with them the way one learns to live with arthritis.'

file folders with little tabs sticking up. However you want to arrange it, you can get about 40 pounds of paper into each box.

Fascinated, the way the chickadee is fascinated by the snake, Lemelson watches as the trucker's helper begins unloading the boxes. He puts them right on the floor between the tables and the judge's bench. One of the lawyers is out there like a field commander, pointing to spots on the floor. This one goes here. That one goes there. No sooner is that load arranged than the courtroom door opens again, and here comes another teamster, puffing and pushing a fresh load of archive boxes on a hand truck. Now he's lugging his stack off the hand truck and putting it on the floor. The door opens again. Here comes another yobbo pushing a hand truck with archive boxes piled as tall as he is. You can hear the floor groaning from the weight of the load as the wheels roll over the hardwood.

The field commander is out there, and the archive boxes are lining up in rows like a tank formation. Lemelson's pale gray-blue eyes are the size of radar dishes. He's speechless. The cargo humpers keep coming. Pretty soon 70 or 80 square feet of floor is occupied by this squat battalion of archive boxes. You don't have to be an engineering genius like Lemelson to figure out that there is now a ton of paper sitting there. More than a ton, perhaps a ton and a half.

"Well," Lemelson says to his lawyer, "at least it's not on top of me."

Neither of them laughed. They both had the feeling it was only a matter of time. There was a judge but no jury. Apparently the ton of paper was supposed to impress the judge and intimidate Lemelson.

Something impressed the judge; no question about that. Lemelson lost. It wasn't even close.

He gritted his teeth and announced he was going to appeal. The next message said: "Okay, go ahead. We'll search for evidence in Europe."

That meant they would send a lawyer to Europe to take depositions from anybody they could find who had dealings with Jerome H. Lemelson or his invention. Here you have the greatest device for generating paper ever thought up by the legal profession: the deposition. All successful inventors know about depositions. They learn to live with them the way one learns to live with arthritis.

A deposition is a pretrial maneuver in which lawyers take sworn testimony from people out of court, usually in somebody's office. A court reporter records the testimony on a stenotype machine and then types up a transcript. The number of pages of testimony that can come out of an hour of this is fabulous, and some depositions go on for a week. What might actually be divulged about Jerome H. Lemelson or his works on any of these thousands of pieces of paper was beside the point. The point was that Lemelson would have to hire a lawyer to represent his interests during each deposition, day after day, city after city, across the map of Europe. The sheets of paper would go into archive boxes, and every sheet meant another little hemorrhage in Lemelson's net worth.

This case began in the 1970s. It grinds on still. So far it has cost Lemelson $250,000 in lawyers' fees, and the meter is still ticking. It sounds like something from out of *Bleak House,* which Charles Dickens wrote in 1852 and 1853, but it is merely a typical episode in the life of an American inventor in the 1980s. Which is to say, it is the story of a man trying to dig his way out from under a ton of paper.

IS THERE ANY MORE FEVERish dream of glory in the world, outside of Islam, than the dream of being an inventor? Certainly not in the United States; and probably not in Japan or any other industrial country. An invention is one of those superstrokes, like discovering a platinum deposit or a gas field or writing a novel, through which an individual, the hungriest loner, can transform his life, overnight, and light up the sky. The inventor needs only one thing, which is as free as the air: a terrific idea.

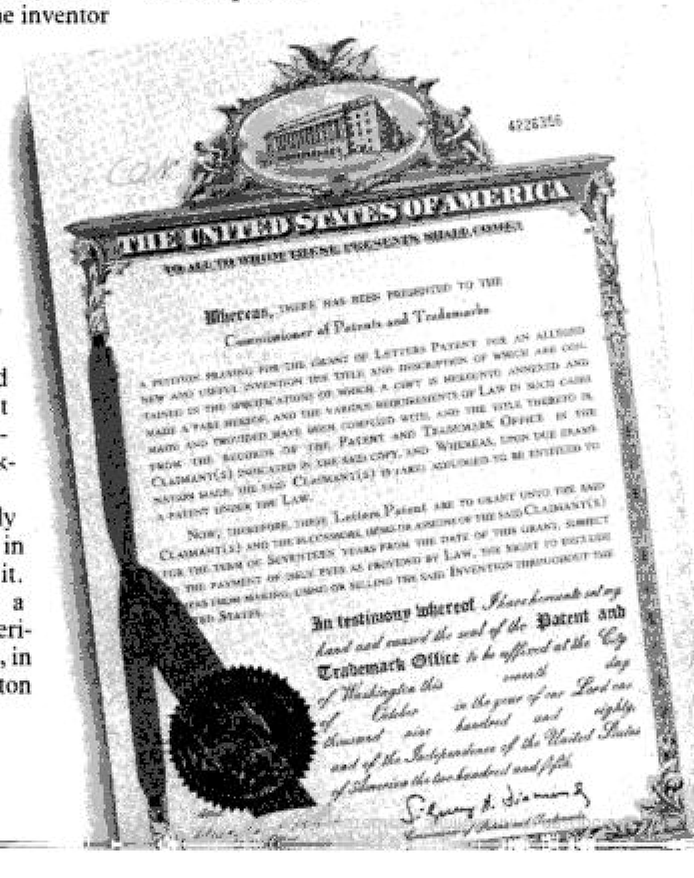
He doesn't need connections. The great American inventors of the past hundred years, the so-called age of technology, have not come from prominent families. They have not had money. They have not been part of the highly touted, highly financed research teams of industry and the universities. They have not been adept politically or socially. Many have been breathtakingly deficient in charm.

Thomas Edison was scarcely educated at all; three years in public school, and that was it. Alexander Graham Bell was a teacher who began his experiments, leading to the telephone, in the cellar of a house in Boston where he rented a room. Steven Jobs and Steven Wozniak, of Apple Computer fame, were a pair of public high school A-V Types. A-V Types are audio-visual nerds who wear windbreakers, carry a lot of keys and wire up directional mikes for the drama club. The Silicon Valley of California, center of the most spectacular new industry of the second half of the 20th century, computers and semiconductors, is known as the Land of Nerd, the Planet of the Nerds and the Emerald City of Nerdz. The centimillionaires of the Silicon Valley want nothing to do with the traditional Society of nearby San Francisco. They can't get into Trader Vic's wearing their nerd shirts, which are short-sleeved white sport shirts with pencil guards on the pockets.

Wilbur and Orville Wright were regarded as two wet smacks who ran a bicycle repair shop in Dayton, Ohio, when they arrived at Kitty Hawk for their airplane experiment in 1903. Neither had graduated from high school. But theirs was the invention that dazzled Jerome H. Lemelson and thousands of other boys who were born in the early 1920s.

As a teenager, Lemelson was typical of the airplane "hobbyists," as they were known, quiet boys who built gasoline-powered model airplanes, took them out in the fields and flew them by wire or remote control. There were still a lot of open fields on Staten Island, where he grew up. His father was a doctor, a general practitioner, but Lemelson's pas-

A U.S. patent.



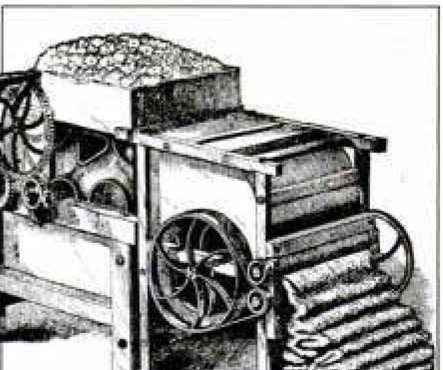
FACING PAGE: JEROME H. LEMELSON/PHOTO BY HUMPHREY SUTTON

'The first flash of genius lights up only a few yards of the road. The road is long and uphill.'

sion was airplanes. During the Second World War he found his way into the engineering department of the Army Air Corps. After the war he earned a bachelor's degree in aeronautical engineering at New York University, then went to work at NYU for the Office of Naval Research's Project Squid. Project Squid was supposed to develop rocket and pulse jet engines.

One day in 1951, Lemelson took the subway over to the Arma factory in Brooklyn, which made control mechanisms for aircraft, to see a demonstration of a fully automatic, feedback-controlled metal lathe. *Feedback* was a hot new word in engineering circles. Nobody there on the work way at Arma took a second look at Jerome H. Lemelson. He was 28 years old, neither fat nor thin, neither very tall nor very short, not bad looking and not Tyrone Power, either. He had a broad forehead, light brown curly hair, large eyes and a long, straight nose. He was quiet, polite, reserved and a typical hardworking young engineer, by the looks of him, if you looked at all.

Lemelson took more than a second look



Eli Whitney invented the cotton gin, but like many other inventors in the U.S., he saw his invention stolen.

at the metal lathe, however. An ordinary metal lathe turned a metal rod while an operator shaved it down to whatever diameter or shape he wanted by adjusting a tool bit. In the case of the feedback-controlled lathe, the bit was controlled automatically by punch cards. The crowd murmured a lot as the bit rose and fell to unseen commands.

Lemelson began wondering how far you could take this idea of a programmed factory machine. Over the next three years he developed the designs for a "universal robot." The robot would have an arm with joints. It would rivet, weld, drill, measure, pick things up and move them. He drew up a 150-page patent application and submitted it to the U.S. Patent Office in Washington, D.C., on Christmas Eve 1954. Unbeknownst to Lemelson, an inventor named George Devol had filed an application for a robot two weeks earlier. Theirs were the first industrial robots. As it turned out, both men had a long wait ahead of them.

In the meantime, Lemelson was already working on a second application for an offshoot of the universal robot, a "flexible manufacturing system," which was the automated machine shop.

THAT SAME YEAR, 1954, Lemelson married an interior decorator named Dolly Ginsberg. The first stop on their honeymoon was Bermuda. The second stop was the Willard Hotel in Washington because it happened to be across the street from the Search Room of the Patent Office. Lemelson was already deep in the grip of The Dream.

The Search Room was an enormous archive the size of Uline Arena, where the Washington Capitols, the professional basketball team, played their games. It was full of ancient wooden shelves and boxes, known as shoes, containing nearly 150 years' worth of patent documents. The spaces between the stacks of shelves were so narrow that the clerks had to shimmy past each other to fetch the shoes for people doing patent searches. This led to a lot of waiting and sighing. Dolly heard one patent lawyer complaining to another: "There ought to be some way to mechanize this place."

She happened to mention this to Lemelson. That started him off on another track, resulting in his "video filing system." The documents would be recorded on reels of videotape or magnetic tape. The average patent application was 10 pages long. You could store 100,000 applications on just four reels of tape. You would look at them on a television screen in stop-frame pictures. (His conception of the stop-frame picture would lead, during the 1960s, to filmless photography, still pictures created from video images.)

Instead of having GS-8 civil servants shimmying between stacks of shelves, you would press a few buttons and send a playback device along a track to a slot where the tape was. But how could the device connect with the tape and enable you to play it and wind it back and forth? Lemelson thought about that awhile and conceived of the mechanism that eventually became the core of the audio cassette player. He presented video filing and its components in a 60-page patent application in 1955.

And he waited some more. Several years went by, and the Patent Office still had not issued any patents for all these brilliant ideas. Lemelson was now learning one of the facts of life about being an inventor in America. The first flash of genius lights up only a few yards of the road. The road is long and uphill.

More than once, he and Dolly had to fall back on her earnings as an interior decorator. There was only one way an inventor could make money rapidly without waiting for the patent process to go its

The first issue of Popular Mechanics. From its inception in 1902, the magazine has spotlighted inventions.

course, and that was to design toys. In the case of a toy, you prudently filed for a patent but went ahead and sold the design immediately, if you could. Lemelson had an idea for a face-mask kit for children that would be printed on a cereal box. A child could cut out the pieces, assemble them in different combinations and put on the mask. He filed for a patent and took his drawings to one of the cereal manufacturers. The company said it wasn't interested, and so he put the drawings away and forgot about them.

One day, three years later, he is in the grocery store, and there on the shelf is a cereal box with a face-mask kit on it. It's put out by the very people he showed his drawings to. He can't believe it. The way he sees it, he's staring at as blatant a case of patent infringement as you could imagine. He files suit. So now he's in court.

ILLUSTRATION AT LEFT FROM THE BETTMANN ARCHIVE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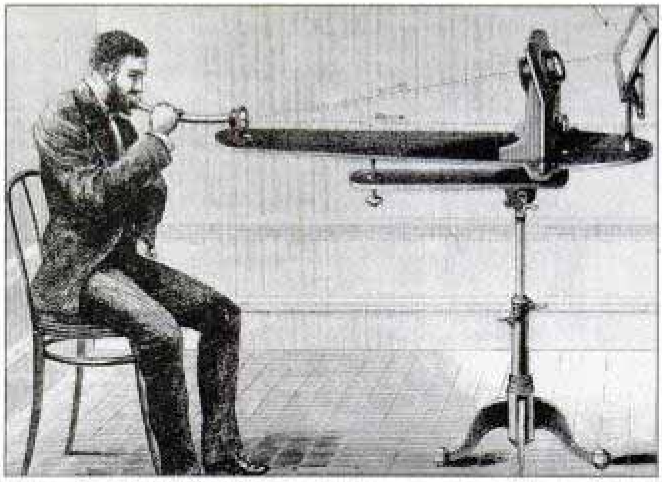

Alexander Graham Bell's "photophone" turned sound waves into light. It followed his invention of the telephone.

It's a jury trial. The judge comes in, and he gives Lemelson and the lawyers a long look down his nose.

"This is a patent case," he says. He lets the term *patent case* hang in the air for a moment, like a bad smell. "I have better things to do with my time than listen to patent cases. It is now 10:15. You have until 3 o'clock this afternoon to complete your arguments."

Sure enough, at 3 o'clock on the dot he looks at his watch, stands up and, without saying a word, walks out. Lemelson has an expert witness testifying for him at the time, and the fellow is sitting there on the stand with his mouth hanging open.

Then the judge pops back in. "Ladies and gentlemen of the jury, my apologies. I neglected to dismiss you. You are dismissed."

It turns out the case has been dismissed, too. Lemelson appeals, and a new trial is called—before the same judge, who summarily dismisses the suit, this time for good.

WHEN LEMELSON spoke of these things to other inventors, they smiled, without joy. He was just getting the picture. First, many American corporations, including many of the most respected, ignored patent rights without batting an eye. They didn't give you so much as a sporting wink. Second, the courts couldn't be bothered. Practically none of the judges who heard patent cases had any background in patent law, much less engineering. It was unfamiliar terrain, which seemed to make them irritable. On the one hand, they couldn't stand all these obsessive small-fry inventors, these parasites on the hide of Science, with their endless theories and their transducers and capacitive-sensitive relays and the rest of that paralyzing jargon. But on the other hand, if they, the judges, could understand an invention, then it must not be much of an invention. They had developed "the doctrine of obviousness." If an invention looked obvious, they declared the patent invalid.

The inventors kept ratings of the chances of having their patent rights upheld in the various Federal jurisdictions. Back when Lemelson was starting out, your chances ran from zero in the 8th Circuit, which covered most of the Midwest, to 45 percent in the South. The 2nd Circuit, covering New York, was rated about average, one chance in four.

But what about the corporations? How could they get away with flouting the patent system and patent law? It was simple, the inventors told Lemelson. All that the corporations needed to overcome was their scruples, if any. In the United States, unlike Japan and parts of Europe, patent infringement was not considered a form of theft, so there were no criminal penalties. There were not even punitive damages in patent cases unless the inventor could prove "willful infringement." To avoid that, a manufacturer merely had to take the precaution of going to its own lawyer and having him write an opinion saying that such and such a product did not infringe upon any existing patents for such and such reasons. It didn't matter how cockeyed the reasons were. That was what lawyers were for.

Once the manufacturer had that document in hand, the worst that could have happened, even if the firm had been found guilty in court, was that the manufacturer would have had to pay the inventor the royalties he would have received if a license had been obtained. There were lawyers who would actually advise their corporate clients to ignore patents, calling it a no-risk strategy.

Just in case the inventor was new at this game, the manufacturer would let him know the odds, discreetly, or, if he looked a little thick, bluntly. To get a case as far as the trial stage was going to cost $40,000. Was he ready for that? To get a case through the trial and all the appeal stages—was he ready for $250,000? For good measure, it usually added some variation on the theme, "We're gonna bury you under a ton of paper." If a corporation was big enough, it would threaten anybody, not merely little lone-wolf inventors but even another, smaller corporation. When J. Reid Anderson, the chief executive officer of Verbatim, a company specializing in computer storage devices, went to a big manufacturer complaining of patent infringement, he was told: "We have more patent attorneys than you have people in your company, and they are just sitting back waiting for someone to start a patent fight like this."

Lemelson's saving grace was that he was not a cynic. He didn't have a cynical or even a morbidly pessimistic bone in his body. Despite everything, he believed that it wasn't a bad world. His most important inventions had disappeared somewhere in the papyraphagous mew of the Patent Office. A manufacturer had just walked right over him, without stopping, and the court he had gone to for help hadn't even been able to hide its contempt for Jerome H. Lemelson. Moreover, he had just learned that this was the customary state of affairs for small-fries of his vocation.

But that was just what it was—a vocation, a calling. By now, Lemelson derived an aesthetic or spiritual—or some kind of—satisfaction that went beyond the money he wasn't making from inventing. He was irrepressible. He was thinking up new inventions at the rate of one a month, a pace that he managed to keep up for the next 30 years.

ONCE LEMELSON HAD designed robots that did every imaginable industrial chore, he designed a robot that inspected what the other robots had done. He invented robot-vision or "image analysis" machines that could, among other things, detect diseased blood or tissue cells, such as cancer cells. He invented the "computer-controlled coordinate measuring machine," which would later be used to measure and align the tiles on the exterior of the Space Shuttles. He invented a computerized tourniquet that would allow a surgeon to perform an operation without stopping to turn valves to alter the flow of a patient's blood. He designed several systems for transfer of information between computers. He designed two laser-powered recording and reproduction systems, Lasercard and Videocard, to perform the computer functions now performed by floppy disks. He invented a widely used "automated teller machine" that scans credit cards and checks out their credit status. He invented both a cordless telephone and a cordless videophone.

At the same time, he was turning out toy and novelty designs. He designed the

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There wasn't much for early viewers to see, but even television test patterns drew an audience. Once a novelty, TV is now a familiar part of daily life.

"watchpen," a ballpoint pen with a watch built into it. He invented the flexible-track car toy—one of the biggest-selling toys of all time—manufactured by at least five companies under different names, "Hot Wheels" being the best known. He invented the Velcro dart game, in which you throw a Velcro-covered ball, instead of a steel-tipped dart, at a Velcro-covered dart board. He invented the "printing putty toy," best known under the brand name Monster Print Putty, with which you can remove words and pictures from a newspaper and reprint them on another piece of paper. Lemelson was thinking up these things, doing the drawings, writing the descriptions and dispatching them to the Patent Office so fast, his two sons called him The Blur.

DURING THE EARLY 1960s, when Lemelson was pushing 40, the patents finally started rolling in. First was his video-filing system, in 1961. Then the automated warehouse in 1962. In 1966, almost 12 years after he had submitted the application, his universal robot patent was issued. Devol's had come through five years earlier.

Lemelson closed his first major deal in 1964, selling an exclusive license for his automated warehouse system to a firm called Triax, but almost immediately he was up to his neck in lawsuits. Other firms, he and Triax charged, had already begun pirating the invention in violation of Triax's license. That litigation continues today, 22 years later.

In 1967, he sold an exclusive license to an English company, Molins, for the automated machine shop. In 1973, he made the best deal of his career, selling an exclusive license for his cassette drive mechanism to Sony. Sony sublicensed it to more than a hundred Japanese firms. Today, practically every audio cassette player on the market operates with the Lemelson drive.

None of this brought any dramatic improvement in Lemelson's style of living. In 1959, after the birth of their second son, he and Dolly had moved from a garden apartment in Metuchen, New Jersey, looking out not onto a garden but U.S. Route 1, to an 8-room house in Metuchen on a quarter of an acre. It wasn't until 1985 that they moved to greener, grander scenery in Princeton. No small part of the picture was the hundreds of thousands of dollars that Lemelson was spending on legal fees trying to deal with American firms.

From the first, there were cases of what he regarded as the most arrant infringement. It absolutely stupified him. The retort of "go ahead and sue" (. . . "and we'll bury you under a ton of paper") was standard practice. Some firms were bluffing. If you brought suit, they would settle. But there was only one way to find out, which was to sue. Other firms were not bluffing. They would spend half a million dollars in legal fees to keep from taking a license and paying royalties they knew wouldn't run over $150,000. Lemelson couldn't figure these people out. He didn't know whether they were trying to teach a lesson to other small-fry inventors—the lesson being that Lemelson's legal bills were running well over $150,000—or whether these were displays of sheer competitive ego.

Sometimes the lawsuits sprang up on so many fronts, it was hard to keep track of them. Lemelson found himself suing all the major manufacturers of the flexible-track car toy. These cases live on today. Some of the suits turned ludicrous, but the laughs never came cheaply.

In one case, Lemelson was suing the U.S. government and two private manufacturers over the same invention. He decided to abandon the case against the government and grant it a license free of charge. The private firms sought to block this move, apparently on the grounds that the government's acceptance of the license implied recognition of Lemelson's patent rights.

He ended up spending $18,000 in lawyers' fees to give the license away.

Lemelson was in noble, but expensive, company. Robert Goddard, now called—officially, by the U.S. government—the father of American rocketry, ran a lone-wolf rocket program west of nowhere in the New Mexico desert in no small part to try to put an end to the pirating of his patented inventions—chiefly by the U.S. government.

Fifteen years after his death, the government gave his wife $1 million to settle his many claims of infringement. There was something melancholy about this refrain of the widow and the million dollars.

One day Lemelson met a lawyer who had been in on the Armstrong case. Edwin Armstrong was the inventor of FM, frequency modulation, the greatest advance in broadcasting since the invention of the radio itself. In 1940, the Radio Corporation of America offered Armstrong a flat fee of $1 million for his FM patents. The lawyer had been in the room when Armstrong was handed the check. Armstrong looked at it and then, with great deliberation, tore it up and dropped the pieces on the floor.

In 1948, Armstrong sued RCA, Motorola and several other corporations for patent infringement. The lawyers rubbed their hands and licked their chops and started manufacturing a ton of paper. By the early 1950s, Armstrong was lamenting, "They will stall this along until I am dead or broke." It was the former. On the night of Jan. 31, 1954, he jumped out the window of his Manhattan apartment 10 stories above the East River. For some reason, he put on his overcoat, scarf, hat and gloves before he jumped. Late that year, his widow accepted a million-dollar settlement. It was the merest fraction of what his invention had become worth.

THEN THERE WAS THE case of another loner, Gordon Gould, one of the three main holders of patents on the laser. Gould and Lemelson were about the same age. They had hit upon their major concepts at about the same time, the mid-1950s. Gould had been a 36-year-old graduate student at Columbia University when what he called

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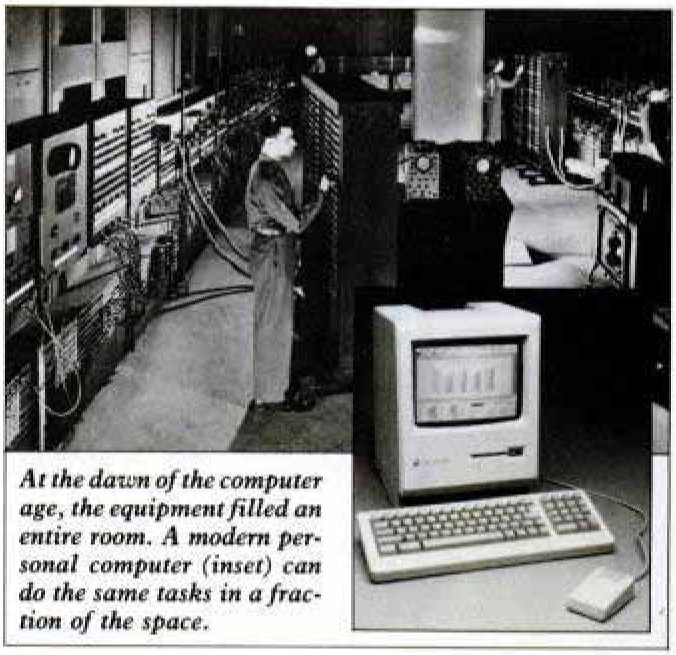

At the dawn of the computer age, the equipment filled an entire room. A modern personal computer (inset) can do the same tasks in a fraction of the space.

"the fire" first possessed him. He was the one who thought up the acronym *LASER* (for Light Amplification by Stimulated Emission of Radiation). For 27 years he was embroiled in legal battles on two fronts, with the Patent Office and with laser manufacturers.

By the time a court ordered the Patent Office to grant him his key patents, Gould had retired. He was spending his golden years with his lawyers. He had 12 lawsuits going in the United States and Canada. His legal bills had come to $2.5 million, much of it paid for by a firm that would get 64 percent of his income—down the road—if he won the suits.

As for himself, Gould indicated in an interview, he was long past the stage of life in which the big money would interest him, even if it ever came.

Lemelson's problems were still more complicated, because he had so many

Dr. Robert Jarvik and his Jarvik-7 artificial heart: It's been used to keep patients alive for heart transplants.

patents. He lived like a chess player who takes on 40 opponents at once, walking from board to board, trying to keep straight in his mind what threats are coming up where.

Well, at least Lemelson had had enough victories to be able to keep breathing in the avalanche of paper and lawyers' bills. Very few independent inventors had the money even to get in the game.

In the late 1970s, it began to dawn on government statisticians that the United States was no longer the great world center of technological innovation. Over a single 5-year stretch, 1971 to 1976, the number of American citizens receiving U.S. patents declined by 21 percent. The number of foreign citizens receiving U.S. patents increased by 16 percent. By 1979, about four of every 10 new U.S. patents were going to foreigners. That year, the subject began to break out into the press. *Newsweek* ran a cover story titled "Innovation: Has America Lost Its Edge?" The conclusion was that it had lost it, or was losing it, to the Japanese. That was not news to Lemelson. The underlying problem, as he saw it, was the sad fate of the independent inventor.

By the late 1970s, the corporations had managed to create the impression that in the 20th century the greatest technological innovations were no longer coming from the loners, but from the corporate and university research teams. But this had never been true. Innovation and corporate research were very nearly a contradiction in terms; at bottom, the corporations were interested only in improvements in existing product lines. As for the universities, they actually looked down upon invention as an amateur pastime, despite the fact that much scientific study, especially in the area of electronics, was nothing more than the analysis of discoveries made by inventors.

IN 1975, LEMELSON WAS APpointed to the Patent and Trademark Office Advisory Committee. In July 1979, he testified at Senate hearings investigating what was beginning to be called "the innovation crisis." In a prepared statement, he said that corporations and the courts had combined to create an "antipatent philosophy" in the United States. "Company managers know that the odds of an inventor being able to afford the costly litigation are less than one in 10; and even if the suit is brought, four times out of five the courts will hold the patent invalid. When the royalties are expected to exceed the legal expense, it makes good business sense to attack the patent."

He contrasted this with the situation in Japan, where patent law was taken seriously, both morally and legally. "Although the majority of my income is derived from foreign licenses, I have *never* had to enforce a patent against a foreign infringer. I leave it to you to conclude the reason as to why the attitude is so different. My licensees have told me that they recognize the clear value of invention from an economical point of view. They feel the United States has lived off the fat of its own technology for so long that we don't recognize that the consequence of the legal destruction of patents is a decline in innovation, a situation that is not within anyone's economic interest.

"What all this means to the inventor is that he either quits inventing or he licenses foreign."

ONE FINE DAY A FEW months ago, Lemelson was in his New York office on Park Avenue, near Grand Central Terminal, talking to a reporter from a magazine. The two of them were sitting on a couch across from Lemelson's desk. The reporter had on a checked suit and a shirt collar like Herbert Hoover's. It looked about 4 inches high. Underneath his necktie you could see a brass-plated collar button of the sort that went out 46 years ago. Lemelson's office, on the other hand, had a cool, immaculate, low-slung, modern look in tones of beige, gray, taupe and teak. Lemelson himself was just as neatly composed. He was wearing a navy blazer, dark gray pants, a blue shirt and a sincere necktie. He was now 62 years old and what remained of his curly hair was turning gray. But he was as trim as a digital watch. That morning, as usual, he had run a mile and a half and done 40 push-ups, 50 sit-ups and a hundred sidesaddle hops. His face had the gaunt athletic look of those who stare daily down the bony gullet of the great god Aerobics.

The reporter with the collar was wrapping his eyebrows around his nose as he tried to think of the technical terms concerning Lemelson's inventions. Lemelson listened patiently and sipped a glass of

LEFT FROM WIDE WORLD PHOTOS; RIGHT, UPI-BETTMANN NEWSPHOTOS

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orange juice. Every now and then, one of the two telephones on the desk would ring. Lemelson would excuse himself and walk to the desk. One telephone had an ordinary ring, and he would answer that one by saying hello. The other one rang with an electronic burble. That one he would answer by saying, "Licensing Management." Licensing Management Corp. was a firm he had created chiefly to sell licenses for his own inventions to manufacturers.

"Licensing Management. . . . Yes. . . . This is Jerry Lemelson. . . . Oh, hi. . . . No, I can't do it this week. I have three days of depositions coming up."

The other telephone rings.

"Hello? . . . Oh, hi. . . . Thursday of next week? I can't make it. I have to be in Cleveland. . . . What for? For a deposition."

It goes on like that.

"Hello? . . . Yes. . . . Oh, hi. . . . This afternoon? . . . I won't be here that late. I have an appointment with my lawyer in half an hour."

Lemelson walks back to the couch. The reporter with the trick collar says, "If you don't mind my asking, when do you . . . *invent*?"

"On the train."

"On the train?"

"On the train out to Princeton, where I live."

"On the train," the fellow with the collar repeats it, all the while staring at him, apparently wondering if Lemelson is putting him on. But Lemelson isn't the type.

Then the fellow says, "Your opponents say, or they imply, that you make your money by filing lawsuits."

Not much ruffles Jerome H. Lemelson, but this gets under his skin.

"Who said that?"

"One of the lawyers."

Lemelson shakes his head. "Oh, sure. They accuse me of being litigious. But I've *lost* money on litigation. I've spent more than a million dollars on it, and I don't even like to think about the time."

"Then why get involved in it?"

"*Why*? To protect my rights. What do you do when your rights are being violated? Lie down? Walk away? You show me a successful inventor who hasn't been a scrapper."

Then his expression changes. "I don't know if I should even stress this side of it. It all sounds so negative. I don't want to discourage inventors. I want to encourage them. I think we ought to have something like the National Inventors Council that we had during World War II. The government called upon our people for inventions to help win the war. They received 400,000 ideas during World War II alone, and over 4000 of them actually went into production, and they helped win the war. I'd like to see this type of thing revived to see if we can win the technological battle with the rest of the world."

He thinks a moment. "There's nothing wrong with our patent system itself. We just need to protect patents. And actually things are getting a little better. There's a new Federal court for handling patent cases now, the court of appeals for the Federal circuit, and the judges know patent law. Your chances are much better now. They're about 50-50."

"If every opponent in every piece of litigation you have going right now decided to settle in your favor, how much money would you receive?"

The thought of the corporations suffering this sudden mass attack of equity makes Lemelson laugh. "Millions. It won't turn out that way, of course.

"But I don't have any regrets. This has been a good life. I've been independent, and I've done exactly what I wanted to do."

THE TRAIN TO PRINCEton was 15 or 20 minutes out of Penn Station, and everybody was settling into the dim blue haze of the car and the jouncing and bouncing. The roadbed was in a little better shape than it used to be. They were starting to replace the old wooden ties with concrete. It would be easy enough to invent better rail systems, and no doubt plenty of people had, but they would never be built, and so it wasn't worth thinking about.

A little more of the lurching there in the haze, a few more metal shrieks from between the cars, and—bango!—it came to Lemelson, just like that. The drug delivery system, the whole thing—it all came to him while he was sitting there. For a long time he had been trying to think of a way to use drugs to treat a diseased area of the body without having to diffuse the chemicals and subject the entire body to their effects, as happens in chemotherapy. For people with certain forms of cancer, it would be a godsend. And now he had it! The time-release thing! The insertion system! All the parts were in place!

Lemelson reached into his briefcase and pulled out the pad he always kept on hand for such moments as these. He was aware for the first time of the man sitting next to him. The man looked like nothing more than a dead-average New Jersey commuter, but you never knew. You just never knew. Lemelson began writing it all down in a shorthand he had created for himself. The drug delivery. The time-release. He was no longer aware of the haze and the motion of the car. He was soaring. It was like the beginning, once more, of a dream come true. PM

Reaching For The Sky

BY WILLIAM HOFFER

The power, elegance and sheer magnificence of America's tallest buildings have preoccupied our top architects. Within a generation, we may see a 500-story skyscraper.

When Richard Roth Jr. contemplates 16 city blocks of downtown Houston, he sees a misty vision of the future. Rising from a broad base, tubes of high-strength structural steel, each with the cross-section of an equilateral triangle, reach heavenward. At various heights the triangular tubes terminate, leaving a single central spire that tops off more than a mile above street level. Standing a full 500 stories tall, this skyscraper of the future would surpass by more than four times the height of the Sears Tower in Chicago, which currently holds the title of the world's tallest building.

"It's a possibility," says Roth, who is president and chief executive officer of Emery Roth & Sons, the renowned New York architectural firm founded by his grandfather. Among its countless notable credits, the firm assisted in designing a former claimant to the skyscraper throne, the twin towers of New York's World Trade Center. "In this day and age anything is a possibility," Roth continues. "The technology is there. If anybody wants to build a 500-story building, we're available to do it.

"But is it really a necessity?"

To answer that question, one must examine the unique history of skyscrapers. It is no accident that the skyscraper is an American invention. Throughout the past 100 years, a steady advance of technology and wisdom has enabled architects and engineers to move ever onward and upward. Those technologies were available to all civilized nations, but it characteristically has been the arrogant and ostentatious American entrepreneur who raised his sights higher. In sum, the skyscraper may be considered the most visible manifestation of the legendary American ego.

The role of the ego in skyscraper development is illustrated by a set of dusty drawings that lie buried within Roth's files. When plans were announced for Chicago's Sears Tower to become the tallest building in the world, Roth was immediately contacted by officials of the Port Authority of New York and New Jersey. He was asked to plan an addition to one of the twin towers of their

TWIN TOWERS, WORLD TRADE CENTER, NYC/PHOTO BY JAKE RAJS

'If anybody wants to build a 500-story building, we're available to do it. But is it really necessary?'

World Trade Center in Manhattan's financial district so that the Big Apple could retain the title of having the world's tallest building. "By removal of the TV tower, we had enough strength within the building to support another 10 to 20 stories on one of the towers," Roth explains.

It would have been little more than a multimillion-dollar ego trip. "Saner heads prevailed," says Roth, and the project was scrapped, but the hysterical reaction to the loss of the title illustrates the key role of Yankee pride in the skyscraper story. Constructing the tallest building in the world is a challenge that the American entrepreneur cannot resist. And there is little doubt that what the Port Authority was unwilling to do will, indeed, be accomplished within the next few decades. The supremacy of the Sears Tower is not likely to last through the 20th century. And when it does rise above the 110-story, 1454-foot reigning monarch, the next world's tallest building—and the next one and the next one after that—will be an elevated testimonial to the boundless pride that is one of the prime reasons that Americans built America.

Last January, Professor Lynn Beedle of Lehigh University, who directs the Council on Tall Buildings and Urban Habitat, assembled the nation's tall-thinking architects and engineers to celebrate the 100th anniversary of the skyscraper. They convened in Chicago to gather in reverence around the site of the now-departed Home Insurance Building, completed in 1885. It was the prototypical skyscraper, the first American building to feature a frame that carried nearly all (82 percent) of the load. Rising an incredible 7½ stories above street level, it signaled a new form of architecture that was uniquely American, both in purpose and character.

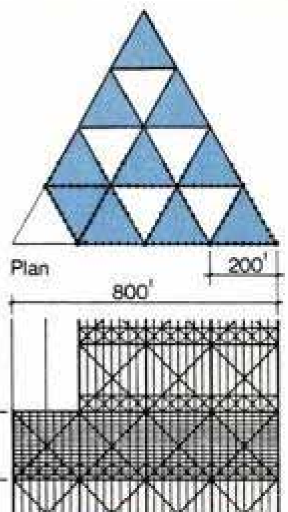
THE ACTUAL WORD *SKYSCRAPER* WAS FIRST applied not to a building, but to an oversized British racehorse. However, it soon became the generic term for America's contribution to urban architecture.

"You had the enormous forces of the expanding American economy after the Civil War," says Carl Condit, professor emeritus at Northwestern University and one of the world's pre-eminent authorities on the history of the skyscraper. "You had enormous pressure to build office space in New York, which was essentially a medieval style of city. Land values were extremely high, so to maximize the height of a building on a given area of land meant to maximize the return on the investment."

The skyscraper probably became inevitable when a particular event occurred at New York's old Equitable Life Assurance Society Building on Broadway between Pine and Cedar streets. This 5-story building was notable for its utilization of the Otis Elevator Co.'s newfangled safety lift. The owner of the building, a certain Henry Hyde, formulated a theory that—although it was the least accessible part of the building, provided the most cramped quarters and was insufferable in the summertime—the highest floor might command the highest rent simply on the basis of prestige. Hyde sold engineer George B. Post on the idea, leasing him a top-floor office for double the rent of ground-floor space. Hyde's singular notion of selling prestige over comfort assured that Yankee ingenuity would surely pursue methods of building ever higher.

"You had the practical advantage of putting damn near everything in one building, too," Condit points out. "By the 1880s, high-rise buildings not only contained offices, they contained restaurants and clubs and telegraph centers and stock tickers. A few of them actually had rooms—club facilities with residential rooms. And, of course, they had all the appurtenant facilities. If you have a restaurant and a bar, you have all the people who will serve you. The skyscraper concentrated things which could be used to carry on all kinds of activities having to do with the administration of business.

"Finally, I think you have something that's peculiar to the American mentality," Condit continues. "The technical factors that came together to make a skyscraper habitable indicated that something could be done here that had never been done before. So somebody's going to do it."



Roth's more than mile-high structure (top) consists of 16 steel frame tubes bundled into an 800-foot equilateral triangle (middle). The tubes are staggered, creating shafts of open space for atriums. Diagonal steel beams (bottom) combined with the triangular tubes are the most efficient structure for resisting wind loads on skyscrapers.

FACING PAGE: RICHARD ROTH JR./PHOTO BY HUMPHREY SUTTON
THIS PAGE: PHOTO BY HUMPHREY SUTTON; ILLUSTRATION FROM SOBEL/ROTH, ARCHITECTS

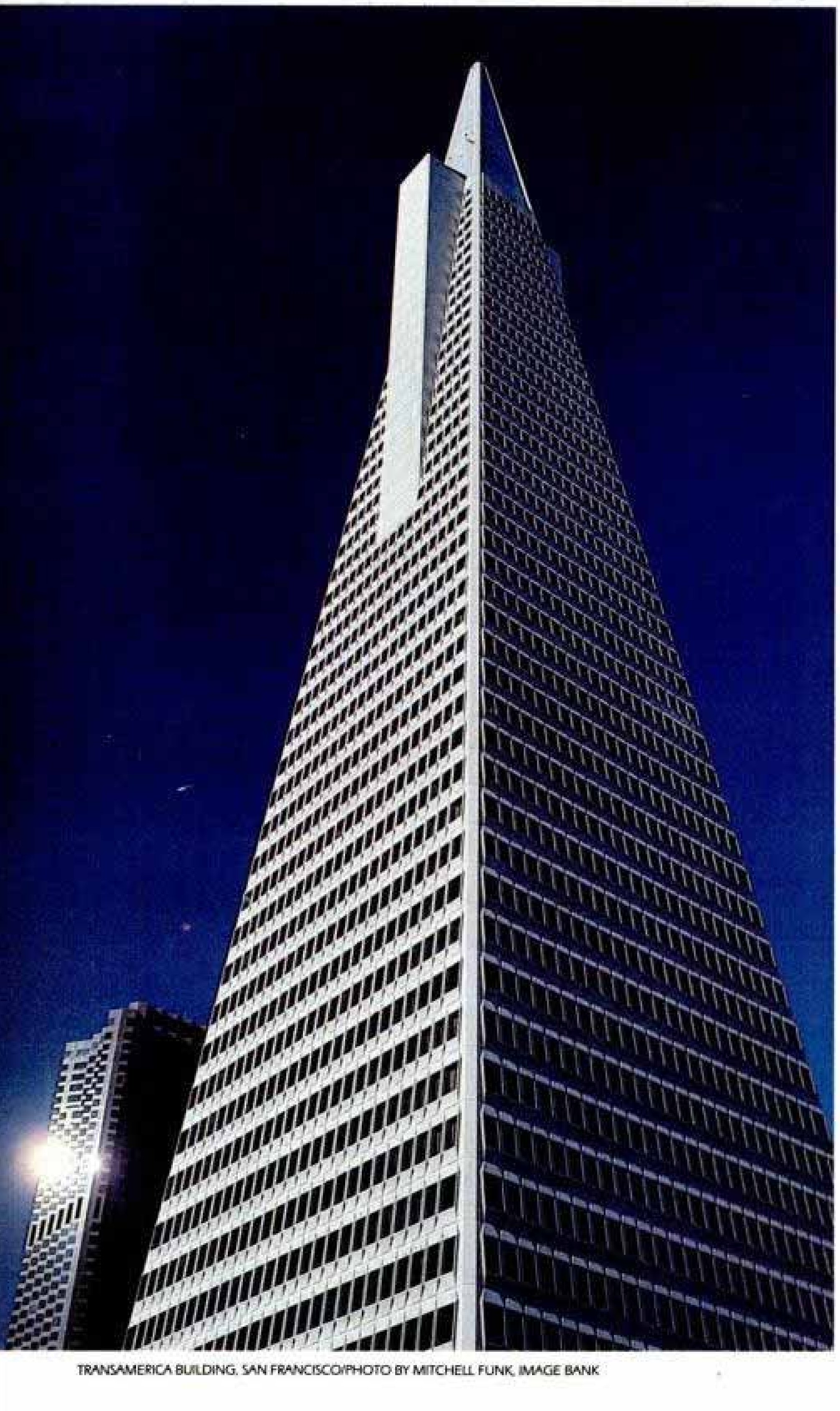
Between 1889 and 1894, more than 20 skyscrapers were erected in downtown Chicago, rising 12 to 16 stories in height. Landowners saw their property values explode upward.

Historian Homer Hoyt wrote that the Chicago businessman's slogan became: "Tear down that old rat trap and erect a 16-story building."

But nowhere did the boom take hold with more competitive flair than in New York. In 1889, the Tower Building, featuring a wind-braced structure, was completed. That technique allowed architects to raise their sights further.

In 1890, Joseph Pulitzer completed construction of the World Building, the first to rise above 300 feet. That set the stage for a 40-year war that would see more than 200 skyscrapers rise in Manhattan alone.

By 1908, the Singer Building reached 47 stories to a height of 612 feet. One year later it was eclipsed by the 50-story Metropolitan Life Insurance Company Building at 707 feet.



TRANSAMERICA BUILDING, SAN FRANCISCO/PHOTO BY MITCHELL FUNK, IMAGE BANK

The intensity of the war is best epitomized by a legendary conversation between retailing magnate Frank Winfield Woolworth and architect Cass Gilbert.

In 1911, Gilbert was working on plans for the Woolworth Building. "How high is this building going to be?" Woolworth asked.

"That's for you to decide," Gilbert replied.

Woolworth asked, "How high is the Metropolitan Life Insurance Building?"

"Seven hundred and seven feet."

"Make mine 50 feet higher!" Woolworth ordered.

The Woolworth Building eventually rose 60 stories to a height of 792 feet.

Critics charged that the proliferation of skyscrapers would blot out the sun from Manhattan altogether, causing New York officials, in 1916, to adopt what Condit calls "the most farsighted piece of building legislation in the history of the city." That was the setback ordinance, requiring any building over 400 feet to diminish in size the higher it rose, thus opening up the view and allowing sunlight to filter into the canyons of the city.

BY THE 1920s, THE COMpetition to build and own the world's tallest building had taken on aspects of Keystone Kops comedy. Architects and engineers guarded their battle plans as carefully as any general. If word got out that someone was planning an 875-foot-tall building, someone else would add a couple of stories to the penthouse of his building to make it even taller.

The 77-story Chrysler Building was topped off in 1929 at 1046 feet. Its marvelous crescents, tapering upward in a high, slender spire, are almost completely decorative. A portion of the spire can be used to house a pressure water tank, but the spire is there simply to lay claim to the title of world's tallest building.

It was a distinction the Chrysler Building would hold for less than two years. In 1930, construction began on a $52 million project on the west side of a prestigious Fifth Avenue site. What was planned was the most ambitious skyscraper yet imaginable, one that would feature 102 stories rising 1248 feet above the streets. Actually, only 85 floors could be used for business purposes, but a 200-foot, 17-story mooring mast for dirigibles was calculated to qualify the Empire State as the world's tallest building—a title it would retain for 40 years.

The grandeur of the project was not lost upon those involved. Chief architect Richmond Shreve soared to ethereal heights as, writing in *The Architectural Forum* in June 1930, he prefaced his remarks about the Empire State Building with lofty prose:

" . . . Truly the architect walked among the great, and none held his head

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Shreve came back to earth long enough to admit that the project at hand was beyond the scope of any one individual—even if he were an architect. This was a team effort on a scale never before seen in the construction industry. During the course of the project, meetings were held at least once a week. In Shreve's office gathered the elite of the construction industry: former presidential candidate Alfred E. Smith, president of Empire State Inc., the owner corporation; Homer G. Balcom, structural engineer; representatives of Meyer, Strong & Jones, design engineers for the heating, ventilating, electrical and elevator systems; F.J. Brutschy, mechanical engineer; and D. Everett Ward, representing the mortgage holder, Metropolitan Life Insurance Co.

The team concentrated on a single principle. The flow of materials had to resemble an assembly line. Some 58,000 tons of steel had to be routed to the site and lifted into place so that the delivery lines would never cross one another. The subcontractors' tasks were scheduled with the precision of a fine timepiece.

The results were impressive. During times of optimum construction the steel framework rose at a rate of 4½ stories per week. The entire project was completed in an astonishing 18 months.

The Empire State Building opened for business at 11:30 a.m. on May 1, 1931, when the lights of the main lobby were turned on by remote control from Washington, D.C., the switch thrown by President Herbert Hoover. A party on the 82nd floor wailed long into the night, and the joyous festivities were broadcast via radio to millions of listeners who hoped this latest temple to mankind's abilities might symbolically rally the nation out of its growing Depression.

Critical reaction was mixed. *The Architectural Record* in January 1932 yawned: "It is just another building to walk past—adequate, perhaps, but humdrum."

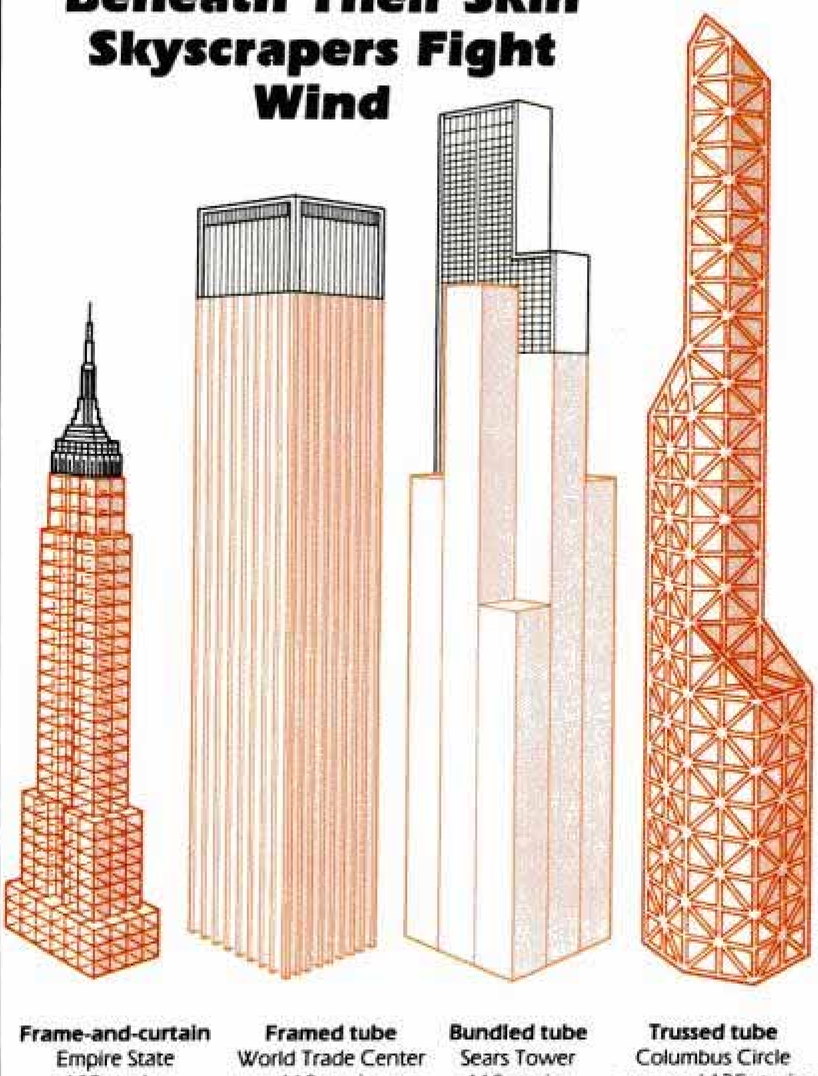
But the public was captivated and remains so to this day. It held the title for so long that when artifices like the World Trade Center buildings and the Sears Tower finally came along, the Empire State remained a testimonial to an older, more ornate era of construction.

There is a legion of admirers that believes the Empire State Building was the last great skyscraper built in America. Chief among them is Charles F. Guigno, director of operations at the Empire State Building and a vice president of the present owner, Helmsley-Spear Inc. Standing on the observation platform on the 86th floor, Guigno gazes south where, at the lower end of Manhattan, twin towers rise eight stories higher. "Those," he says, pointing, "are the boxes that this building came in."

A DECADE OF DEPRESSION followed the construction of the Empire State Building, and that was followed by another decade of adjustment before the skyscraper once more reached higher toward the heavens.

There was no question that Americans would build taller. The only question was

Beneath Their Skin Skyscrapers Fight Wind



Frame-and-curtain
Empire State
102 stories

Framed tube
World Trade Center
110 stories

Bundled tube
Sears Tower
110 stories

Trussed tube
Columbus Circle
proposed 135 stories

Ask an architect to define a skyscraper, and he will say it's any building with a height/width ratio greater than 7-to-1. But ask a structural engineer, and he'll tell you a skyscraper is any building whose major load is due to the wind. Architects work at drawing boards on dreams. But engineers have to deal with the real world, and their definition is perhaps more useful.

The forces exerted even by a gentle breeze, acting on a lever that can be thousands of feet long, do apply tremendous loads to a skyscraper. In a hurricane, the stress factor is truly awe-inspiring.

In the design of a tall building, breaking is out of the question, but bending is permissible. The upper floors of New York's World Trade Center whip several *feet* in a high wind. To find out how different building structures are made to deal with the physical problems, you have to go under the structure's skin. All tall buildings have one thing in common: They can be considered as a beam cantilevered upward from its foundation. The greatest strength and stiffness are achieved by placing all of the support in the building's perimeter. And the lowest cost is reached by using all the supporting structure to resist bending and carry weight.

The classic design is a frame-and-curtain-wall construction. New York's Empire State Building is the greatest example. Its heavy stone walls provide most of the building's stiffness. But the Empire State was built more heavily and more expensively than more recent competitors and future tall buildings. For a lighter, roomier and less expensive construction, engineers have followed by building with structural supports as outboard as possible for maximum rigidity. Load-bearing walls are placed against a framed tube in this construction, seen in the World Trade Center.

The Sears Tower in Chicago—still the world's tallest building—uses a bundled-tube construction technique, which allows lighter weight walls and more window space. In the future, the tallest buildings will use a trussed tube design, which bears even greater load per square foot of lighter construction materials.

A 135-story building that had been planned for New York's Columbus Circle was expected to make use of the trussed tube method, opening a new era of tall buildings.—*Lee Green*

PM ILLUSTRATIONS BY MARIO FERRO

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when and where. One vision of the future came from Frank Lloyd Wright. In 1956, the legendary architect conceived the "Illinois," a 528-story, mile-high, tripod-shaped tower that would dominate the Chicago skyline and be, said Wright, "centuries more permanent than the pyramids." The 130,000 occupants of the office building would be transported through the 18.5 million square feet of the Illinois via 56 atomic-powered elevators.

Wright's vision was premature, however. The technology to create his dream was not yet in place.

The necessary evolution in skyscraper design was promulgated in the early 1960s by the late Fazlur R. Khan of the Chicago office of the renowned design firm of Skidmore, Owings & Merrill. Khan reasoned that the tube, which was at the same time light and resistant to buckling, was an ideal form for the tall building. Vertical columns could be spaced narrowly along the perimeter and linked by strong lateral beams, making the entire building a strong box-shaped column.

The tube concept is the reason that modern super-tall buildings are all variations on the theme of a simple rising column. The twin towers of New York's World Trade Center, as Guigno points out, are obvious examples.

FROM THE FIRST MOments of planning, officials of the Port Authority of New York and New Jersey had it in mind to build the world's tallest building. One scheme called for a single 180-story tower nearly twice as high as the Empire State. But the most feasible design called for twin towers that would rise 1350 feet in stark simplicity.

Combining his efforts with those of the structural engineering firm of Skilling, Helle, Christianson and Robertson, architect Minoru Yamasaki designed each tower to be a gigantic square box beam. Wind-tunnel tests showed that the structure would withstand winds up to 150 mph with no ill effects.

The concept of "sky lobbies" was critical. This called for each tower to be separated into three zones delineated by sky lobbies on the 48th and 78th floors. Anyone going higher than the 48th floor would have to take an express elevator there and change to a local. This allowed three local elevators to operate in a single shaft and freed up to 75 percent of the floor space for tenants.

The World Trade Center would cost $900 million, but it would stand as the newest monument to construction technology, a pair of the world's tallest buildings, housing 50,000 office workers and attracting 80,000 visitors every day.

Construction began in 1966 on what at times seemed to be an impossible job. Much of the land was merely a portion of the Hudson River filled over with years of garbage, alluvial sediments, building and excavation spoils, the remains of docks and, as one observer said, "every damned thing." Excavators faced the task of digging through this accumulated trash and into the Hudson River bottom, while avoiding the maze of telephone lines, electrical cables, and gas, steam, water and sewer lines that undermines the surface of all of Manhattan. And they had to do all this without disturbing the operations of two Port Authority Trans-Hudson (PATH) train tubes.

Merely relocating the telephone lines proved to be the biggest such job in the history of the New York Telephone Co., involving the main trunk line for all major trans-Atlantic telephone systems—including the hotline to Moscow.

Competition was most intense in New York. The Metropolitan Life Building, 707 feet, was on top for four years.

Unable to find a single supplier who could meet its needs, the Port Authority ordered more than 200,000 pieces of structural steel from 14 different U.S. manufacturing plants. A computer program was developed to track each piece from the moment the order was placed through the fabrication process, shipment, storage and installation. The steel components, weighing as much as 52 tons apiece, were stored in a Penn Central yard in Jersey City. When needed, they were shipped via flatbed truck through the Holland Tunnel and hoisted into place by one of eight Australian-built kangaroo cranes, so named because as the building rose higher, the cranes were moved (or hopped) to the top floor.

Despite the construction heroics, however, the World Trade Center relinquished the title of world's tallest building even before it was completed. Supremacy was quickly captured by Chicago's $170 million Sears Tower, its 110 stories rising 1454 feet above Wacker Drive.

The structural key to the Sears Tower is what Khan called the bundled tube. Quite simply, if one tube was strong, a bundle of them would be stronger—and allow you to build higher with safety and efficiency. If you could look down at the skeleton of the Sears Tower, you would see a bundle of nine 75-foot-square columns, rising to various heights. At its base, those nine columns form a 225-foot square occupying an entire city block. But various columns terminate at the 50th, 66th and 90th floors, leaving only a single 75-foot-square column to reach the zenith. The steel columns that form the inner sides of the bundled tubes provide incredible strength without lacing the entire frame with cumbersome and costly crossbeams.

"Sears did not come to us and say they wanted to build the world's tallest building," recalls John Zils, project engineer for Skidmore, Owings & Merrill. Nevertheless, all factors conspired for an assault upon the altitude record. Sears needed office space for 12,000 employees and, as its own primary tenant, could guarantee immediate occupancy.

The final impetus came from projections that if Sears did, indeed, build the world's tallest building, that fact alone would attract enough cash-paying tourists to make the entire venture profitable. "When we finally decided that it would be the tallest, everything got very intense," Zils remembers. "It was really fun to come to work in the morning."

TO KEEP THE FLOOR space open, engineers wanted to eliminate, as much as possible, the need for diagonal bracing members. With steel vertical columns positioned every 15 feet and welded to 75-foot horizontal beams, they calculated that they needed to add diagonal bracing only at floors occupied by the mechanical systems necessary to keep the building in operation.

Structural engineers worked out a plan to mass-produce the 76,000 tons of structural steel columns varied in thickness and quality, depending upon their location in the tower. Each was 39 inches deep, so that all the columns could be fabricated on a single jig. Similarly, each 75-foot horizontal beam was molded from a single pattern.

While still in the shop, each horizontal beam was cut in half and one end was welded in place against a vertical column.

By welding in the shop, the engineers

PHOTO FROM THE IMAGE BANK

cut down considerably on the hassles and expense of welding at the construction site. Scheduling was coordinated to minimize the need for storage, so that when each column and beam module was driven to the site, it was immediately lifted into place by one of four cranes occupying the corners of the rising tower. Once set into place, the half-sections of the beams simply bolted together. "It was," says Zils, "like a big tinker toy."

Ask any architect or structural engineer involved in skyscraper construction whether we should build higher than the Sears Tower and you will get a measured response. Most believe it is not necessary, and that economic factors probably favor skyscrapers in the 60- to 80-story range. Most of them also have plans sitting around for buildings that would wrest the title from the Sears Tower.

Noted New York structural engineer Irwin G. Cantor has expanded Khan's bundled-tube concept into what he calls a "megastructure," which is one large framed tower that would incorporate a series of smaller buildings, perhaps 10 stories each, into it. Each of the smaller structures would be anchored to the megastructure, but only loosely, allowing the oversized skeleton to absorb the phenomenal stresses placed upon a super-tall building.

The megastructure itself would not be used for human-occupied space, but would likely be the site of massive mechanical support systems. Cantor is now designing a megastructure which will rise 80 stories above the streets of Manhattan, but he sees no reason to stop there. The megastructure, he believes, could safely and efficiently rise 200 stories—nearly double the height of the Sears Tower.

ARCHITECTS AT HARRY Weese & Associates in Chicago and Lev Zetlin Associates in New York have created plans for a 210-story Chicago World Trade Center to be built in spiraling increments. The top section of the tower would be rotated 45° relative to the base. In effect, the spiraling columns would act as gigantic guy wires for added strength. "It's not theoretical," says Weese. "It could be easily built." All it would take, is "somebody who had bottomless pockets."

Others agree with Weese. Modern construction costs being what they are, it is a good bet that the next world's tallest building will be constructed by a developer in whom the irresistible force of the ego is considerably stronger than the immovable object of the pocketbook. Likely candidates, therefore, are those who have already exhibited signs of an uncontrollable desire for vertical recognition.

New York real-estate mogul Harry Helmsley has taken himself out of the running. Owner of the Empire State

Building and scores of other Manhattan towers, Helmsley acquired a construction site at Lexington Avenue and East 46th Street a few years ago. "He came to us," Roth recalls, "and said he'd like to build the world's tallest building." Helmsley had in mind a 125-story tower that would bring the title back to the Big Apple.

Roth's team set to work amassing data and soon encountered a fundamental problem. The site was immediately over underground tracks feeding Grand Central Station, which undermined the strength of the substructure.

"After 80 stories on that site, there would never be a payback," Roth says. "You'd have to put so much steel for extra strength that the last 45 stories would never show a profit. Therefore, to build 125 stories would truly be an ego trip."

Businessman that he is, Helmsley settled for 80 stories and has not since raised his sights.

Then came Trump.

Youthful developer Donald Trump exhibited the requisite ego when he proclaimed his $200 million Trump Tower at Fifth Avenue and East 56th Street "the most exciting and sophisticated architectural experience of all time." Trump Tower quickly became known as a symbol of opulence and pride.

Thus it was no surprise that, when the city of New York planned a new building on the site of the old Coliseum, Trump submitted a towering proposal. But his plan for a 135-story, world's tallest building was rejected in favor of a lesser project that would bring the city a greater rate of return. Again, the super height of the building made for dubious economics.

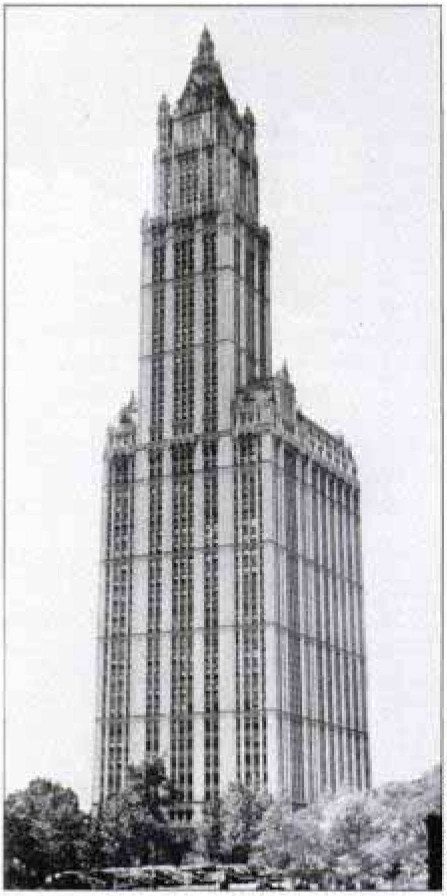
There are whispers that he is now considering building a 140-story tower on a site *in* the East River.

THERE IS, HOWEVER, more than a reasonable possibility that the next titleholder may not even be an American building.

Two years ago, Emory Roth & Sons worked on preliminary drawings for a building in Seoul, South Korea, that would have surpassed the Sears Tower by five stories. It was to be ready in time for the 1988 Summer Olympics, but the project fell through.

"The rumor, although never corroborated, was that the Rev. Sun Myung Moon was behind all of this," says Roth. "At any rate, I don't think the world's next tallest building will occur in the United States. I think it will occur in some country that's looking to make a splash. There are a lot of Third World countries that would say, 'Why not do this? It will put us on the map.' "

But if the next world's tallest building arises anywhere outside the United States, look for another claimant to the throne to follow quickly. One suspects that American developers will be unable to restrain themselves.



"Make mine higher!" F.W. Woolworth ordered architect Cass Gilbert. His building rose 792 feet.

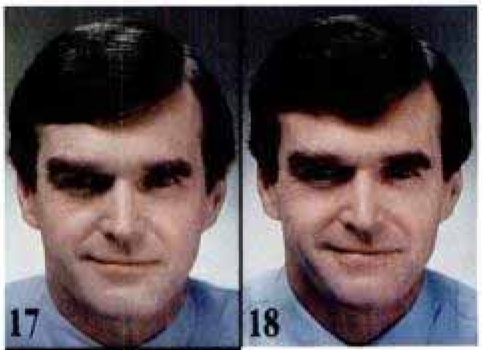
And perhaps instead of jumping the height another 10 stories or so, an American builder will erect a monument so incredible that its supremacy will remain unchallenged into the foreseeable future.

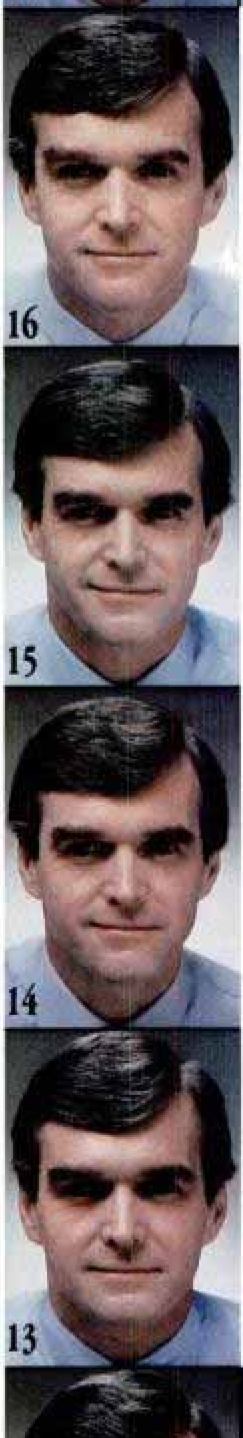
Roth describes his drawings for a 500-story tower as "what architects and engineers do when they've got nothing else to do and they sit around talking."

His colleague Robert Sobel has noted that plans for the 500-story tower were created in a spirit of "experimentation and adventure." It was Sobel and Nat Krahl, professor of civil engineering and architecture at Rice University, who conceived the idea that a mile-high tower was feasible if Kahn's bundled tubes were built not in a square configuration, but in the far stronger shape of the triangle.

The structure would consist of 16 tubes, each a 200-foot equilateral triangle, bundled into a larger triangle 800 feet to a side. A large "footprint" encompassing 16 city blocks would be needed to offset the lateral loads.

Thus far, the 500-story skyscraper is merely an inquiry into possibilities. Yet, its skyrocketing configuration points in the direction of the future of the American skyscraper. PM





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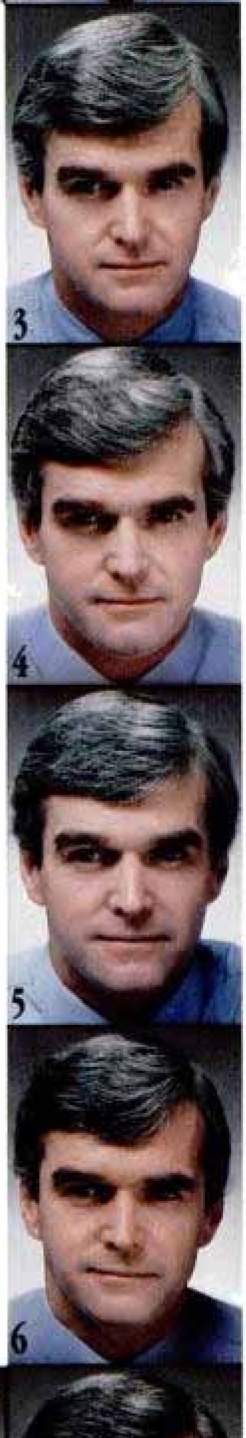
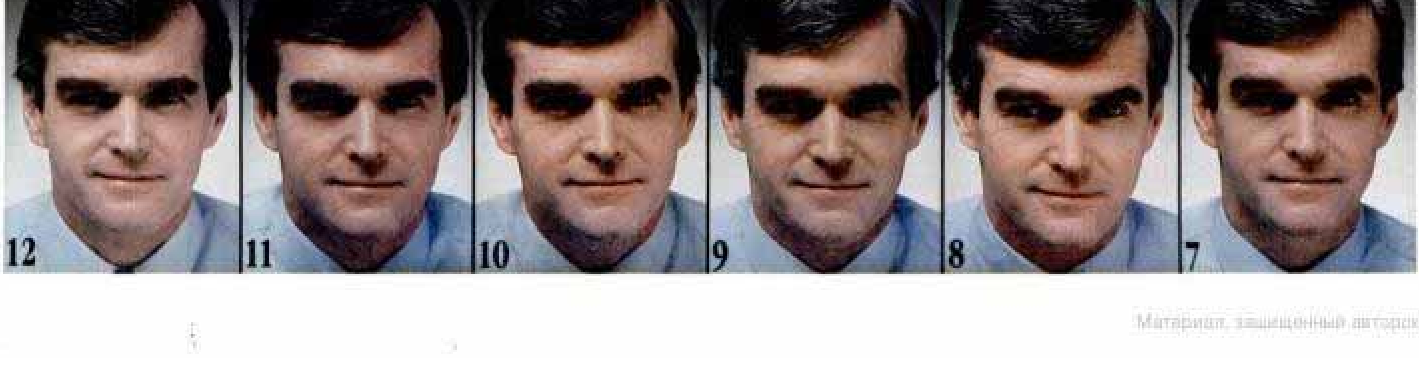
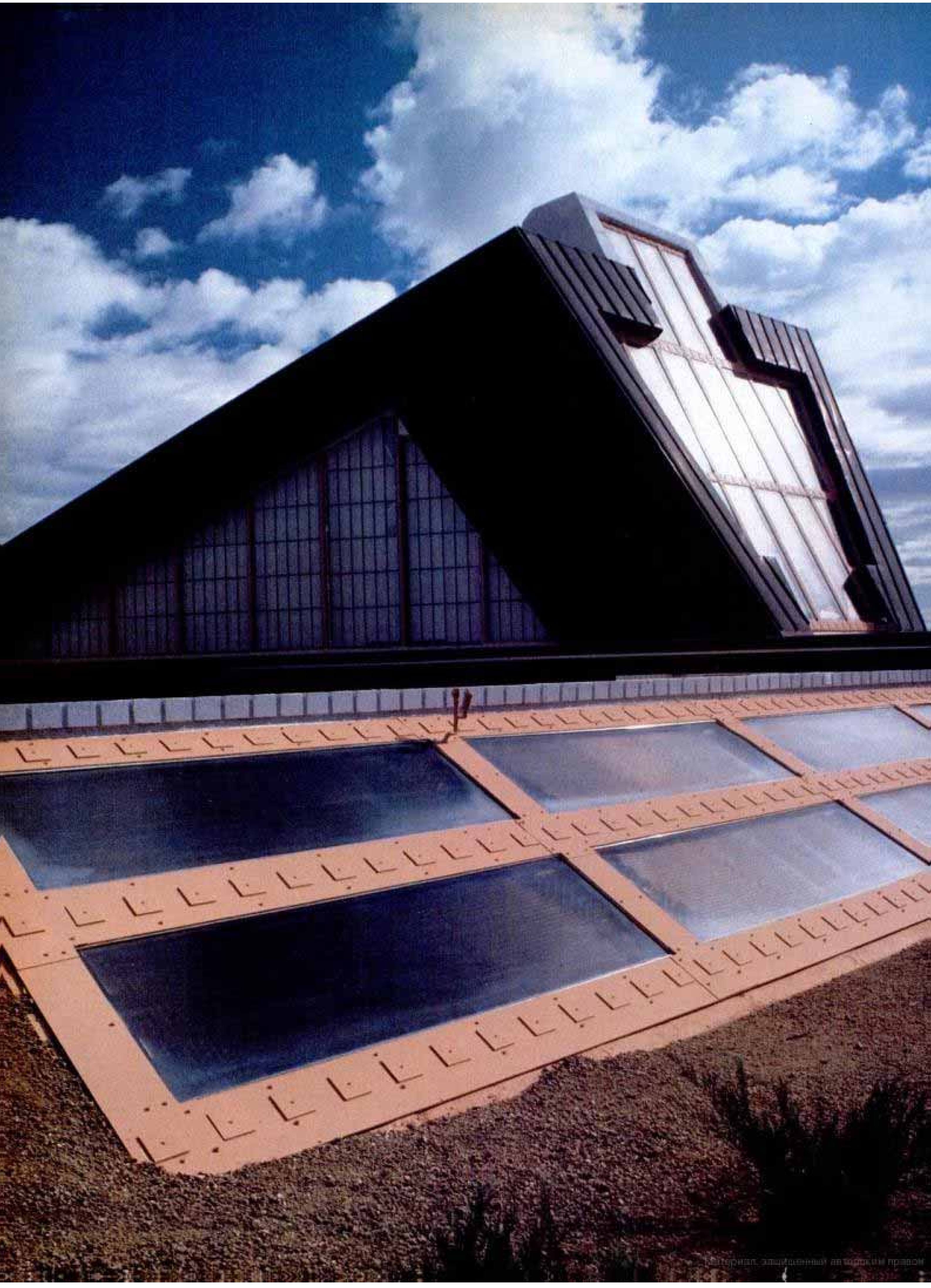
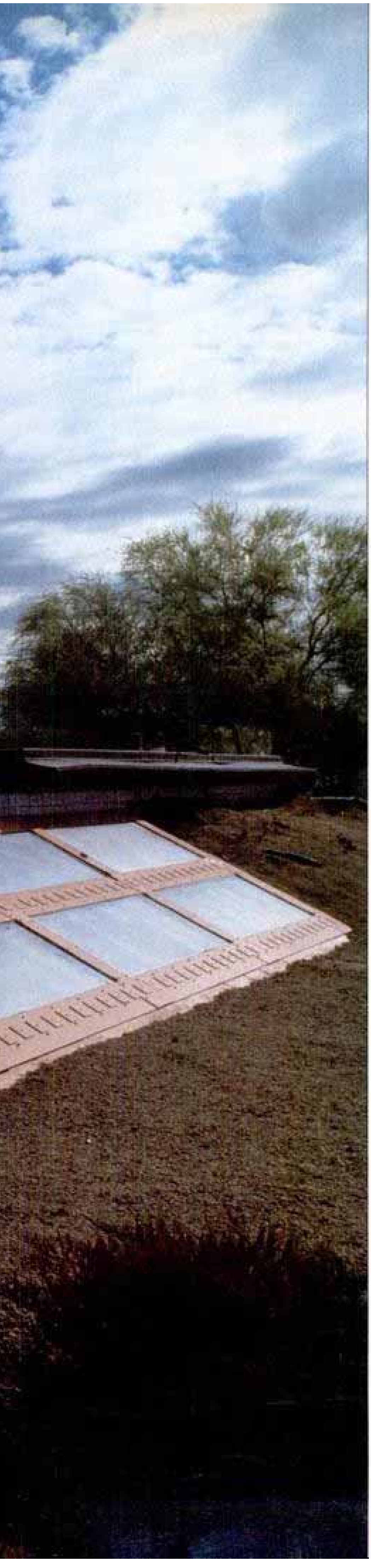








For more than 200 years, Americans have dreamed of owning their own homes. That dream is alive and well.

A Man's Castle

BY WALTER UPDEGRAVE

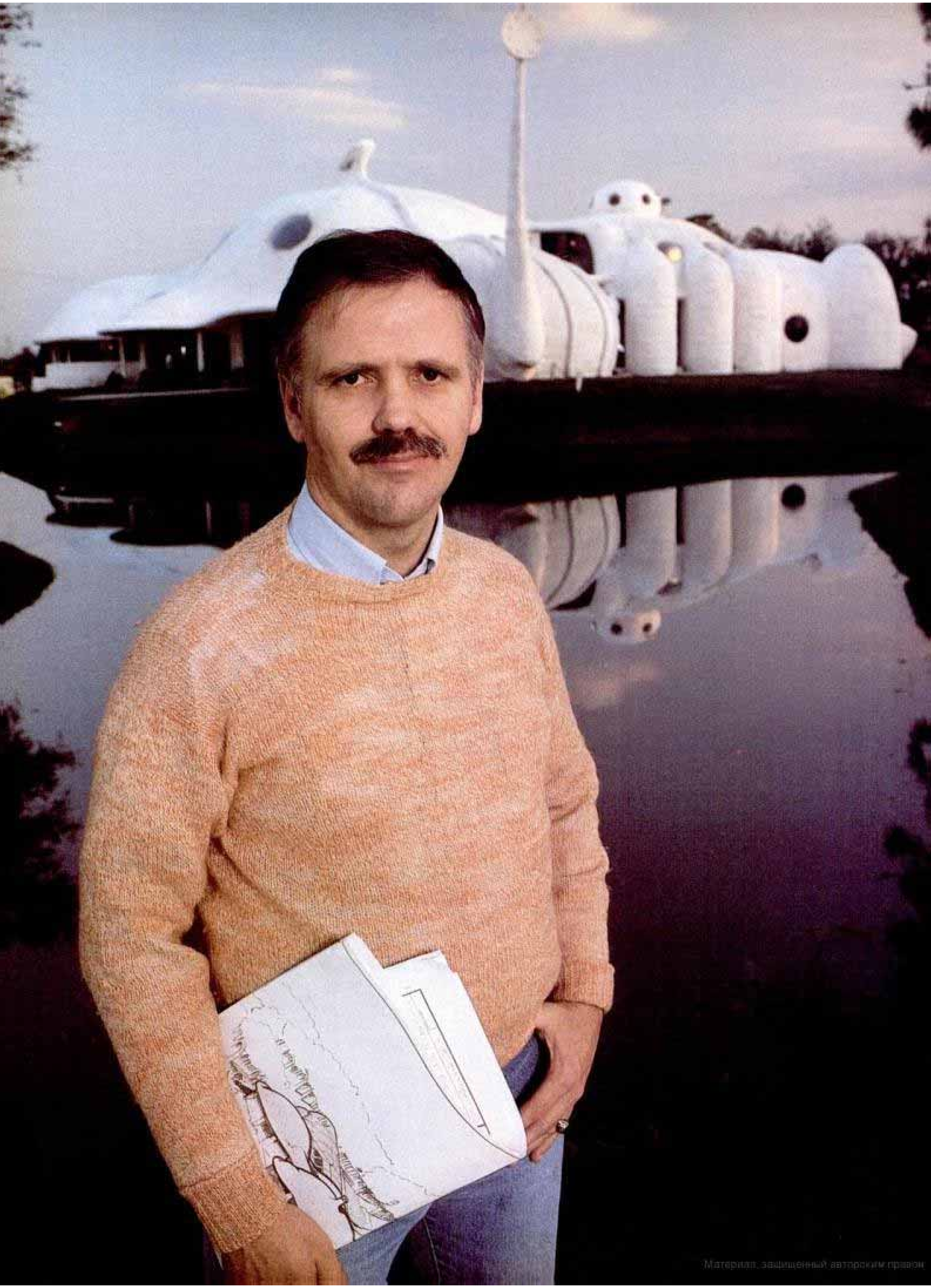
Depending on your point of view, Roy Mason, the 47-year-old architect and avowed futurist in Washington, D.C., might qualify as a high-tech visionary on the vanguard of modern architecture or a half-baked crackpot on its lunatic fringe. Take, for example, his idea for a transcontinental apartment building. As Mason envisions it, this 8-story structure will stretch like a ribbon across the country, linking the East and West coasts with a major highway that runs along the roof. He's also hatched a design for a maternity hospital shaped like an egg with delivery rooms that resemble wombs.

But Mason's true mission is to build the house of tomorrow today. To do this, he doesn't use wood or brick or aluminum siding. No, Mason builds with balloons and foam.

"Today's building methods lag far behind our technology," says Mason. "It doesn't make sense to build a wood frame just so you can hang insulation on it when you can build with the insulation itself." So Mason has invented a new building technology—"architronics," a combination of architecture and electronics. He inflates a huge hot-air racing balloon, then sprays the inside with polyurethane foam insulation. After the foam hardens, Mason peels off the balloon to reveal his creation: a foam-dome house that looks like a cross between a mushroom and a marshmallow. The combination of the foam's rigidity, spherical shape and thickness—6 to 8 inches—gives the house all the structural strength it needs without a conventional wooden frame.

Mason's showcase, the house that embodies his belief that architecture should reflect the latest technology, is Xanadu, a futuristic foam palace located near Walt Disney World in Florida. This high-tech foam igloo contains a "house brain" that controls energy consumption, a "sensorium" room with biofeedback sensors that detect your mood and select music to cheer you up or calm you down, and an earthbound version of R2D2, a "robutler" that does

HOUSE OF THE FUTURE AT AHWATUKEE, ARIZONA/PHOTO BY BRIAN R. WOLFF



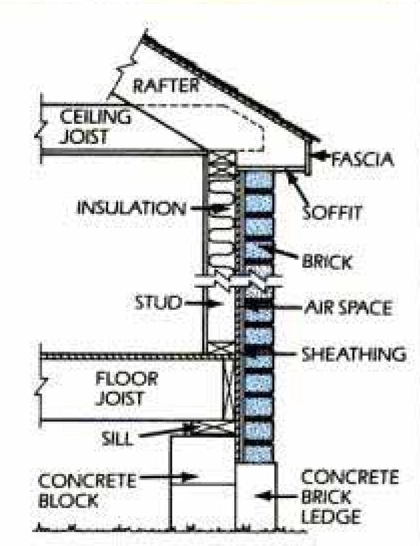
According to Mason, "It doesn't make sense to build a wood frame just to hang insulation on it when you can build with the insulation itself."

household chores such as vacuuming and other cleaning.

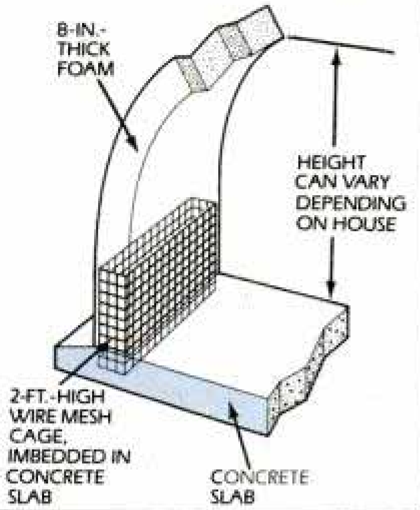
But Mason considers Xanadu a crude prototype. Ultimately, he wants to build a house where the brain has a left and a right side. The left half will control lighting, security and energy management, while the right side will entertain us. He sees a day when the family will gather around the "electronic hearth," a giant computer/video screen, to do everything from planning vacations—the screen will flash images of Africa, Europe or Antarctica on request—to discussing with the house brain why Johnny got an F in advanced computer programming on his second-grade report card (the house brain says Johnny's been playing too much Donkey Kong). And on cold winter nights, the family of the future, toasty and warm in its well-insulated foam dome, will cuddle up, much as our pioneer ancestors did, around the fire in the hearth—not a real fire, of course, but a video image of a flickering flame.

Of course, Mason isn't the only architect who has a slightly, shall we say, idiosyncratic idea of what a house ought to look like. One architectural firm, Jersey Devil, a group of three architects from Princeton and one from Ball State University, has specialized in designs so radical and offbeat that Mason's work looks almost mainstream in comparison. Over the past decade, Jersey Devil has built a number of bizarre-looking houses, including ones shaped like a snail, a football and a helmet (not an NFL helmet, but the headgear for a knight's suit of armor). The group's current project is called the Hoagie House because its long, low, loaf-like shape resembles the Philadelphia sandwich of the same name.

Nor is Mason the first person to believe that avant-garde technology will shape both the way we live and what we live in. Back in 1927, architect-engineer-philosopher R. Buckminster Fuller used technology then being experimented with in the fledgling aircraft industry to create one of his first futuristic designs, the Dymaxion house. Built with high-strength alloys and tensile structural techniques, Dymaxion resembled an oversized spinning top and looked as if it belonged on the set of a grade-B sci-fi movie. Later, Fuller patented the geodesic dome, employing a form of construction based on an icosahedron, a sphere consisting of 20 triangular surfaces.



In a conventional house, insulation is hung on the frame within the outer and inner walls. Mason's foam serves as both wall and insulation.



During the '60s, geodesic domes—inexpensive and easy to build—were ballyhooed as the perfect alternative to the resource-guzzling American lifestyle. At the height of the fad, one group even planned to build an entire city of icosahedral domes in southwestern Colorado.

Still other visionaries have opted for more down-to-earth designs—underground or earth-sheltered houses. Some proponents of this technique burrowed their houses into hillsides, using the earth as an insulator. Others, like architect John Bernard, buried the entire house underground, then cut skylights into the roof to let in sunlight. A house sitting below the frost line stays cool in summer and warm in winter. The disadvantage is that the subterranean environment can make life a bit gloomy.

But there is also the larger issue of the basic appeal these nonconformist designs hold for American home buyers. Do we really expect a generation of Americans weaned on Cape Cods and raised in split-levels to go for Mason's Buck Rogers image of the future, or for a house that looks like an Italian hero roll? And what of those tradition-bound homeowners who hunger for the ultimate American castle, the house that architect Richard Meier has dubbed the SFRSSH-2g, the single-family, ranch-style suburban house with 2-car garage? Do we honestly believe that anyone who aspires to this version of the American Dream would ever settle for a house 6 feet below the surface or one that looks like a toadstool?

That's hard to say. The American house has undergone some radical transformations over the past few years and American home buyers have resorted to zanier ideas than foam bubbles. We've squeezed into tiny houses crammed onto postage-stamp-sized lots. We've shoehorned ourselves into condominiums that, in another era, might be mistaken for oversized closets. And we've financed these cracker boxes with an alphabet soup of mortgages—ARMs, VRMs, SAMs—that we don't really understand or trust.

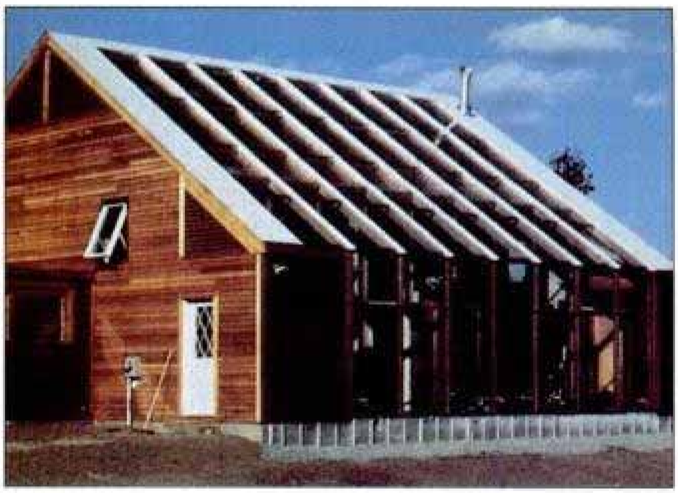
BUT EVEN THOUGH THE American house has changed in recent decades, our fervent desire to own it hasn't flagged at all. Whatever the alternatives—a rambling suburban ranch, a hand-hewn log cabin, a cramped high-rise condo—and whatever the cost, Americans always find ways to own their own homes. The dream of homeownership runs so deep in this country that it is virtually considered a birthright.

"It's the glue that holds our system together," says George Sternlieb, director of the Rutgers University Center for Urban Policy Research. "Our society is based on the implicit promise that if you work hard and save your money, you will be able to enjoy the most important material symbol of the good life—owning your own home."

But although this overriding desire for homeownership can be traced at least as far back as the 17th-century Puritans, who equated a society of homeowners with an egalitarian and democratic community, it wasn't until the post-World War II building boom that the United States truly became a nation where homeowners outnumbered renters. And the man who, more than any other person, made it a reality was William Levitt, the master builder who turned 5500 acres of Long Island farmland into one of the largest housing developments in the

FACING PAGE: ROY MASON/PHOTO BY HUMPHREY SUTTON. ILLUSTRATIONS ABOVE BY MARIO FERRO

Geodesic dome: part of R. Buckminster Fuller's legacy.



Solar housing: drawing energy from Mother Nature.

world. In 1947, Levitt began building his first Levittown, a community that within three years would house 60,000 people in 17,441 new homes.

Over the next decade, Levitt was able to build almost 48,000 new houses, turning out one every 16 minutes at his peak of production in the early '50s.

The houses that Levitt built were hardly palaces, though, and the monotonous row after row of them led critics to label them "ticky-tacky." But they were affordable. His Levittowner model, a boxy 3-bedroom house of 1000 square feet, sold for $9990 in 1952. If you had an income of roughly $3000 and could scrape together a $600 down payment (veterans and defense workers could buy for nothing down), this modest castle was yours for a mortgage payment of $60 a month. The more luxurious Country Clubber—1600 square feet, three bedrooms, two baths and a fireplace—went for $16,990.

With Levitt and others like him churning out houses at such a hectic rate and bargain prices, the United States quickly became a nation of owners. By 1950, more than 50 percent of American families owned their homes.

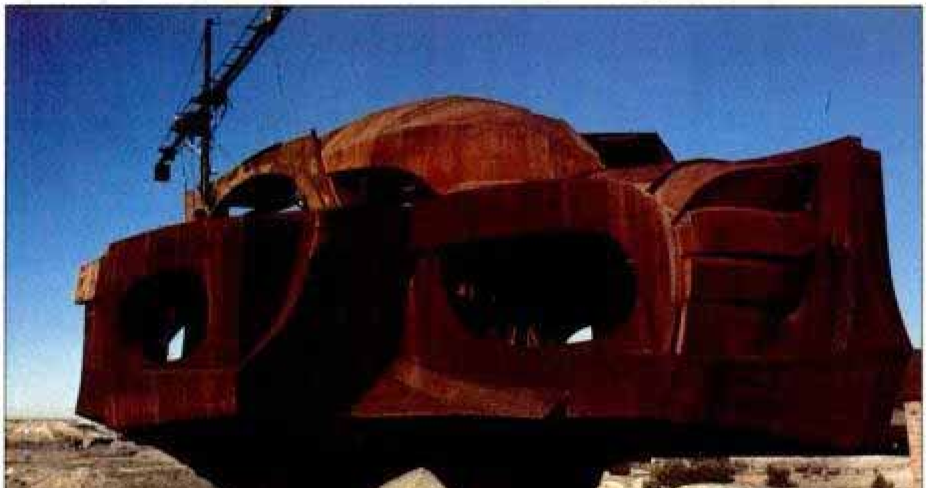
As the migration to the suburbs began in the '60s, Americans began demanding more luxurious homes. The American Dream shifted from the desire to simply own *a* house to a burning need to have a *particular* house—usually a rambling 3-, 4-, even 5-bedroom and 2½-bath split-level, or a roomy Cape Cod with an extra bedroom or two carved out of the attic, or that surest symbol of success, the SFRSSH-2g.

Ideally, this suburban palazzo would be nestled comfortably beneath a shady tree on a grassy lawn of at least a quarter acre, preferably a half, and would have a gas-guzzling Ford Country Squire station wagon parked in the driveway.

In the '70s, the American house underwent a personality change—from shelter, a place that harbored our lives, hopes and dreams, to something less nostalgic: an investment. With inflation raging, mortgage money below 10 percent and Uncle Sam's generous tax deductions, housing was the No. 1 inflation hedge. Those who'd bought Levitt-type houses in the '50s unloaded them at a profit and traded up to a grander homestead.

BUT THESE HALCYON days came to an abrupt end in October 1979. The Federal Reserve Board decided its top priority was controlling inflation and suddenly the American house, especially the sprawling suburban castle, found itself under siege. Mortgage interest rates jumped to 11 percent in 1979, 13 percent in 1980, 15 percent in 1981 and 18 percent in 1982. This made houses prohibitively expensive. The Harvard/MIT Joint Center For Urban Studies estimates that between 1979 and 1983 some 800,000 young households were shut out of the housing market.

As a result of this affordability crunch, the proportion of homeowners vs. renters in the U.S. actually *declined* for the first time since the Depression. What's more, it has continued to decline every year since, meaning that for many families the dream of homeownership is still just a dream. But the economy also exerted a profound influence on the *structure* of the house. The new house of the '80s is a lot smaller than the house of the '70s. Between 1979 and 1982, according to the National Association of Home Builders, the median-sized new single-family house lost roughly 120 square feet of floor space—fewer bedrooms, no den or separate dining room. Houses have since inched up in size, but they're still smaller than in the heyday of the '70s. Land is scarcer, too. While a quarter acre was standard equipment with the old SFRSSH-2g, builders today squeeze new homes onto a tenth of an acre—sometimes less. With the advent of condos, there's a good chance you won't get any turf at all.



It looks more like a UFO than a home, but Robert Bruno's house in Lubbock, Texas, is actually a mass of steel resting on four giant concrete pads.

TOP LEFT PHOTO BY A.B. JOYCE, PHOTO RESEARCHERS.
TOP RIGHT PHOTO BY NORMAN B. SAUNDERS, BOTTOM PHOTO BY TODD JAMES

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Ralph Waldo Emerson

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But these numbers don't begin to describe how much people were—and still are—willing to compromise to own a house. The Barratt Co., which builds in the Silicon Valley of California, has sold condos measuring a claustrophobic 432 square feet. You'd have to link four of these together to equal the room in one Levitt Country Clubber.

And Kaufman and Broad, another California firm, is building—and, incredibly, selling—a subdivision called Homeplus where the houses come in two sizes: small, 924 square feet, and smaller, 840 square feet. These aren't condominium apartments. They're single-family detached homes on their own little (*very* little) plots of ground. The Homeplus houses (actually they're mobile homes dressed up to look like site-built houses) come with a lot that is all of 2400 square feet.

Whether it's a baronial estate or a high-rise apartment, a man's home is still his castle.

But if downsizing helped lower the price of housing, it also created a marketing problem: How do builders sell miniature houses and condos to a generation of Americans who yearn for the good old SFRSSH-2g? One way is to be forthright—explain that costs have risen, interest rates are higher and it's time to settle for a scaled-down version of the American Dream. But that approach goes against the instincts of every PR and advertising person from Madison Avenue to Wilshire Boulevard. So, instead, builders and developers turned to a combination of cost-cutting construction techniques, architectural sleight of hand and good old American marketing hype.

Rule No. 1: If you can't give them big, convince them small is just as good or better. Flip through the industry publications and popular shelter magazines and you'll see features about "small homes that *live big*" and stories about "space-stretching" techniques that "wring extra square footage" out of close quarters. The suggestion is that the modern house, though smaller, is bigger. Well, not really bigger, but it's supposed to *feel* bigger.

One favorite claim is that cathedral, or vaulted, ceilings rising to heights of 14 to 15 feet or higher compensate for the lack of floor area with cubic volume and make cottage-sized houses "explode" with space. Sliding glass doors leading to patios or courtyards are supposed to "bring the outdoors in" and "visually expand the size of the room." The fact that many of today's houses no longer have distinct living rooms, dining rooms and kitchens is touted as a plus. Hallways? Walls? "Wasted space," cry today's builders.

Increasingly, the developer's aim is to divert your attention from the actual house and focus it instead on an image, a theme conjured up by the builder's marketing and advertising staff. The process starts with the name of the project. Deer Run, Country Meadows, Heritage Court—names like these have little to do with the houses or the site, but are shameless attempts to woo buyers by evoking a nostalgia for a cozy, rural past.

But it's a tease. The houses themselves don't deliver on this promise to transport you back in time. Look closely and you're apt to find that the colonial clapboard siding is waferboard and the shutters plastic, the front porch on your neo-Victorian is too small for a rocking chair and the inside of your Mediterranean-style house isn't much different from the Plantation Mansions down the street.

IT'S NOT MERE COINCIDENCE IF THIS FAKERY reminds you of a movie set. In fact, Rodney Friedman, an architect with Fisher-Friedman Associates, a firm that has built thousands of houses over the past 30 years, sometimes refers to his architectural work as "sceneography" and proudly admits he takes cues from the Hollywood studios.

"I was doing some work for 20th Century Fox in 1972 and was taking a tour of the studios when I came to the realization that we do the same thing," recalls Friedman. "We're creating an image for a residential community. You just have to know which buttons to push." The buttons are the shape of the roof, the textures—brick, shingle, clapboard—and the landscaping—lush jungle bush, a forest of trees, an English garden.

"By fooling around with the materials," says Friedman, "you can get a Tahiti Village next to a Spanish Village next to a Tudor Village, if you want." Not quite. What you get is a Hollywood-set version of a Tahiti, Spanish or Tudor village.

Friedman designed a townhouse project in Redwood City, California, that was built around a cement lagoon. The townhouses were built in a contemporary California style—steep-pitched roofs, dramatic angles, open balconies—and finished with cedar shingles. Sensing the possibilities, the architect added a clubhouse with a lantern on top—and voila! Lighthouse Cove, a bit of old New England.

In the marketing brochure, the developer noted that as the shingles weathered to a silvery finish, Lighthouse Cove would take on the look of a New England fishing village. *New England*

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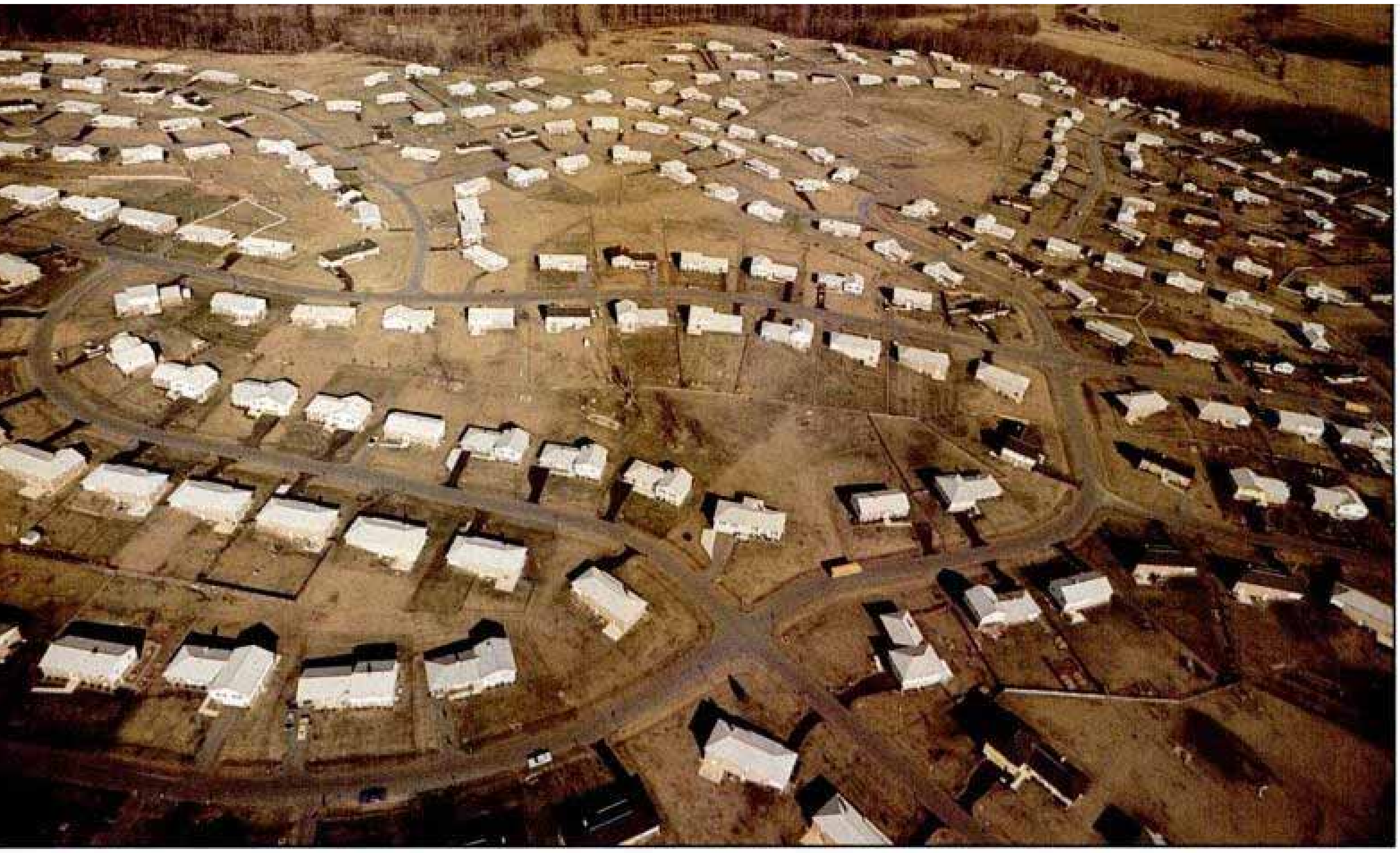


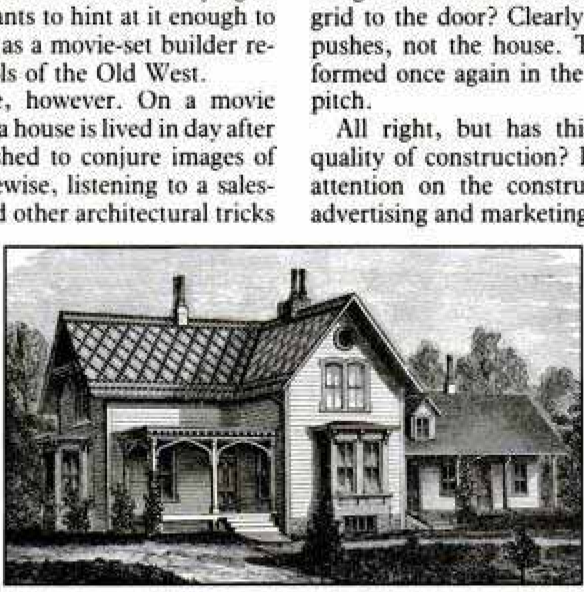
The suburban home of today may look different from its predecessors, but owning one is still part of the American Dream.

fishing village? Even if they filled the cement lagoon with a fleet of fishing boats, stocked it with cod and halibut and imported a crew of old salts from Gloucester to trawl it every day, Lighthouse Cove would still look like a Northern California housing subdivision. But Friedman contends he's not trying to duplicate a fishing village. He just wants to hint at it enough to stir people's memories of one, much as a movie-set builder recreates only the most obvious symbols of the Old West.

There's one significant difference, however. On a movie screen the fakery isn't noticeable. But a house is lived in day after day. Will the buttons Friedman pushed to conjure images of New England work years later? Likewise, listening to a salesman's pitch about vaulted ceilings and other architectural tricks that supposedly make small rooms "explode" with space is quite different from coming home to your 500-square-foot condo or 900-square-foot house each day and staring out the glass sliding doors to the patio to convince yourself it really is like an extra room out there.

Quite simply, the spiel in the marketing brochure has become more important than roof trusses, walls and foundations. The brochure for one major development in a New York suburb sets a scene that is carefully crafted on heavy-stock paper and is illustrated with tasteful artists' renderings. It describes the houses as "rural estates where traditional designs blend subtly with contemporary trends. Where months of planning have gone into the curve of a window."

But the houses differ sharply from this image. The $445,000 Colonial model has a brick facade facing the street, but the sides are covered with the same vinyl siding you'd get on an $80,000 house. And if you walk through and inspect the impressive row of French doors leading out to the patio, you'll find they're not French doors at all. Instead of individual panes separated by wooden muntins, these doors have a plastic grid fastened over a single sheet of glass to give the effect of small panes framed in wood. Is this the subtle blend of traditional and contemporary design? Did it take "months of planning" to screw that plastic grid to the door? Clearly, the image is the reality the builder pushes, not the house. The American house has been transformed once again in the '80s. The house is now a marketing pitch.



A house of another era. Cost then: about $2500.

All right, but has this latest metamorphosis affected the quality of construction? Do builders lavish as much care and attention on the construction of houses as they do on the advertising and marketing materials that go along with it? Or is the often-heard saying true, "They don't build them like they used to"?

The official industry view is yes, we don't build them like we used to, thank God. According to the NAHB, new houses are vastly superior to those built 20 or 30 years ago. And in many respects this is true. While houses of the '80s aren't generally as big as those of the '70s, they are larger than most of those built in the '50s and '60s.

A house today usually comes equipped with a better heating and cooling system and superior wiring. Great strides have also been made in energy efficiency. "Today's new homes use as much as 50 percent less energy than homes built 10 years ago," estimates Donald Luebs, director of the NAHB Research Foundation. "They have better doors and a tighter envelope." A new house also comes stuffed with what builders call amenities, such as whirlpool tubs in colors that sound like ice cream flavors—French vanilla, Swiss chocolate, raspberry purée.

But changes behind the walls and floors have had a questionable effect on housing quality. Copper is losing ground to

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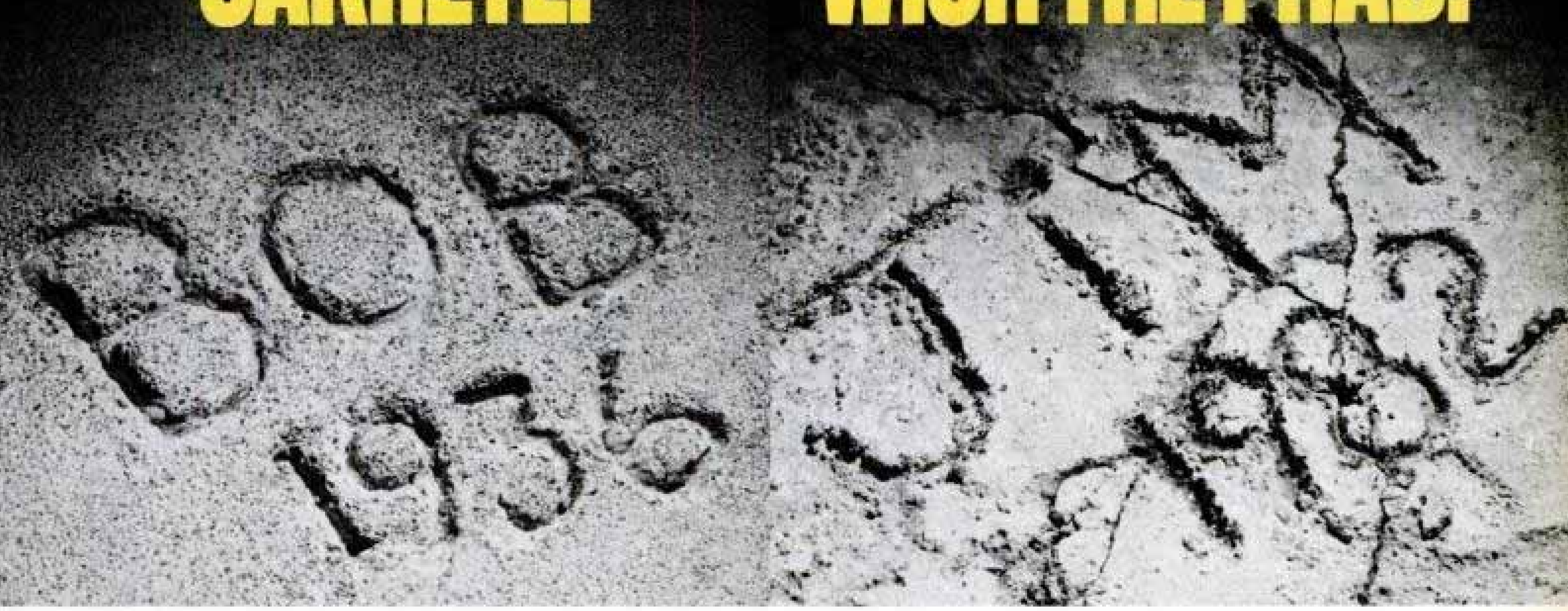

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plastic. Polyvinylchloride, or PVC, is already widely used in drainage systems, despite the claim of critics that it emits dangerous toxins when burned. And some builders are stringing new houses with polybutylene, a flexible, expandable plastic tubing, to carry bathing and drinking water. Plywood, once the standard sheathing for floors, walls and roofs, is being replaced by such materials as waferboard, particleboard and polystyrene foam panels.

Some builders are doing away with wood sheathing in the walls altogether and turning instead to foil-faced laminated paper—essentially, cardboard.

Builders will tell you they've turned to these new products because they work just as well or better than traditional ones. "But that's baloney," says Ronald Passaro, a director of the American Society of Home Inspectors. "No matter what they say, they're going to them because they're cheaper." Still, performance, not price, is the real issue. Will laminated paper hold up as well as plywood against the stresses of weather and everyday living? Can we be absolutely sure polybutylene will last the 40 years we get out of copper and that it won't leach into our drinking water? No one has the answers to these questions because none of this stuff has been around long enough to prove itself.

GIVEN THIS TREND TOward PVC, polybutylene and polystyrene foam panels, could Roy Mason's vision of a polyurethane foam dome be a likely successor to today's houses after all?

Architect Robert A.M. Stern doubts it: "People are always having fantasies that we're evolving a new aesthetic of architecture based on new technology. But it's not true." A house is more than just a structure; it is an almost mystical blend of memories and emotions that are tied to physical symbols—a white picket fence, a front porch—that resist change.

Rodney Friedman, the architect qua movie-set builder, gives a little test at speaking engagements. He rattles off a list of items, including a house, and asks the audience to draw each one in just a few seconds. "Ninety-nine-point-nine percent of people draw the identical house," says Friedman. "It has a peaked roof, a chimney, sometimes with smoke curling up from it, and a tree on each side." He's never had anyone draw a high-rise and circle a window, and, since Friedman hasn't given his test to Mason, he's never had anyone draw a fungus.

What all this suggests to Stern is that "the American dream house of the future will be the American dream house of the past with better plumbing." In other words, we may have more advanced electronics within our houses, but when it comes to the *shape*, don't expect any zany departures. So Mason may be correct in predicting "Star Trek" technology inside the house, but the look outside will be strictly "Leave It To Beaver."

A house that, paradoxical as it may seem, is both a throwback to the past and a glance toward the future is the New American Home 1986, which Stern designed for the National Council of the Housing Industry and *Builder* and *Home* magazines. Stern's New American Home is simple yet grand, unpretentious yet imposing. It combines Regency-style details—entry columns, low-pitched roof, large windows—with the straightforwardness of a farmhouse.

But what's most striking is how it differs from the cookie-cutter houses of today. At 2200 square feet, it isn't huge, but is much larger than today's norm. The exterior isn't vinyl or fake Colonial clapboard, but brick—90,000 bricks in all. And it is filled with those "wasted spaces" that have been jettisoned from today's "efficient" homes—a formal dining room, a den, a high-ceilinged screened-in porch. "These so-called wasted spaces are the essence of architecture and life," Stern contends. "We realize now after a generation of sleeping in the kitchen with our feet in the living room that that's not a good way to live. People want a house where you can close some doors and get some privacy." The only problem with this house of yesterday and tomorrow is that it sells at today's price: $269,000—about three times the average cost of a new home.

How can builders deliver such a house at a price the American home buyer can afford? The answer may bring the American house to its final transformation.

THE AMERICAN HOUSE of the future won't be sprayed into a balloon and it won't be constructed on site by carpenters banging together studs and beams. It will be produced inside a factory. Of course, many houses are now built that way, but there may be one major change. This house will look like a traditional American house, but, much like the car that will be parked in the driveway, it will be built by a Japanese company using Japanese technology and good old Japanese design. You see, while the U.S. housing industry

There's no mistaking that architect Robert Stern's New American Home 1986 differs from the cookie-cutter houses of today. It's filled with what a lot of other designers consider "wasted space," such as a den and a dining room. Stern feels the so-called wasted spaces are the "essence of architecture and life."

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has been spending its energy finding innovative ways to market houses, the Japanese have been developing the technology and design skills to produce high-quality housing with assembly-line techniques. Sekisui Chemical Co. Ltd., a leading maker of factory-built homes in Japan, can turn out a house every 44 minutes at its highly automated factory near Tokyo where robots weld together steel frames. And, unlike most American manufactured houses, these don't look like they've been ground out like sausage links. "They look like site-built houses," says Charles Graham, a researcher at Texas A&M University's architecture school who has just completed a 2-year study of Japanese home manufacturers. "The Japanese have better quality control in their plants, the houses are designed better and they're more sturdy than American factory-built homes."

The Japanese also have spent millions to develop better building materials. Misawa makes something called PALC, which could replace the conventional wood-frame wall. PALC—precastable autoclaved lightweight concrete—is a mixture of silica and limestone poured into molds and baked to a ceramic-like finish. It weighs a fourth as much as concrete and is soundproof, fire-resistant and capable of withstanding earthquakes.

Sekisui is also working on a new building material called Synselite, a composition of cement and wood chips that could also one day replace the conventional stud-and-sheathing wall.

GIVEN JAPANESE FIRMS' superior technology and ability to adapt products to the U.S. consumer, Graham predicts home buyers here will snap up Japanese-made houses much the same as they're buying Toyotas, Nissans and Hondas off showroom floors across the country. And, in fact, the Japanese invasion is already under way. Some Japanese home builders, such as Daiwa House, are already building in the United States, although they're building on site, not in a factory. And Nissan Corp., the automobile manufacturer, has reportedly tried to buy 20,000 acres of land in Colorado to set up a manufactured-housing plant.

Graham believes the Japanese can grab 25 percent of the U.S. manufactured-housing market within five years and dominate it by the end of this century.

So, sometime around the turn of the 21st century, after you've settled into your new Colonial or split-level or that old American standby, the SFRSSH-2g, take a peek behind a shutter, underneath a gable or at the back of the garage door. Don't be surprised if you find a discreet little tag with the rising sun at the top and, at the bottom, the words "Made In Japan." PM

Castle Keep

BY BETTY FRIEDAN

At 5 a.m., the digital radio alarm jars Michele Marquis out of bed. As she showers, her preprogrammed coffee-maker is already gurgling. While the microwave oven prepares blueberry pancakes, her electronic message center announces the day's agenda.

As a General Electric marketing manager, Marquis was instrumental in designing the many SpaceSaver appliances mounted under her kitchen cabinets. "I don't have any spare time. With product design, I look to the consumer, and I use myself as an example—what I think I need. Then I go out and find the technology that applies."

Are these computer-programmed designs going to revolutionize life for the American housewife? Will women, "freed" more and more from housework by sophisticated appliances, abandon their homes to become enslaved to the time clock? I don't think so. There always will be some degree of rebellion against the complete mechanization of our lives. In my vision of the future, family life will retain human values and flourish by offering more choices to all of its members.

The mechanized home

Appliance manufacturers have created an incredible array of gadgets for the home. Gadgets that can be preprogrammed to start when you want them to and can diagnose their circuitry to tell you how to fix operating problems; microwave ovens that can sense the "doneness" of food and decide when to stop cooking; and centralized home computers that you can instruct by phone to turn lights on and off, operate appliances or turn on the air conditioner.

A very interesting thing about so-called time-saving devices that manufacturers have over the years introduced into the home is that many actually *increased* the number of hours American women spent cleaning house. Take, for instance, a chore such as cleaning carpets. It used to be done, maybe, two or three times a year when the man of the house would hang the carpet outside and the woman and perhaps the children would beat out the dirt. Now look at the modern vacuum cleaner, an appliance that eliminated the participation of helpers and at the same time increased the frequency of the chore 100-fold.

Another aspect of new appliances is the greatly increased standards of cleanliness they impose. Somehow women bought the idea, reinforced by appliance and detergent manufacturers, that having a washing machine meant they had to wash more clothes more often and had to change and wash bedsheets more often.

So, the amount of cleaning done by American women in the mid-'60s (four hours a day) was the same or more than that done by their mothers or grandmothers.

Changing attitudes

In my book *The Feminine Mystique* (W.W. Norton & Co. Inc., 1963), there is a chapter called "Housewifery Expands To Fill The Time Available." It wasn't the introduction of home appliances that spurred women to spend less time on housework. It was when women began to take themselves more seriously, with the women's movement of the 1970s, that they began to *make* housework take less time. Whether it was going into the working world or volunteering in the community or having other goals, women had better things to do.

I don't think women can be persuaded anymore that they're better mothers because they wash out diapers by hand rather than use a diaper service or disposable diapers. They are no longer passive to the sellers' message that they should make things cleaner than

As the number of 2-income families grows, robots and other technological advances will be used at home to cut down on the time spent on housework.

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Kitchens were originally meant as a place for servants to work. Today, the dinginess of an earlier era has given way to a modern look. In addition to a bevy of modern appliances, there's often room for the whole family to take part in cooking. Many designers are starting to include activity and dining areas in their kitchens, giving access to all members of the family.

they need to be. A recent survey conducted by *Good Housekeeping* showed that 68 percent of the women surveyed had lowered their cleanliness standards "a great deal." That, in my mind, is a step in the right direction.

Industry experts can read the statistics as well as anybody—statistics that show women and men won't buy products such as scouring powders, floor wax and others that require too much time and labor. Instead they'll install no-wax floors, buy automatic toilet-bowl cleaners, paper plates and napkins, and use 25-watt lightbulbs to hide the dirt. Economics dictates that manufacturers start paying attention to this.

There is no technological reason that industry has yet to develop more automatic cleaning devices that save time, such as automatic vacuum systems that eliminate the accumulation of dirt. A few years ago, a modular home designed by the Illinois Institute of Technology won a design competition in Japan. Among its major features was a robot that served food and cleaned. I think people will embrace new technology that reduces household drudgery. And the increasing clout of the 2-income family will demand that manufacturers meet that need.

Women at work

About 61 percent of married women with children have full-time jobs. That separates the lifestyles of most American households from that of Michele Marquis, who, as a single woman living alone, uses her own life as an example of what consumers need.

The vast majority of American women will, I think, continue to choose to have children. But many have postponed child-bearing into their 30s and even 40s because their jobs are structured for men who have wives to take care of the details of life. In some countries, such as Sweden, society recognizes that the women needed in the work force are the same ones who give birth to children, and maternity/paternity leave and child-care assistance are provided. An American woman who wants to give birth faces loss of pay, job security and seniority. Prospective fathers, now more desirous to share in child-rearing than ever before, are also locked into jobs that don't provide parental leave or on-site child-care facilities.

So, many women are caught in the "superwoman" bind of competing in jobs for economic reasons and for opportunity, while keeping their home lives in order in houses still designed for men and women of the past.

Even with the harassing, ulcer-producing conflicts women are facing at the workplace, I don't think they will ever return to the home as full-time house slaves. Every piece of research I've read indicates that women will continue to work, even if they can afford not to, because their work in society defines and gives meaning to their lives. In one poll, women were asked whether, if someone were to leave them $1 million, they would continue to work. The majority, even those with unglamorous factory jobs, indicated that they would.

Filling new needs

Until robots and other technology are available to take over difficult household labor, people are turning to other ways of saving time.

Service industries are sprouting up to meet modern needs and to compete for the disposable income of 2-income families. If you're willing to pay, these services will clean your apartment or house, mow your lawn, cater your party and care for your children. A Commerce Department official counted 11 housekeeping franchises in 1984. Their sales jumped to about $42 million that year from $28.9 million in 1983.

Mary Uber-Smith and Bill Smith are a young Oakland, California, couple who both work 40 hours a week, Mary as a computer software tester and Bill as a night chef. Like many modern couples, they split housework, gardening and bookkeeping between them. Most nights Mary prepares herself a salad or other light meal, gets take-out food or eats at a restaurant. On the few nights when they are able to eat together, they eat out or Bill cooks.

Women and men are spending more time in restaurants. In fact, according to industry statistics, only 30 percent of all meals are home-cooked for the entire family. The rest are meals prepared individually, frozen dinners, take-out food or meals eaten in restaurants. Americans spend more than one-third of their food budgets eating out, and the number of fast-food outlets alone has more than tripled since 1960.

Redesigning the home

In my book *The Second Stage* (Summit Books, 1981), I point to the home—the actual physical structures we live in—as playing a central role in keeping men and women from transcending old sex roles that often lock us in.

It is interesting to look at the evolution of the kitchen as an example. Kitchens were initially designed for servants, and they were usually miserable places to work. When the housewife took over as the server, the kitchen became a mock business designed around her. Now, with the family sharing the cooking and cleanup, the kitchen is becoming more of an activity center.

"The kitchen is actually becoming more like a living room. Even though we don't spend as much time cooking in the kitchen, it always seems that we end up there," says Virginia-based kitchen designer Jean Mattingly, explaining her increasing inclusion of activity/dining areas in her kitchens. Some of her remodeling schemes actually include duplicate appliances, such as two stovetops

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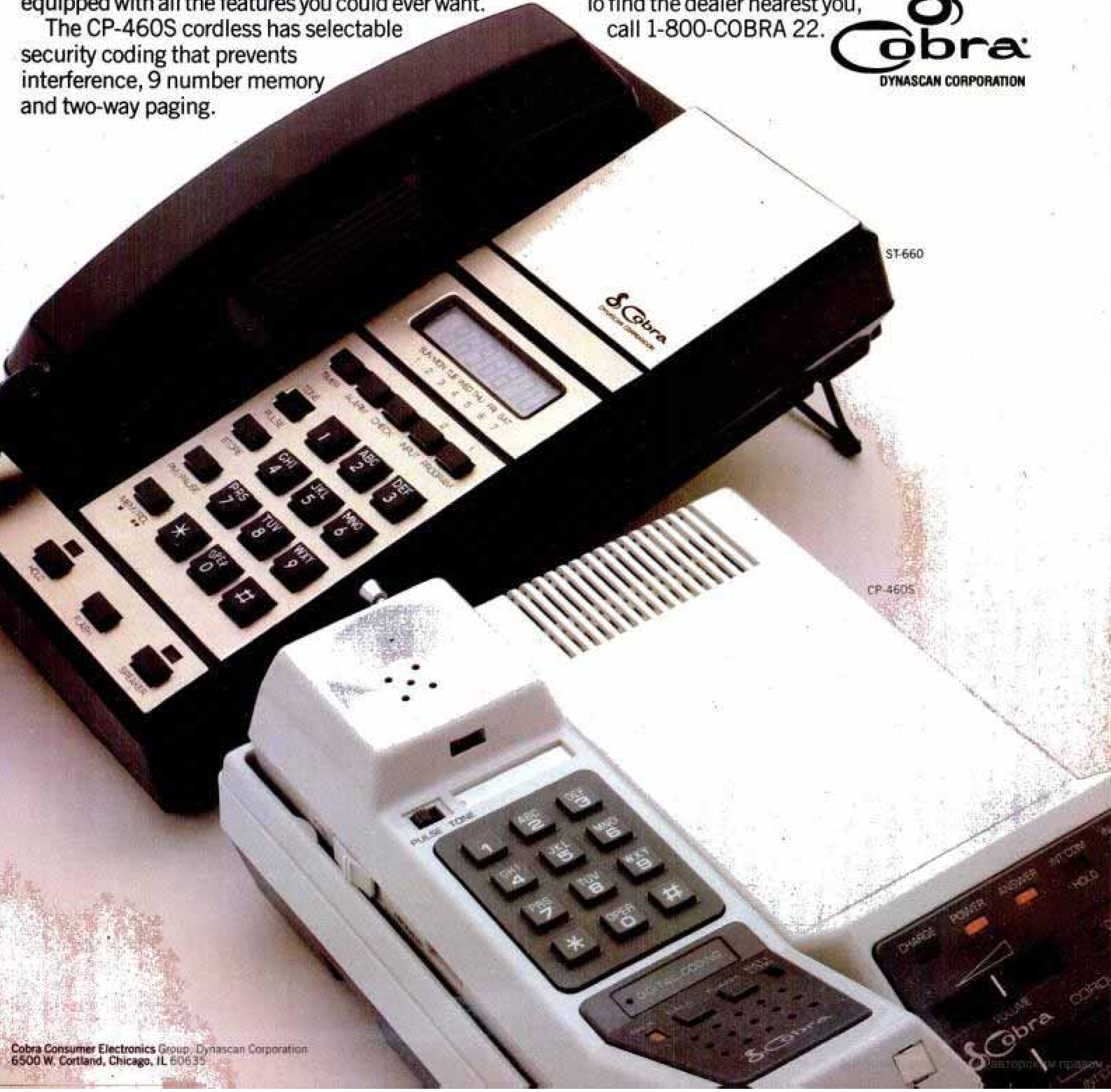

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A computer watches over the "House of the Future" near Phoenix, Arizona. Sensors keep an eye on all doors and windows and are connected via computer to local police and fire stations. The computer also regulates climate control, the solar collectors and energy consumption. The house itself centers on an atrium that is circled by the other rooms. It contains no hallways or other forms of "wasted space."

or two dishwashers, in response to what she sees as a trend toward using the kitchen less for daily meals and more to prepare meals jointly with guests or for weekend entertaining.

"We're still living in houses that are essentially Victorian," asserts industrial designer Robert Graeff, who heads Virginia Tech's Center for Product and Environmental Design. "We are reconsidering the entire layout of the house plan, from the appliances outward, and it is interesting to see how much of it is quite unsatisfactory" for modern family needs. He has formulated an industrial design problem he calls the Family-Serve Kitchen, as opposed to today's Housewife-Serve Kitchen, that provides access for all family members.

One design proposed by his students is an insulated version of the walk-in pantry. Cooled with outside air with the help of a simple thermostat device, it would be capable of preserving fruits, vegetables and most other perishables that are often hidden and dried out in modern energy-consuming refrigerators. Smaller cooler and freezer compartments could be built in for those few items that need colder temperatures.

Other components of the kitchen include cabinets that lower so that even children can reach their contents, a dishwasher that eliminates the need to load and unload racks, a table that can adjust to different heights and ventilator lids that lower to completely cover the stovetop to eliminate odors and residue.

Graeff's center is seeking backing from industry to develop some of its other concepts for bedrooms, bathrooms and water-saving sanitary fixtures. "We look at how the entire house is integrated into its environment. We have to be concerned with more effective use of solar energy, of dwindling resources," Graeff says.

Addressing housing needs

The housing industry is lagging far behind the evolving structure of the family. Most housing in the United States (two-thirds in 1980) consists of single-family detached houses originally designed for the nuclear family—working father, full-time housewife, two or more children. In real life, this description fits less than 6 percent of American households.

I think there are a lot of women and men in different times of life and in different family constellations who want a better variety of housing than is offered today. Even specialized communities built for senior citizens or singles are not taking into account the need for both privacy and shared space. We don't really have designs that experiment with breaking out of single-unit isolation.

One concept whose time may have come is the idea of multiple-family dwellings that combine private living areas with shared laundry, child-care and restaurant services for the convenience of tenants.

The concept of service housing is not new. In the 1880s, boarding homes and apartment hotels were flourishing. Other experiments along these lines at that time were dining clubs, where members would pay employees to cook meals, and cooperative kitchens, in which members rotated the cooking responsibilities.

The home of the future

Predictive articles of the 1950s had us enjoying ample leisure time in our prefabricated homes while the lawnmower/cultivator propelled itself around the yard, robots electrostatically cleaned our carpets and beds made themselves.

There will always be an irreducible amount of housework to be done. Right now, in households with two wage-earners, wives still do an average of 35 hours of housework per week, compared with 11 logged by husbands. But what housework there is to do in the future will be shared more equitably by family members. Boys and girls today are being brought up to take care of themselves, to run appliances, to cook because they have to. And there's no reason they shouldn't. What I would call the pluralistic housework of the future will give a new richness and savor to American life.

Women will continue to work outside the home, but I don't think that they will exchange their old frustrations as housewives for the new frustrations of a dehumanized workplace. The increasing value that both women and men will place on their families will force employers to create a more human climate with more flexible work schedules and respect for parental roles.

I don't think that we will ever accept a totally mechanized environment, but rather will select and use technology in ways that will enrich our lives—women, men and children. PM

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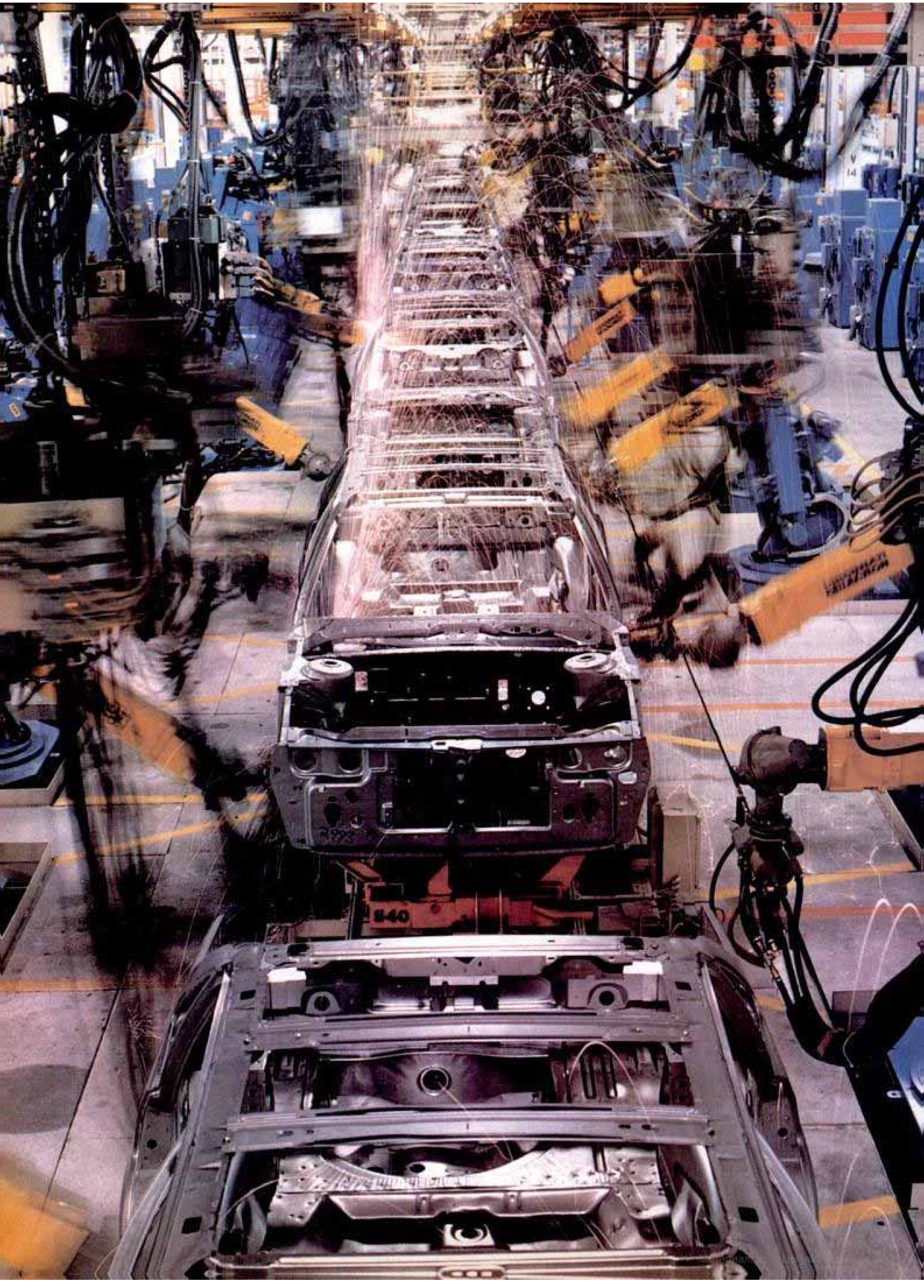


In the 1990s, Detroit will still be turning out a car with one engine and four wheels. But almost everything else will be different.

A Nation On Wheels

BY JOHN NAISBITT

At 6:45 on a late-winter Thursday morning, John Schinella, having already showered, exercised and dressed in a 3-piece beige business suit with contrasting brown tie and handkerchief, walks about his kitchen preparing a high-energy breakfast of banana-flavored protein. His movements are efficient but unhurried as he mixes ingredients while keeping his eye on the clock, checking his progress against the 7:15 time to leave for work. A visitor is offered a share and drinks up. Then, quickly, blender and glasses get rinsed before being stowed in the dishwasher, and an orange and an apple are placed on the counter for a midmorning snack. His wife, Roxanne, joins him and minutely explains to us the benefits of healthful eating.

Schinella gives us a quick tour of his 9-room lakefront house. The color theme inside is consistent with the outside. Carpeting, paint and furniture are honey beige. That background is offset by vibrant reds and blues from Schinella's own watercolors that punctuate the walls of each room. Throughout the house, glass walls and skylights bring in lots of natural illumination. Outside, an 8-foot-wide deck, now covered with 3 inches of an overnight snowfall, surrounds two sides. Across the road, frozen Wing Lake, under the first light of dawn, forms a pleasant winter vista in this posh Detroit suburb.

"Here's my studio," Schinella explains as he leads to a glass-enclosed, skylighted room just off the kitchen. Three drawing tables, an assortment of art paper files and a stereo that, with the flick of a switch, fills the room with classical music are positioned in neat order on the same wall-to-wall carpeting that is used throughout the house. "Sketching with watercolors is one of my favorite hobbies. I also like to work wood. Much of this house I helped put together myself, including the woodwork for a stairway bannister and the deck fence. My dad and I also do lots of refurbishing of his place on Lake Winnepesaukee in New Hampshire."

Later, downstairs in the attached garage, Schinella climbs into one of his favorite cars, a gleaming silver 1986 Pontiac Fiero GT. It's 7:15 and time to set out for the half-hour drive over snowy roads to the GM Technical Center about 20 miles distant.

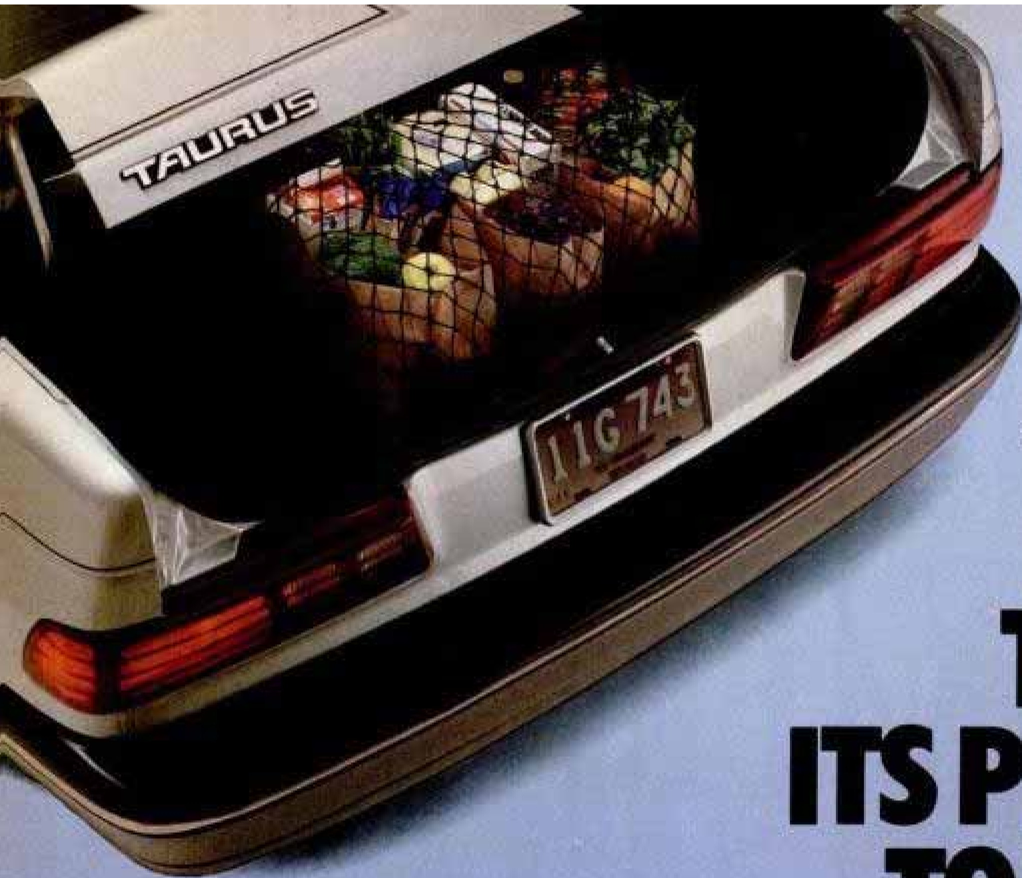
John R. Schinella, chief designer, Pontiac II Studio on the Design Staff of General Motors, is off for another day of work designing cars of the future. Schinella talks with pride about the car during the 30-minute trip.

"The cage frame with plastic body is a breakthrough for designers," he says. "Since the Fiero came out in 1984, we've made two big changes in styling—the Indy 500 front end and this slanting roof rear. That's fast for automobile design. In a steel car, the changes would have taken about three years to get into production. That's why we think you'll see a lot more plastic bodies on cars in the next five years."

Styling is named consistently in surveys as the No.1 reason buyers choose a car. John Schinella, 46 years old and an old hand with 25 years' experience at General Motors design studios here and in England and Australia, is one of the best car designers in the field. His current assignment: responsibility for the design of Pontiac's sensational Fiero and Firebird sports cars, including future variations.

At his office, Schinella confirms his appointments for the day. Yes, the visitor can accompany him to the color and fabric room at 9 o'clock. There he meets with Dave Holls to go over some new paint colors for the Fiero. Holls is Schinella's boss by a couple of levels at least. As director of all of GM's North American exterior and interior designs for cars, Holls oversees studios for each of the car and truck divisions. The two discuss the

LE BARON ASSEMBLY LINE/PHOTO BY CHRYSLER



One of the many examples of Ford's attention to detail is the cargo restraining net on the LX. It helps keep grocery bags from tipping over and loose packages from sliding around.

THE NEW FO
ITS PERFORMAN
TO WHAT'S UN

The mark of a well-designed automobile is total performance.

In the case of Taurus, that means a powerful 3-liter, V-6 engine. Plus dozens of other features that not only respond to the needs of the driver, but to those of the passengers as well.

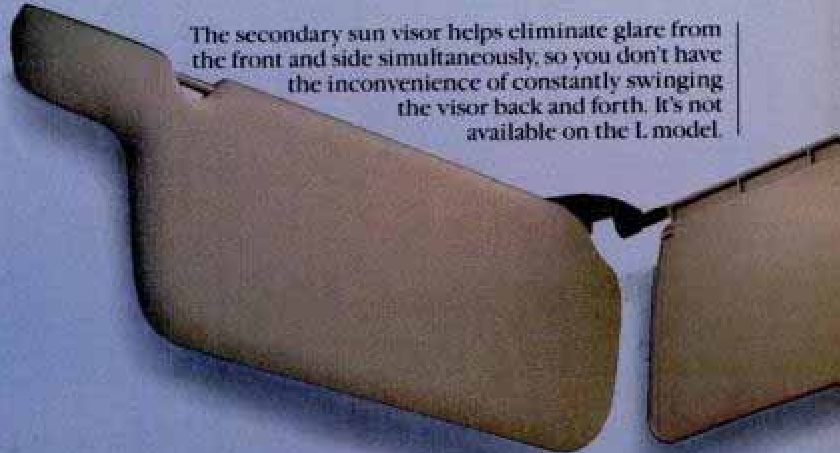
As a result, Taurus performs beautifully.

Even the smallest details have been carefully thought out. For example, the shape of this light switch and its position on the instrument panel make the simple task of turning on the lights as easy as possible.

The trip computer is part of the optional electronic instrument cluster. It provides valuable travel information such as rate of fuel consumption and the distance you can travel until empty.

The optional electronic instrument panel is designed to be "user friendly." All instruments are easy to read and all controls are placed where your hands can easily find them.

RD TAURUS. CE ISN'T LIMITED DER THE HOOD.



The secondary sun visor helps eliminate glare from the front and side simultaneously, so you don't have the inconvenience of constantly swinging the visor back and forth. It's not available on the L model.

Right down to the smallest detail.

The best-built American cars.

At Ford, Quality is Job 1. A 1985 survey established that Ford makes the best-built American cars. This is based on an average number of problems reported by owners in a six-month period on 1981-1984 models designed and built in the U.S.

Have you driven a Ford...lately?

Buckle up–Together we can save lives.

'Styling is the No. 1 reason buyers choose a car.'

merits of new paints for the Fiero.

Later, when the two go into the Firebird studio to go over the 1990 design taking shape, we are politely stopped at the doorway. America's future cars are being designed behind this door, and the press is not privy—yet.

America put the world on wheels. Purists may argue whether it was a German, a Frenchman or an American who actually invented the first automobile. But there's no disputing that the mass-production genius of America put the modern world in the driver's seat of an affordable automobile for the first time. In this century, the building of America has been the building of cars—and everything else associated with them, from roads to radials.

For the better part of a century, the American automobile industry was king. As incredible, and ironic, as it may seem today, we had little competition. Shortly after World War II, when Japan began to rebuild its industries, Japanese business consultants advised against revival of their own auto industry because American cars were better and cheaper.

The first "car" built in America was a horse buggy with a 4-hp, single-cylinder engine, assembled by Charles and Frank Duryea in 1892 to '93. Their second car won America's first auto race, a 50-mile, 9-hour marathon from Chicago to Evanston, Illinois, on Thanksgiving Day 1895.

Ransom Eli Olds built a 3-wheeled steam car in 1891 and a gasoline buggy in 1897. By the turn of the century, he was mass-producing his Curved Dash Oldsmobile, selling 2100 in 1902 and 5000 a year by 1904, when he left Oldsmobile to found the REO Motor Car Co. Henry Ford perfected the assembly line, but Olds had introduced mass production and popular-priced cars to America.

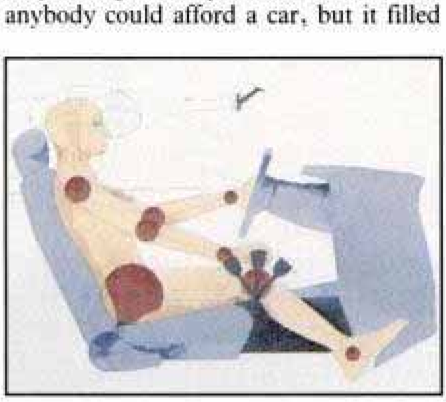
Within a few years, the American automobile had a multicylinder engine in front, clutch and transmission under the front floor, shaft drive to a live rear axle, leaf springs on all wheels, foot-operated brakes, steering by wheel and gear linkage, and pneumatic tires.

Despite these early advances, there were some tough problems that made automobiling a definite challenge. Tires wore out fast and blew out at every opportunity. Gasoline was more like kerosene, and oil was like molasses.

Building a model: Human hands shape clay to create an exact replica of automotive dreams.

Engine maintenance required constant attention. Valves needed grinding, and rings and bearings needed replacement every few months. Sparkplugs and ignition points were iffy, even when new. Cylinder heads had to be removed to dig carbon out of the chambers, and oil sludge could be scooped out of crankcases by the handful.

Ford's famous Model T changed all this in the period around WWI and the early 1920s. Here was a car that combined most of the worst mechanical faults of its contemporaries—and yet it was a milestone development in automotive history. The secret: the first successful use of assembly-line mass production. This not only brought the price down to where anybody could afford a car, but it filled the junkyards with an endless supply of dirt-cheap interchangeable parts that you could bolt together to keep your T on the road indefinitely. Crude as it was, the Ford Model T literally put America on wheels.



Computer-generated woman in the driver's seat will help to determine the compatibility of human and machine.

We stayed alone at the front of the pack until a decade ago when Europe and Japan closed in on a market demanding lower emissions, higher mileage and cheaper cars. Lately, America seems to have made up ground against foreign competitors. In fact, both GM and Ford reported annual earnings of $1.7 billion and $1.2 billion, respectively, in 1985.

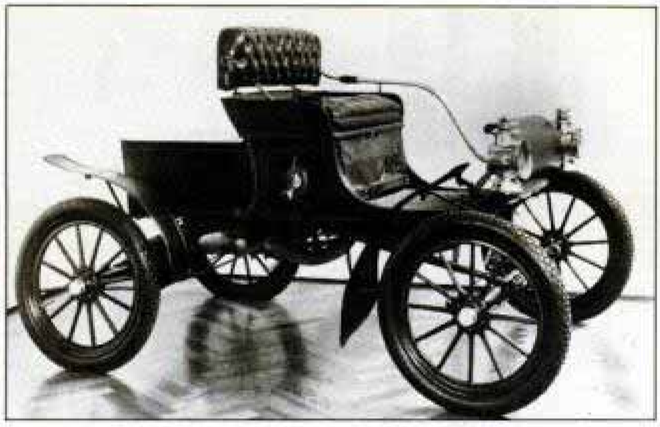
However, evidence suggests that the boom was artificially produced. The main reason that the American auto industry appears so healthy is that quotas were placed on the importation of Japanese cars, first by our government and then by the Japanese manufacturers themselves. The result was not just an ersatz boom. It was higher prices for both Japanese *and* American cars.

When current trade restrictions are lifted, will the house of car(d)s fall? Maybe. Maybe not.

It doesn't have to happen. Another way of looking at a potential tragedy is to consider it a golden opportunity for change. If American carmakers get serious about closing the technology gap—and there are many examples to show that they are already making tremendous strides here—if they cut manufacturing and labor costs by 25 percent, and if they accept the need to go global and at the same time discover their own niches in the worldwide market, they will be able to compete in this brave new auto world. Big "ifs," though.

As you may have guessed, the changes will center on one device—the computer. Computers, or microprocessors, have been in use for a number of years now under the hood to control various engine functions such as air/fuel mixture and spark advance. Once such functions are optimized, fuel economy and exhaust emissions are also optimized. In the last year, the microprocessor's role has been expanded to control such things as heating, cooling and automatic transmission shift points. On some cars with antilock

FACING PAGE: JOHN SCHINELLA/PHOTO BY HUMPHREY SUTTON.
THIS PAGE: PHOTO AND ILLUSTRATION BY BUICK

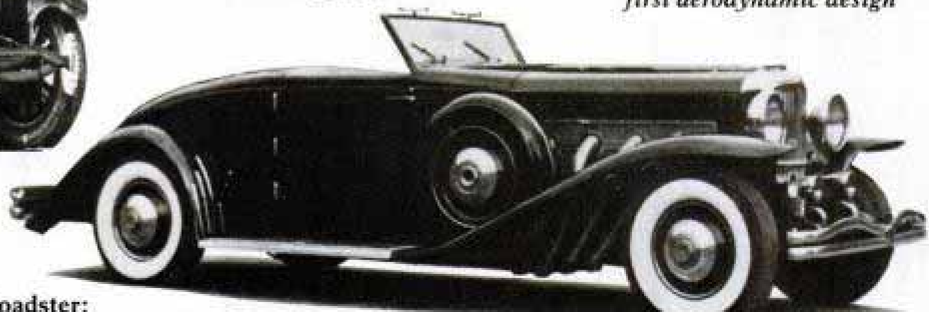


1902 Curved Dash Oldsmobile: ***first mass-produced car***

Model T Ford: ***interchangeable parts***

1934 Chrysler Airflow: ***first aerodynamic design***

1920s Cadillac: ***engine between front wheels***



Duesenberg Roadster: ***Depression-era power and luxury***

brake systems, the body computer also controls this function. On the '86 Buick Riviera, which incorporates a cathode ray tube into the dashboard, even the radio's functions are computer-controlled via the driver's interaction with the CRT.

And this is only the beginning of microprocessor use in tomorrow's cars. There are already a few cars whose suspension setting can be controlled from inside the car. At the flick of a switch, you can change suspension from soft to firm or to a setting in between, according to the road surface or the type of driving you're engaged in. That's now. In the future, a computer will constantly change suspension automatically while the car is in motion through a series of sensors attached to quick-acting hydraulics. You won't have to do a thing.

Computer-controlled 4-wheel steering is also being studied by several manufacturers. The steerable rear wheels cover 10° of arc that, added to the conventional steering on the front wheels, provides enhanced maneuverability.

A modern fighter aircraft is designed for fly-by-wire, with electronic controls replacing mechanical linkages. In tomorrow's automobile, linkage will be replaced by a drive-by-wire system. An electronic sensor will read the gas pedal position, and a central processing unit will interpret this information and activate an electric motor to precisely control the throttle. The drive-by-wire system will mate to a traction control system. On slippery roads, or when power is applied too abruptly, a wheel might break traction. Wheel-speed sensors will detect that this wheel is spinning faster, and the traction control system will signal the central processing unit to limit the throttle, providing the maximum usable torque.

We mentioned before a computer-controlled antilock braking system. Such a system is available now on the Chevrolet Corvette, Lincoln Continental Mark VII, Mercedes, BMW and Audi cars. During braking, wheel-speed sensors detect when a wheel is approaching a lock-up condition. Brake pressure to that wheel is then reduced by the computer. This system can reduce stopping distance without the loss of steering control that occurs when brakes are locked.

Eventually, steering will be done electronically, and when higher speed and larger-capacity parallel processors are available, braking may take place automatically, as needed. As Leonard J. Grozek, technical planning manager of Ford's Electronics Division, says in describing what is no longer merely a dream, "Picture a car with 'eyes' that would automatically take control of your car and swerve or brake to avoid an object."

THE SHAPE OF MANY OF THE CARS you'll be driving tomorrow, or even today, is also influenced by a computer. It's all part of Detroit's ongoing commitment to CAD—Computer-Assisted Design. But human hands still begin the process, shaping clay into exact replicas of what designers first envision as the finished car.

Just walk through the basement areas of GM's main design division in Detroit and you'll catch an occasional whiff of clay seeping out from behind locked doors.

The smell of clay is the odor of mystery. Within those secret chambers, the plans and dreams of the corporate car giants begin to take physical form. Smoothed and finished by loving hands, and with glossy plastic sheets applied tightly enough to clay sides so that they appear to have coats of shiny lacquer, clay models wait for the approval of man and machine.

A mechanical scanner, taller than a tall man but with the delicate touch of a young girl, is rolled into position beside a

PHOTOS FROM DETROIT PUBLIC LIBRARY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1949 Ford: *first new design since WWII*

1959 Cadillac: *biggest tail fins, more of everything*

1960 Corvair: *economy car with power and styling*

1964 Pontiac GTO: *new era of the musclecar*

1972 Pinto: *fuel economy is the future*

1986 Ford Taurus: *high technology and aerodynamics*

clay model. The mechanical arm of the scanner reaches out, traces the graceful curves one by one and converts each aerodynamic molding, every stylistic bump, into a series of coordinates. Then these coordinates are stored as binary bits on a floppy disk that, to a computer, is more readable than the glossiest clay surface.

The wet smell of clay becomes a memory as the process moves to the air-conditioned, office-clean cubicles of the design team.

Clay is converted to video as the stored points are instantly accessed by desktop computer terminals. A car appears on the screen: It's tilted, moved around and examined in detail until every part of the dream can be certified as being worthy of reality. Of course, reality to GM or Ford may differ somewhat from our own consumer-oriented perceptions of a car.

ON A RECENT TRIP TO DETROIT, WE watched anonymous video cars being put through their computerized paces on monitor after monitor. It was a combination of the Indianapolis 500 and a pinball fantasy. But it was all deadly serious.

One test involved a procedure as human-oriented as packing your trunk for a long trip. The video display, under the guidance of the designer, zoomed in and became a full-screen view of a car's open trunk. The screen beneath the trunk was filled with a list of options, such as "golf bag" and "lady's overnight."

The designer touched his light pen, like a magic wand, to one of the on-screen choices. Instantly, a golf bag appeared, as transparent as the car in which it would soon be packed.

With the light pen, he positioned one piece of luggage at a time. Everything fit. But if it hadn't, it would have been back to the clay for redesign and further study of the car's understructure.

"Without computers," Holls told us, "the design process would be far more time-consuming. The computer is helping us primarily in the definition of design. We're confident it delivers a far greater degree of reliability and value."

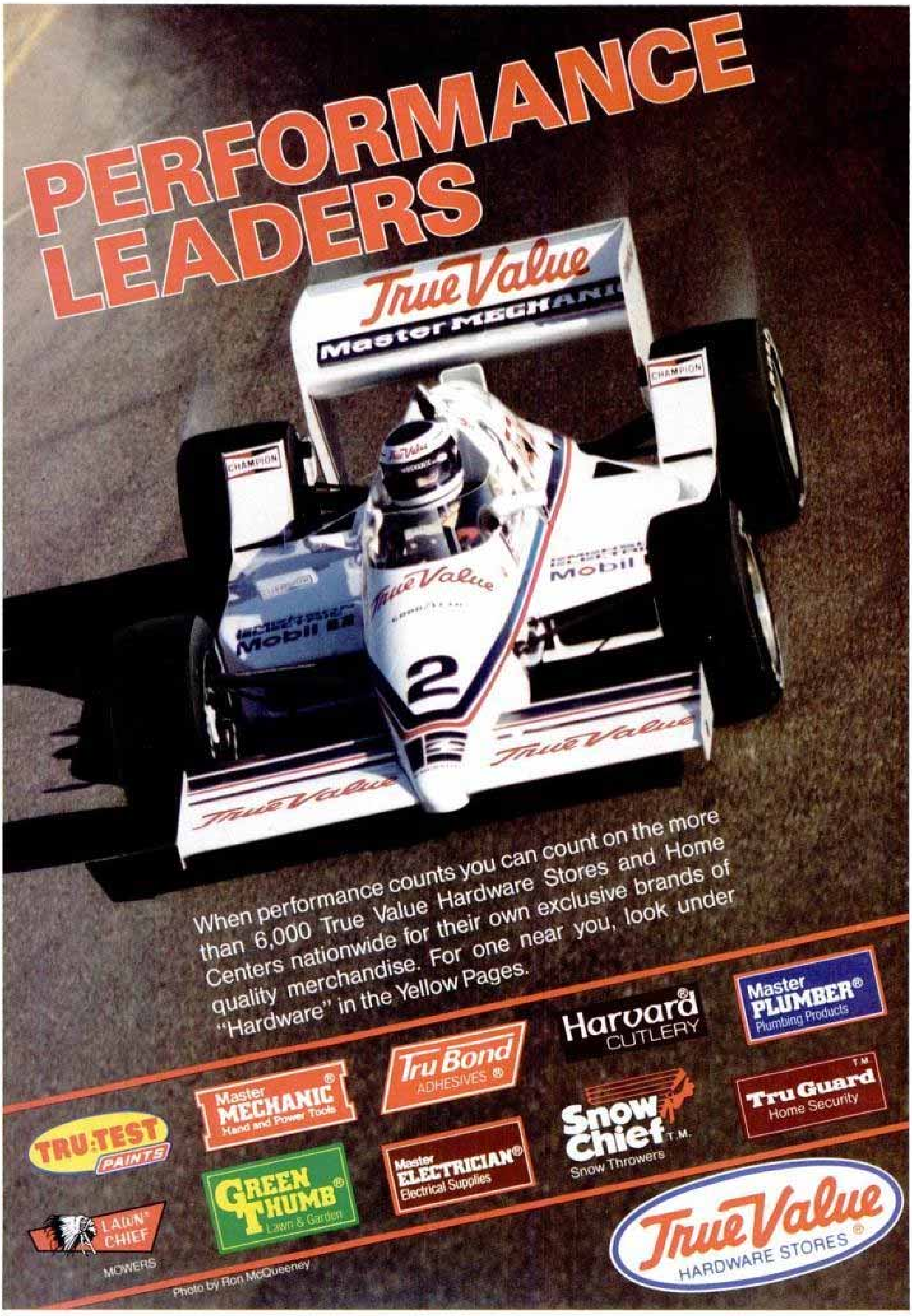
When the design is complete artistically, it must be re-examined structurally. The cleanest, smoothest lines don't guarantee a heavenly ride or good gas mileage.

"We're always investigating new areas with the computer," Don Parker tells us as we are being shown around GM's Fisher Body Division. "With it, we can find inherently weak areas. Or we can see areas that may not do as much work as other areas—and use mass reduction there."

WE WATCHED AS A DOOR POST WAS put through something called finite regression analysis. The video display zoomed in until only a portion of the door post, less than a few inches of it, filled the screen. The computer then displayed a network of triangles all along the magnified part. The woman working the console entered several variables via keyboard and light pen to simulate lateral stress on the door post. Within each triangular area, she questioned the computer for a detailed printout of the stresses and how they affected the stability of the "metal."

We watched spellbound. Had Detroit forgotten how to make a door post? What was all the fuss about? The idea was mass reduction. Less mass means better fuel economy. By using the computer, designers can find out just how much metal to shave away from the finished version so that it will still support a

1964 GTO PHOTO FROM PONTIAC, 1986 TAURUS PHOTO FROM FORD; ALL OTHER PHOTOS FROM DETROIT PUBLIC LIBRARY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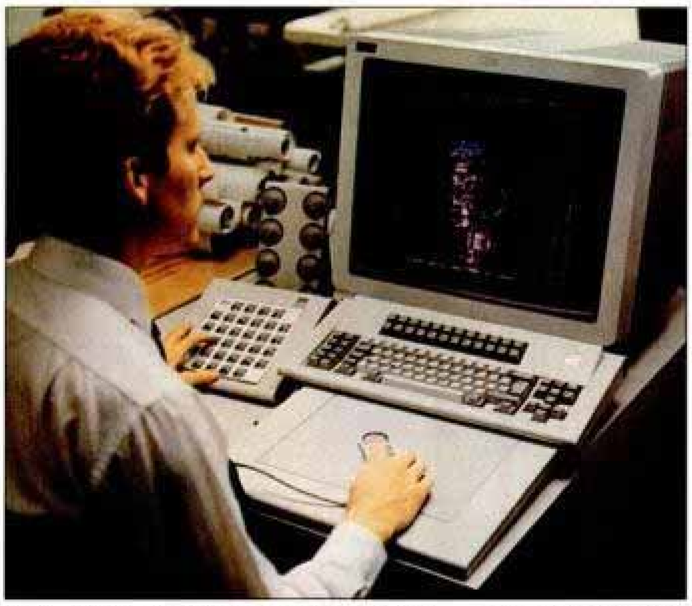

The chassis of the future (above) will have a 4-wheel-steering system that will improve high-speed handling and allow the driver to slip out of tight spaces. Computers (left) have replaced drafting boards in automobile design studios.

roof, yet have the least possible mass.

For several years, CAD also has helped suspension engineers design suspension-component calibrations. The engineers can make a "spring" or "shock absorber" hit a "bump" in the computer and see how it will react at different speeds or with different loads in the car. The engineer can quickly change the calibration, making components softer or harder, depending on how he wants to punch in the ride and handling characteristics of the car. It's a much quicker process than fitting actual hardware to a car, going out to the test track for a trial run, coming back, installing other components, going back out to the track and so on. Finally, a computer is used to design the dies from which the actual parts of the car's body will be cast. From clay, to video, to the blazing furnaces of a steel mill, the typical design project takes four years.

But there are even more applications of the computer just over the automotive horizon. At Ford, we watched a video driving simulator. Seated at the console, the operator could "drive" a car through a number of road conditions. With just a touch of the keyboard, he could drive an entirely different car or adjust such things as spring rates, shock-absorber rebound and roll steel. When the drive felt good, a prototype car could be built for road testing.

But while most of today's computer applications involve structural metal design, engineers are also getting ready to design the functioning parts of automotive machinery on computer. Instead of ghostly, wire-frame images of cars on screen, there are already computer programs that can display exact 3-dimensional representations of everything from hubcaps to camshafts.

Dr. J.W. Boyse of GM's research labs explains how the new GM-Solid computer program works.

Suppose you want to "drill" a few holes into a flat plate of "steel" on the screen. What you do is "subtract" cylinders whose diameters match those of the holes from the plate. Presto. The holes are drilled.

But computers are not the only element whose role is expanding. Plastics, the word whispered in the ear of young Dustin Hoffman in "The Graduate," are coming of age. Growing use of what is called the "cage concept," in which a steel skeleton is fitted with a plastic shell, *a la* the successful Pontiac Fiero, means that far less steel is required. And that means better fuel economy. It also means that model changes will be a far less expensive affair, as the use of plastics can cut tooling costs by 75 percent. Plastic fenders should appear within the next year or two, and by the early 1990s may be seen on half the new cars on the road. This prospect has already produced interesting research and development work on the part of steel companies, for, as Joseph J. Reed, the vehicle systems manager of GE's Plastics Group, says, "If the steel companies don't respond, we'll put 'em out of business." Plastic-skinned cars already *off* the drawing board and slated for production include the newly designed 1989 Camaros and Firebird and the 1990 Chevy minivan. Holls told us that the coming '88 Buick Reatta 2-seater will be equipped with plastic fenders.

Making it aerodynamic: An engineer monitors the wind tunnel fan controls and readout. Smoke flowing over the car tests for turbulence.

In Detroit these days, if people aren't talking about computers, they're talking about aerodynamics. Aerodynamics—the ability of an object to move efficiently through the air—is dictating the shape of tomorrow's cars as much as the Schinellas and the Hollses of the world. Aerodynamics is the key to the automotive shapes of tomorrow, and that's the province of engineers, not stylists and executives.

Ford started the current aero revolution with the slick 1983 Thunderbird and is still leading the pack with its '86 Taurus and Sable. GM will follow suit in 1987

TOP LEFT AND BOTTOM PHOTOS FROM BUICK, TOP RIGHT PHOTO FROM TOYOTA

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'The mass-production genius of America put the modern world in the driver's seat of an automobile for the first time.'

Pontiac Fiero panels are bolted to a steel space frame. This makes it cheaper to change styling and replace damaged panels.

with the Ford-like Chevy Corsica and Beretta. Chrysler is moving more cautiously, but when it replaces the 1978-vintage Omni and Horizon with its Shadow and Sundance P-cars next year, they will have a pronounced aero look.

WHY ALL THIS INterest in aero? Ford Design Vice President Don Kopka says, "Just by the way we shape the metal, we've contributed a mile and a half to the corporate average fuel economy (CAFE)." Ford calculates that it would cost $3 billion for a 1½-mpg CAFE reduction via traditional engineering methods: downsizing, improved engine and transmission efficiency, tires with lower rolling resistance and so on. GM's estimates are even higher.

"We figure it cost us about $10 million in testing and trimming (in a wind tunnel) to get that 1½ mpg. We look at it as a $10 million investment with a $3 billion payoff," says Kopka.

The wind tunnel used to measure aerodynamic efficiency is a multimillion-dollar installation that employs a giant fan to blow air through a chamber. A car or model sits atop a delicate scale set into a turntable so the car can be angled to test its behavior in side winds.

The turntable in GM's huge new tunnel in Warren, Michigan, can detect the extra weight of a half dollar placed on one fender. The turntable measures force in three directions: up or down (lift or downforce), side to side (sideforce) and front to back (drag). Drag is the buzzword in the business—a measurement of the ease or difficulty with which a particular shape can pass through the air. It's expressed by a decimal called the drag coefficient, or Cd for short.

A parachute has a Cd of 1.35; a square board (the proverbial barn door) is 1.17. Cones, pointy end upwind, vary from 0.51 to 0.34 as they get slimmer. The slickest figure is the 0.024 of a slim teardrop. This was also the shape of wheel-driven Bonneville Land Speed Record cars before the era of locomotive-like jet and rocket cars.

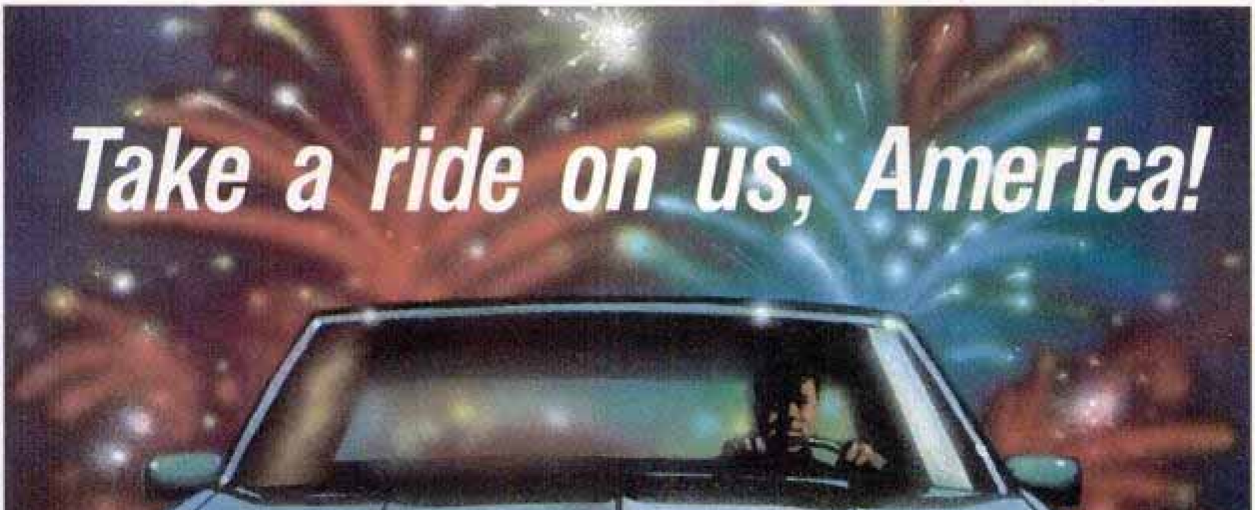
A decade ago, 0.55 to 0.61 was not unusual for passenger cars. Some old shapes also developed so much aerodynamic lift at high speeds that you could feel the steering get lighter as high pressure above the hood lifted the car on its suspension.

On today's cars, noses slant downward to avoid lift, and air dams below the bumpers sharply reduce the amount of air that can get under cars.

"We've only scratched the surface," says Ford's Kopka. Today, most cars range from 0.35 to 0.45 Cd and auto-show cars of varying practicality have values of 0.12 to 0.20.

IN FORD'S CONCEPT 2000X Studio, designers and engineers are working toward the day when they will conceive a shape on the computer terminal, develop it in three dimensions and get computer readouts of drag, downforce, lift and roll, all without putting a model into the wind tunnel. Consultants from Walt Disney World are helping Ford to project full-size holographic images of these computer designs that look like real cars. According to Kopka: "It (the image) would reflect light and be shiny and everything," allowing management to make its go/no-go decisions without the bother of

PHOTO FROM PONTIAC



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'The shape of many of the cars you'll be driving tomorrow, or even today, is influenced by computer.'

clay models. "If you had the guts," Kopka adds, "and everybody trusted the system, the day you saw that holographic projection, you could use the computer's magnetic tape to cut metal-stamping dies somewhere in the world."

Does this mean that all aerodynamic cars will soon look alike? No more than all the cars of the tail-fin era looked alike. They will have certain features in common, but there's still plenty of room for innovation. Subaru gets a Cd of 0.29 with its wedge-shaped XT Coupe and Mercedes matches that with its new 300 sedan. Pontiac gets 0.31 with the Firebird, Ford 0.32 with the "Star Wars" styling of the Merkur XR4Ti and Audi 0.33 with its tubular 5000 sedan.

Touch-sensitive CRT tunes radio, adjusts a/c, monitors trip.

Better aero can lead to a revolution in powertrains. Overcoming drag requires horsepower. Power requirements go up with the cube of the speed. In other words, to double your speed from 20 to 40 mph you need eight times as much power; 64 times for 80 mph. This leads to a measurement called aero horsepower—the power needed to overcome the rolling resistance of the tires plus the friction in mechanical components.

Ford's Probe IV needs only 2½ aero hp to sustain 50 mph on a flat road. "Think about it," says Kopka. "You're talking about a lawn-mower engine here.

"Add another 2 to 3 friction hp and you're talking about a car that can run 50 mph on 5 to 6 hp. That's practically reinventing the automobile," Kopka says. "What kind of engine and transmission do you want? I think you want a very small-displacement, high-revving engine with a constantly variable transmission so you can throttle it down to the point where it's idling at 5 hp and geared up to go 50 mph."

Movable aero aids are also on the way: suspensions that squat at highway speeds, spoilers that deploy further as speed increases, thermostatic radiator slats that close the grille when coolant temperatures are normal and open when the engine gets hot. The only question seems to be, who'll do it first—us, the Europeans or the Japanese?

If "The Graduate" were being filmed today, the suggestion of plastics might be augmented by ceramics. A seemingly unlikely automotive component at first thought, ceramics is the object of much research and experimentation for use in construction of—the revolution begins—car engines. The U.S. Department of Energy has already funded two big projects to develop a ceramic gas-turbine engine, but that still puts us behind research and development teams in Western Europe and Japan.

What so excites the engineers and designers is that ceramics can reach higher temperatures before melting than steel, which means higher combustion temperatures and higher gas mileage. But there are plenty of bugs, such as the material's thus-far inherent brittleness, that have to be worked out, and no one expects to see a practical ceramic engine before a decade has passed.

Five years ago, in *Megatrends* (Warner Books, 1982), I wrote, "The stress on the manufacturing sector is especially intense: Autoworkers, for example, must battle three megatrends at once—foreign competition (the shift from a national to a global economy); automation (the shift from an industrial to an information society); and, finally, the movement from the North to the South."

Wildcat car has gauges on steering hub.

All three are still of key importance, but if one had to be chosen as first among equals, it would have to be the shift to a global economy.

Consider this tale. Almost 40 years ago, in a country other than the United States, a subcontractor to an automaker would call his 25 employees together every morning before work. Standing on a tangerine box, he would exhort them with the message: "We will become global. We've got to become global." The man's name? Soichiro Honda.

In the financial year that ended in February 1984, Honda had gross sales of more than $5 billion, which is not bad for a company that didn't make its first car until 1962.

Soichiro Honda got, and preached, the message early. America is just now getting it. But at least we have finally begun. It is our only hope if the American auto industry is to survive and prosper.

THERE IS GOING TO BE a worldwide renaissance in the car industry in this, the age of information, the age of electronics, but the central question is, who will prevail and who will be left behind?

One industry observer recently wrote, "Perhaps the most important step in revitalizing the industry is the Saturn project. It is designed to make believe that no one has ever made a car before and to start the whole project from scratch—to reopen not just what the car should look like and how it should run but every question of production, supplies, labor relations, the role of management."

Let's look at Saturn. The goal of this brand-new plant is, as one writer put it, "to leapfrog the Japanese in small-car

PHOTOS FROM BUICK

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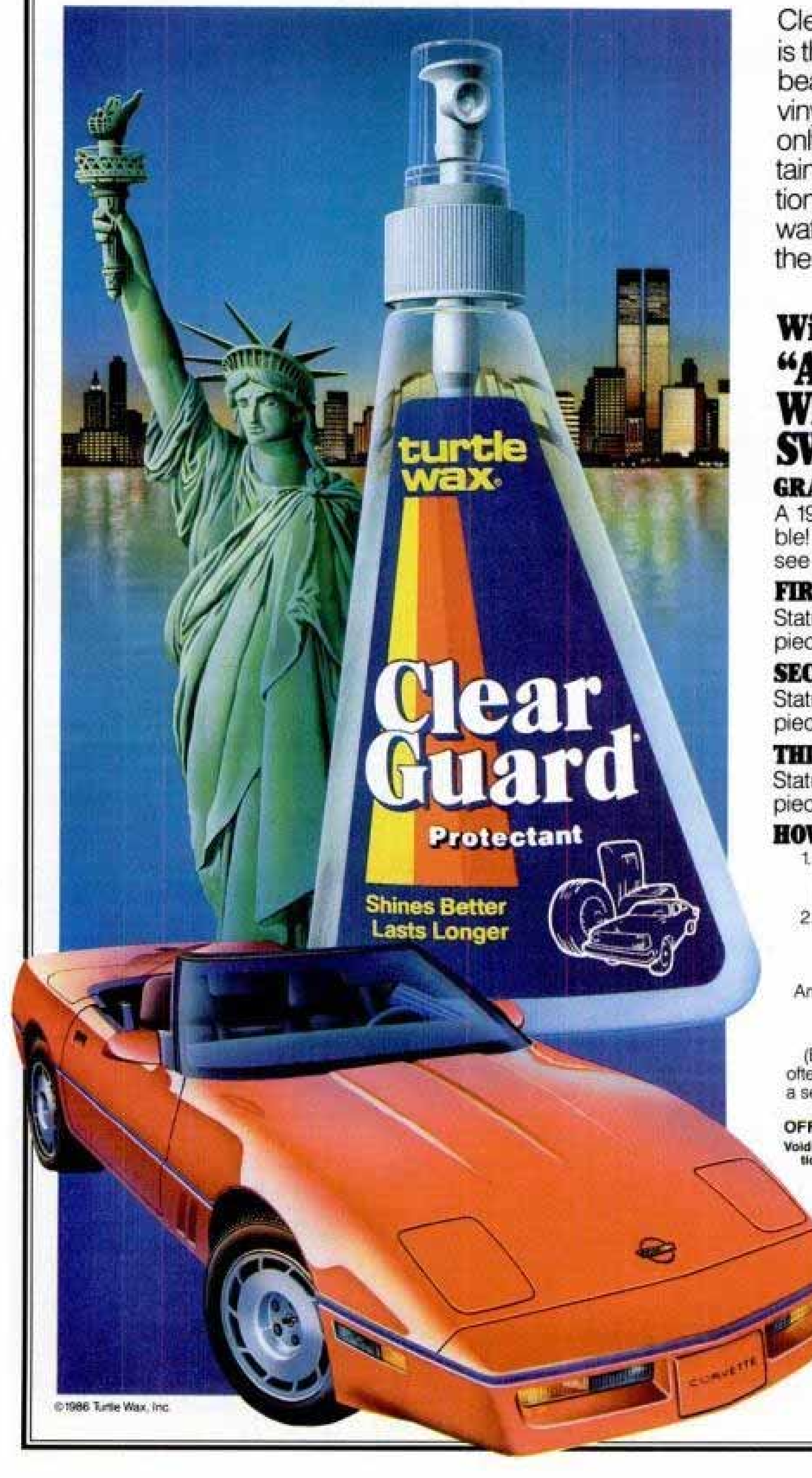

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Artist's concepts of inexpensive small cars of 1990: Chrysler Liberty (above), Ford Alpha (above right) and GM Saturn.

production." About 10 percent of GM's entire research and development budget is earmarked for the Saturn project, which features innovative arrangements not just between employees and managment, but also between management and the United Auto Workers, with the idea of this $5 billion project being to reduce production costs. There is one flaw in the Saturn concept, though, and that is that the product will be limited and it is volume that is needed.

The obvious problem is that there are already so many other skilled small-car manufacturers in the market with a head start. It is essential for GM, and Ford and Chrysler, too, to understand that the world of auto manufacturing has changed. Just look at it. As I've been pointing out for some time, the production of autos is no longer a country industry but a truly global one. Ninety percent of the total world output of car manufacturing comes from the 22 corporations based in Japan, the United States and Western Europe. In 1980, 20 percent of that production took place overseas. Even a casual glance at the automaking activity in South Korea and China should convince anyone that before long we'll be seeing the true "world car," one designed in Detroit—or Paris or Tokyo—"sourced" in two or three different countries and assembled in South America or Australia.

Japan may account for 30 percent of the world's auto production—as against the United States' share of 22 percent—but other Asian countries are moving into the market with little or no fear for the simple reason that the market is now global. The U.S. and European markets, while still healthy, may weaken someday, but there are 15 people for every car in Brazil, 28 in Taiwan and at least 10,000 in China, compared with two or three per car in America or Europe. That's an awful lot of room for world market growth.

TO BE COMPETITIVE IN this global marketplace, U.S. car companies, with their high-priced labor, must concentrate on using computers, rather than traditional labor, to manufacture cars. This is especially true in the making of small cars.

And that's another worry about Saturn. As conceptualized, it is still too labor-intensive to be competitive. I suggest that, given all the considerations discussed, events may overtake the Saturn project, and it may never be completed as now planned.

As Dr. David Cole, director of the University of Michigan's Office for the Study of Automotive Transportation, observes: "It's important to realize that the products themselves are not that revolutionary. The new processes will be far more important."

In 1984, GM produced only 11½ cars per employee. Ford built 16, Chrysler 18½ and Toyota an astounding 66.7 cars per employee! So Detroit has a lot of catching up to do.

The automakers hope to bring the manufacturing engineers into the development process early to ensure that manufacturing efficiency is considered in designing vehicles. Designers and engineers will work closely with suppliers—traditional part-makers like Rockwell and Eaton; newer high-tech firms like Motorola, IBM and Hewlett-Packard; and materials experts like Du Pont and 3M.

Just how successful these efforts are in integrating new systems and technology and reducing costs will determine to what extent GM's Saturn and the two other domestic small-car projects—Ford's Alpha and Chrysler's Liberty—will be true import-fighters.

Meanwhile, protectionism, with its misleadingly prosperous facade, must be seen as a mere stopgap measure. Fortunately, the American companies have been entering into international partnerships for some time now and this bodes well. No one seems too concerned with national boundaries anymore, which is the only way it can be in a global market. As *The Economist* editorialized last year, "The Detroit multinationals are already in Europe in a big way—indeed, they are the only pan-European car countries. The Japanese want to follow them. Britain, in tacit acknowledgement of the demise of its own motor industry, is the most willing accomplice. Nissan was successfully lured to northeast England by govern-

PM ILLUSTRATIONS BY MARK STEHRENBERGER

Few cars today can offer you the size, the luxury and the confidence of Parisienne.

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WE BUILD EXCITEMENT

LET'S GET IT TOGETHER BUCKLE UP.

GM

'In Detroit these days, if people aren't talking about computers, they're talking about aerodynamics.'

ment handouts and union groveling. Honda is ready to strengthen its links with Austin Rover."

As for marketing niches, Detroit is feverishly working on a pride of high-priced, high performance 2-seat sports cars for the '80s, and virtually all of them are being aided by some form of European input.

GM's prestige division goes for broke with its Allante 2-seat personal luxury car, a front-driver slated for late 1986 as an '87 model. Its exterior is loosely based upon GM-20 (Buick Somerset Regal, Olds Calais, Pontiac Grand Am) sheetmetal, but is done better and has a convertible top. The coachwork will be assembled by Pininfarina in Italy and air-freighted to a new Detroit plant for final assembly, the ultimate in just-in-time delivery strategies.

With no need for rear seats, Allante will probably cleave close to the GM-20 wheelbase of about 103 inches. Power will likely come from Cadillac's exclusive 4.1-liter aluminum V8, mounted transversely and coupled to a 4-speed self-shifter.

Alternative horsepower choices include engines from other GM divisions, perhaps Buick's potent 3.8-liter and 3.0-liter Sixes. The roadster will sell in the $45,000 to $50,000 ballpark.

LEE IACOCCA, IN HIS heart, loves performance cars. At Ford, he brought out the Mustang and brought over the de Tomaso Pantera. But Iacocca, the chairman of Chrysler, also loves profits, and his association with Alejandro de Tomaso and Maserati is still a key to them.

Although Pantera has been suggested at least as a code-name for the innovative Chrysler 2-seater, de Tomaso is still selling the old Pantera with its Ford V8 in Italy, and that might lead to confusion. Production of the car in Italy is being considered, with parts and engines supplied by Highland Park. The car will carry a "Built by Maserati" label under its name badge. Chrysler will pull out all the stops on this car, powering it up to drive as many as four wheels with a turbocharged and intercooled 16-valve Four, mounted amidships, displacing either 2.2 or 2.5 liters. Horsepower could be as mild as 175, or as wild as 210.

This model is seen as selling for as much as $30,000 per copy in 1986 dollars, though one theory is that it will be price-competitive with the Corvette. Only 7000 to 10,000 are to be built each year.

Ever since the Audi Quattro debuted, Detroit has been in search of its own streetable 4wd production car. At Ford, the Ghia could be it.

The Ghia design house in Italy is owned by Ford, so access to its creative talents is assured. We don't think Ghia will be the production car's name—Cobra ME has been suggested—but we think this car is pretty darn close to what may be seen here as early as 1987.

An intercooled turbo will breathe life into an overhead-cam inline Four of 2.3 liters at a rate of about 200 hp. It will approximate the present-day size of the Mustang coupe in length and width, and be a front-driver if the 4wd mechanicals can't be sorted out.

The Buick Reatta won't literally be engineered or styled in Europe, but it will be influenced heavily by the European design ethic, according to Buick designer Bill Porter. It's code-named GM-33 because it's to be spun off the new GM-30 Riviera platform. The Reatta's performance will fall between Pontiac's Fiero and Chevy's Corvette. The Reatta is a front-drive 2-passenger sports car astride a 99.5-inch wheelbase with GM-30/Riviera front/rear suspension components. It will jump to the tune of Buick's 3.8-liter, multiport fuel-injected V6 with 180 hp. A German-built Getrag 5-speed manual transfers the power to the ground. Later versions, probably turbocharged 2.8-liter or 3.0-liter V6s and a possible 16-valve 2.3-liter Four now being designed by Olds, will offer a 4-speed automatic/overdrive from the Electra C-body car. It will debut in April 1987, which means the press will see it in late '86. Despite the different customer profiles for these 2-seaters, they represent a whole new market for American carmakers, and one that should do very well, the state of the 1986 to '88 economy willing.

Ford Probe V has a lower drag coefficient (0.137) than an F-15.

ANOTHER POTENTIAL niche that the Americans might find success in filling is that of the large luxury sedan. For one thing, we know how to make them and make them quickly, whereas a buyer of a new Mercedes 300—the midrange model at $35,870—can expect a wait of 25 months.

The important point to remember is that the future *is* exciting. How can it not be when we are on the threshold of producing cars that can move *sideways*, cars with windshields that know when to wipe, cars that will be guided by satellites, cars that are computerized and cars that can do the braking—safely—when a child runs into the road.

It's time to begin a whole new drive to make cars. The second building of America, a renaissance in the electronic age, *must* include our automobile industry, the industry that built America.

Yesterday's car designers sat in dim classrooms, doodling futuristic autos in their notebooks as the professors droned on. Tomorrow's designers may be doodling, too—and dreaming of a keyboard to call their own. **PM**

PHOTO FROM FORD

Motorcraft races with success on Sunday to give you dependable performance every day.

Motorcraft quality parts are tested on some of the world's toughest racetracks on Sunday, so you're not tested during the rest of the week.

High-performance racing cars that generate about 600 horsepower demand tough, quality parts. So does your car. And Motorcraft spark plugs, filters, batteries and motor oil help deliver top performance on the racetrack on Sundays and on the highway every day of the week.

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EXCEEDS THE NEED

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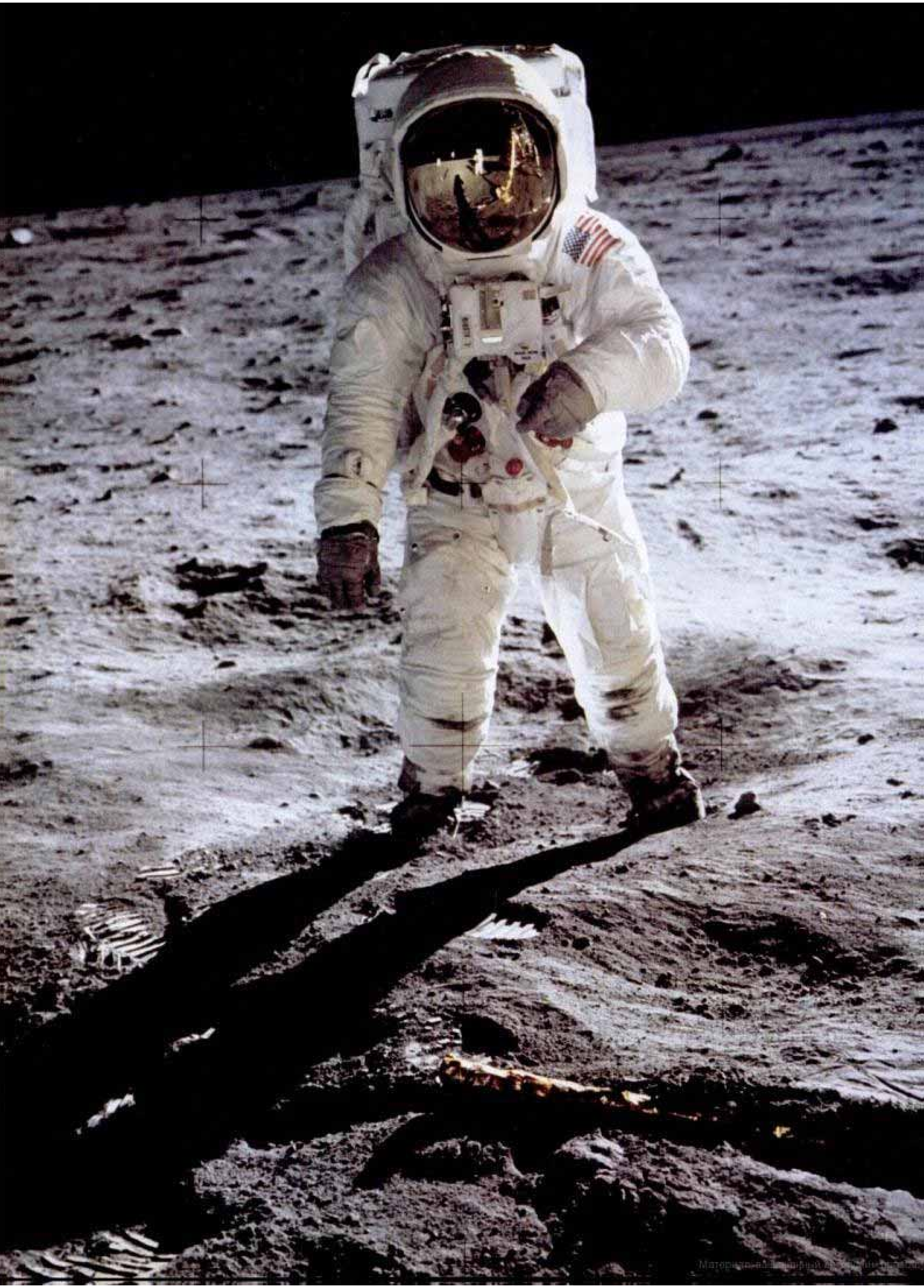


Our next step is to settle the frontier of space.

Wings For America

BY ISAAC ASIMOV

Cliff Hess wiped his brow. His heart pounded against his chest as the moment to activate the space chair's thruster drew near. An investment of thousands of hours of tests and a literal lifetime of devotion to the American space program were about to give birth to something right out of a comic book. But this was real and serious.

At the Johnson Spaceflight Center in Houston, Hess watched a live television transmission from the Space Shuttle *Discovery*. Astronaut Bruce McCandliss, in his spacesuit, was strapped into the big white chair with its rocket thrusters gleaming along a back panel.

There was a moment of silence. Then a countdown. McCandliss pulled back on a joy stick. A tiny flame appeared on the back of the chair and off McCandliss went, out of the cargo bay and into space a few yards away from the Shuttle. The room rang with the cheers from Hess's and McCandliss's teammates. The rocket chair—NASA calls it the Manned Maneuvering Unit—was fully operational and man had taken yet another small step, albeit in the sitting position, into space.

"It may have been one small step for Neil (Armstrong), but it's a heck of a leap for me," McCandliss shouted into his microphone.

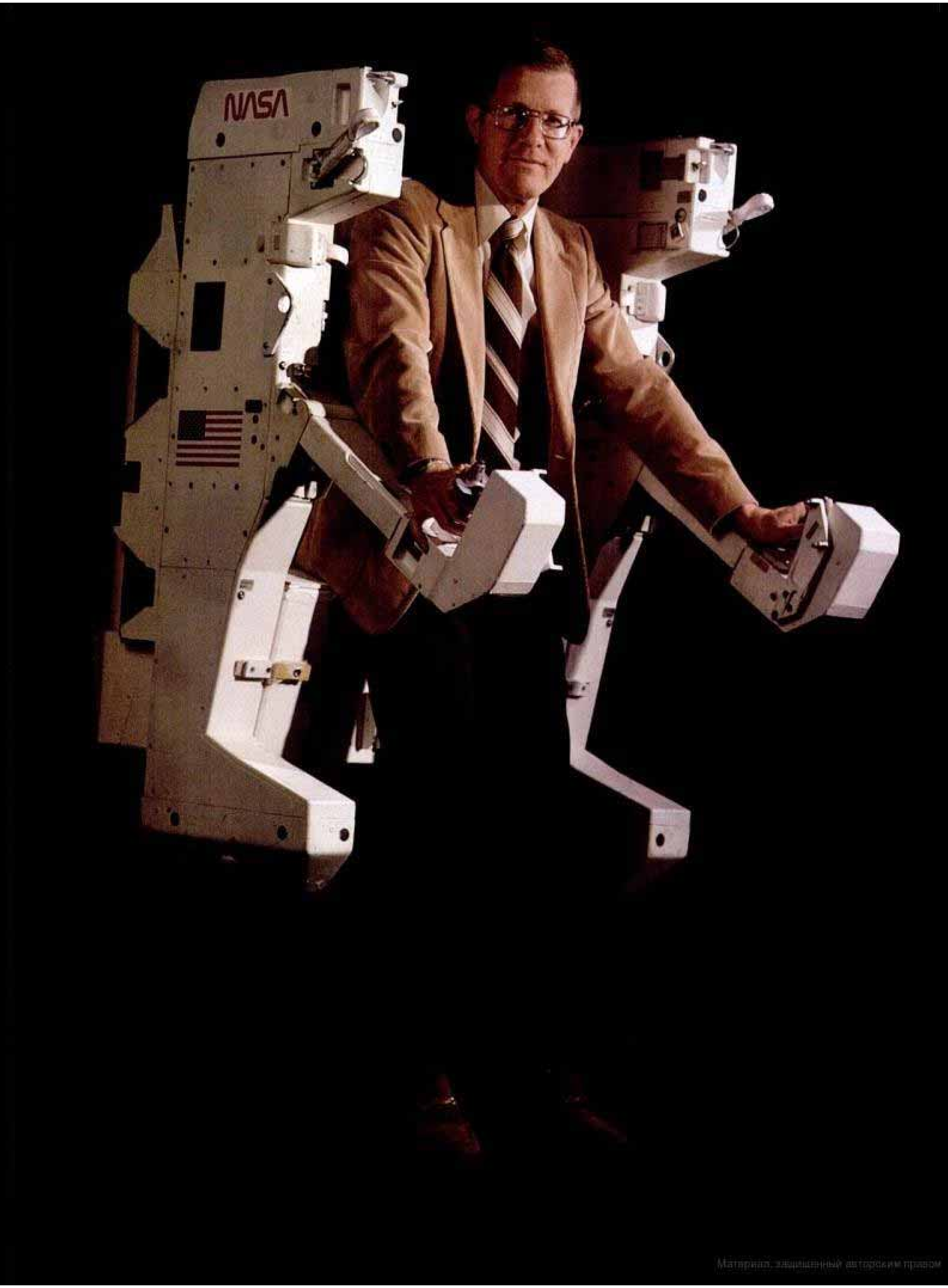
Cliff Hess beamed. "It's rewarding to know your work is appreciated," he laughed.

Hess began his work at NASA while still a freshman at Drexel University in Philadelphia. He was in a co-op program that let him go to school for six months a year and work at NASA for the other six.

"I always wanted to be an engineer," Hess says. "But I never dreamed I would be on the leading edge of space exploration and design." His latest work, assisting in the design of the MMU, launched him into relative celebrity while the nation stood enthralled with the new Buck Rogers chair.

"There's more," Hess said. He told us about an advanced MMU under discussion. It would be boarded and driven around like a deep-sea diving scooter. Hess expressed no

BUZZ ALDRIN ON THE MOON/PHOTO FROM NASA


NASA

doubt that it could be done. "All you need," he said, "are the right tools."

Every job needs the right tools. New jobs often require new tools. And space exploration, the biggest new job ever, has been no exception. The unprecedented problems presented by weightlessness, high acceleration, extremes of temperature and sheer distance have been solved by an unprecedented array of new tools, both large and small. Virtually every aspect of the space program, from walking on the moon to simply having a drink of coffee aboard a spacecraft, has required a detailed rethinking of what was required, and often an entirely new means of accomplishing the task. As the tools for spaceflight emerged from laboratories and engineering workbenches, America quickly found its atmospheric flying—by airlines and private pilots—taking off in new directions, too.

The airline industry had relied on propeller powerhouses and metallic fuselages until the dawn of the Space Age. With the advent of jet engines, and later the arrival of aviation materials developed mostly for the space program, cruising speeds went from the 250-mph range to well over 600 mph. Seating capacities grew to the hundreds. And flight ceilings rose to 35,000 feet and beyond, making possible long-distance, high-speed flying not thought possible just a generation earlier.

In the 1960s, Pan Am revolutionized intercontinental flight with the introduction of the Boeing 707. The first flight was nonstop from New York to Paris in an unbelievable seven hours. Rapid advances in airliner technology followed with the McDonnell Douglas DC-9 and the eventual introduction of the Lockheed wide-body and McDonnell Douglas and Boeing jumbo jets.

Today, the airliners are studying plans for jets that fly at high altitudes and high speeds with improved fuel mileage. And NASA and the military have jumped back into the once-dead supersonic transport market. In fact, with the endorsement of President Reagan, work has begun on an airliner that can go to Mach 8, and conceptual studies are under way for a Mach 20 aircraft that could become an airliner by the turn of the century. Reagan has called it the new Orient Express—New York to Tokyo in just two hours.

OVER THE YEARS since the Space Age began in 1957, the amount and variety of specialized equipment for use in space itself have grown at a dizzying rate. Spacesuits, thermal tiles for re-entry protection, radio communications systems that can span the immense distances involved in space travel, robot landing modules (complete with robot arms) to explore the surface of alien planets, zero-gravity toilets, rocket-powered chairs for individual mobility in space, communications satellites, "smart" computers, solar batteries—the list goes on and on. In many cases, too, the new device needed to solve a problem has required new tools for *its* development.

It's easy to forget how much of this new technology has filtered down to Earth to become an integral part of our lives. "Space Age" has become such an advertising cliche that often one tends to forget the truth behind the claims. But pocket calculators, long-life lithium batteries, laser disks, many synthetic fabrics, cable TV and a host of other consumer products are spinoffs of space-inspired technology.

In a sense, though, all these things are the minor—if essential—details required for space travel. A broader view of where we're going in space focuses upon a different toolbox.

The first, and so far the only, basic tool for human spaceflight is the rocket. Other conceivable methods for attaining such spaceflight are either theoretically impossible (for example, anti-gravity); theoretically possible, but totally impractical (for example, being shot out of a cannon); or simply beyond the present state of the art (for example, making use of the solar wind as a propulsive force).

UP UNTIL 1957, THE U.S. space program was hardly an impressive organization. It consisted largely of some underfunded military rocket specialists and a few dedicated enthusiasts like Willi Ley and Wernher von Braun, who toured the country trying to drum up some popular interest in what most people thought was a crazy idea from a Buck Rogers comic strip.

A 184-pound metal sphere named Sputnik—meaning "fellow traveler"—changed all that. Launched by the Russians on Oct. 4, 1957, the first man-made satellite orbited Earth at a height of almost 600 miles, its radio transmitter sending out subdued beeps. The race for space was on.

One month after Russian cosmonaut Yuri Gagarin's historic flight, American astronaut Alan Shepherd went up—and down—safely for a 115-mile-high suborbital flight. And in February 1962, John Glenn hurtled into space for a 5-hour flight that completed three full orbits around Earth. The space race was beginning to look like a dead heat.

Then the U.S. began to pull ahead. President John Kennedy announced that America would put a man on the moon by 1970, and the Gemini series of space shots started in 1964 made some impressive progress toward that goal. Gemini 3 demonstrated the ability to change course in midflight. Gemini 4 was made memorable by Ed White's 20-minute walk in space. Gemini 6 and 7 completed a successful space rendezvous, maneuvering to within half an *inch* of each other. And Gemini 8 actually docked in space, attaching itself to an orbiting unmanned satellite.

Project Apollo followed Gemini. However, it got off to a tragic start. On Jan. 27, 1967, there was an explosion in Apollo's capsule during a prelaunch test: Killed were astronauts Roger Chaffee, Virgil "Gus" Grissom and Ed White. Despite those who called for an end to the space program, Project Apollo was resumed in October 1968.

Powered by the mighty Saturn rocket (363 feet long, with 7.5 million pounds of thrust from its first stage, 1 million pounds from its second and 200,000 pounds from its third), Apollo 8 took off for the moon on Dec. 21, 1968. This was a trip 300 times farther than the greatest height reached by any Gemini shot. Apollo 8 completed 10 lunar orbits, and then returned safely.

On July 20, 1969, the work of the previous 11 years reached its climax when Apollo 11's lunar module touched down on the moon, and Neil Armstrong made his "giant leap for mankind."

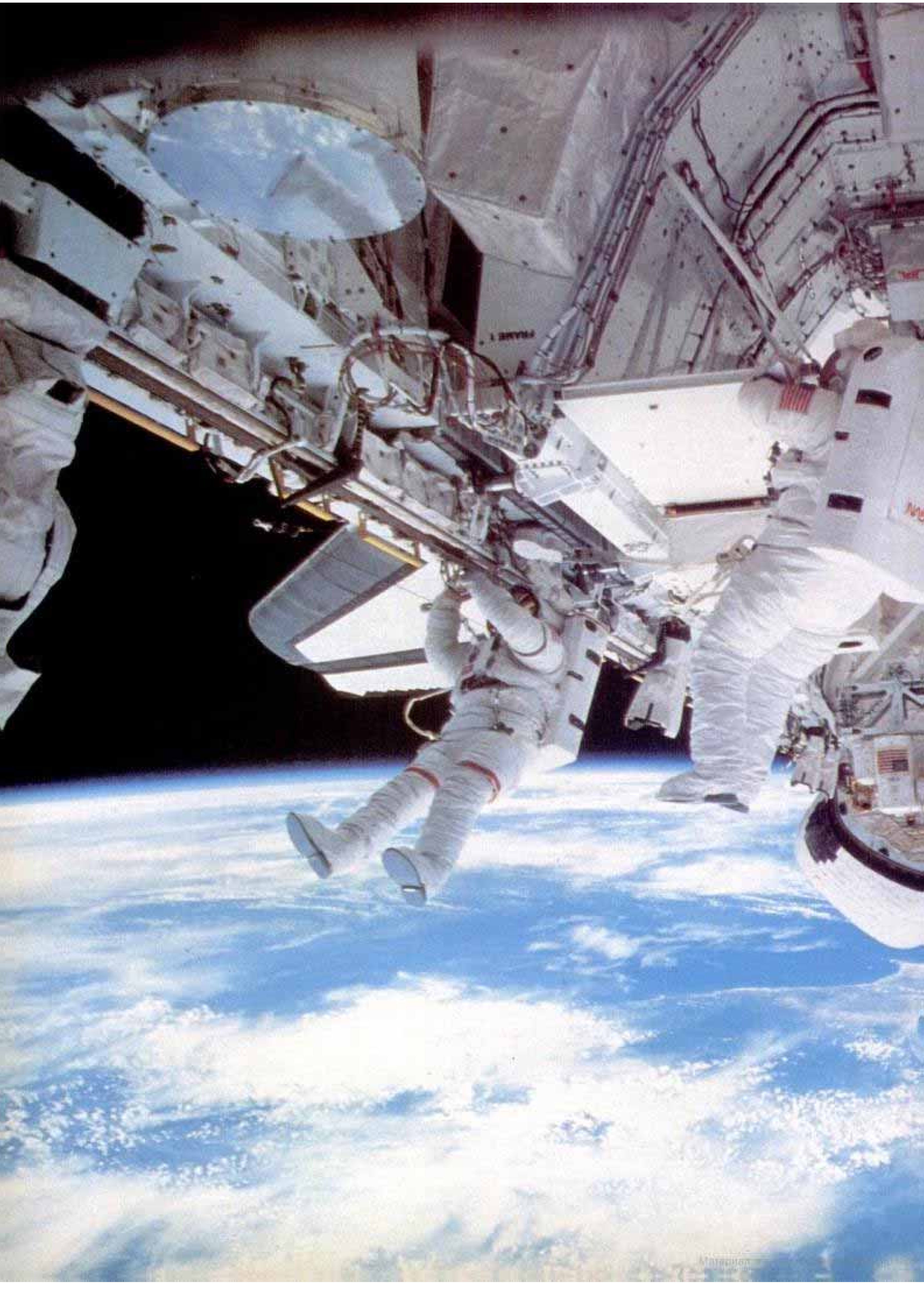
WITH THE SUCCESS of the man-on-the-moon program, NASA shifted its emphasis to some of the yet-unanswered questions about man and space. Can humans live and work in space? What risks does space travel present? What lessons can space teach us? The Skylab space shots of 1973 and 1974 sought the answers to these questions. In May 1973, an unmanned laboratory containing living and working accommodations for a 3-man crew was placed in orbit. Eleven days later, Charles Conrad, Joseph Kerwin and Paul Weitz boarded the laboratory for nearly a month of experiments, after repairing the damage that the laboratory had suffered during its launch. Other crews replaced them, one staying in orbit for 84 days, demonstrating conclusively that man could survive and work for extended periods in space.

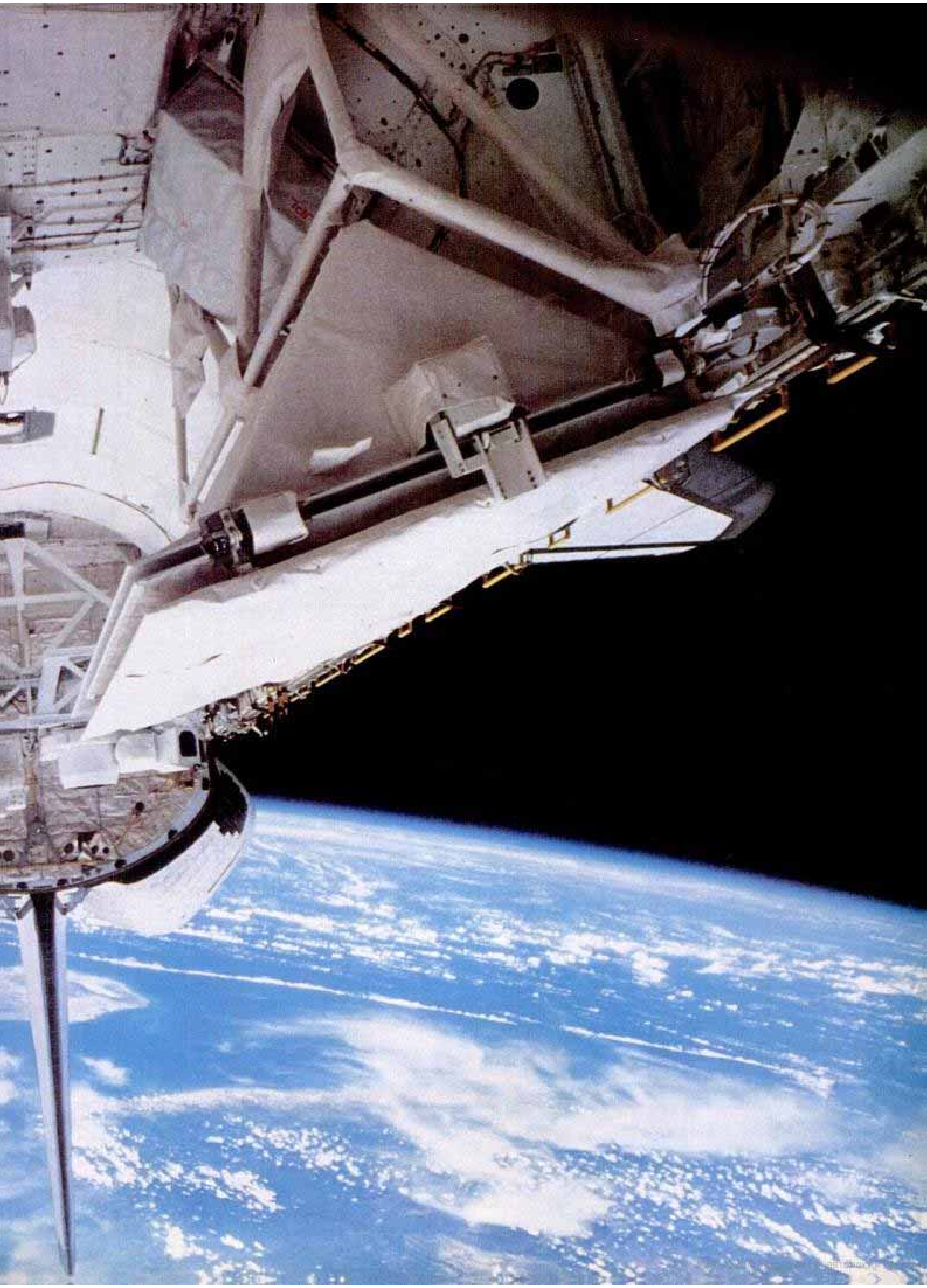
In the summer of 1975, a pair of Viking orbiters, each with a lander, went to Mars. The landers, self-contained robot laboratories, photographed the Martian landscapes, analyzed soil samples and monitored weather conditions and marsquakes—the red planet's own version of earthquakes. The Vikings provided scientists on Earth with the most complete picture to date of an alien planet.

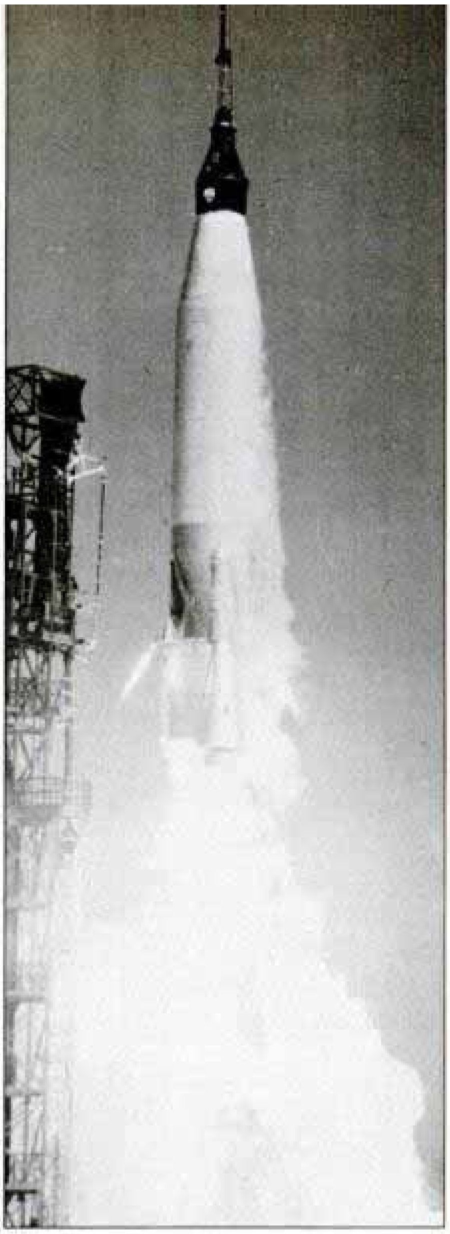
In 1977, two Voyager missions set out to explore Jupiter and Saturn. Photographs from these two missions have provided new insights into the nature of our solar system. Voyager 2 flew by Uranus last winter and is still sending information as it heads for Neptune, approximately 3 billion miles from Earth.

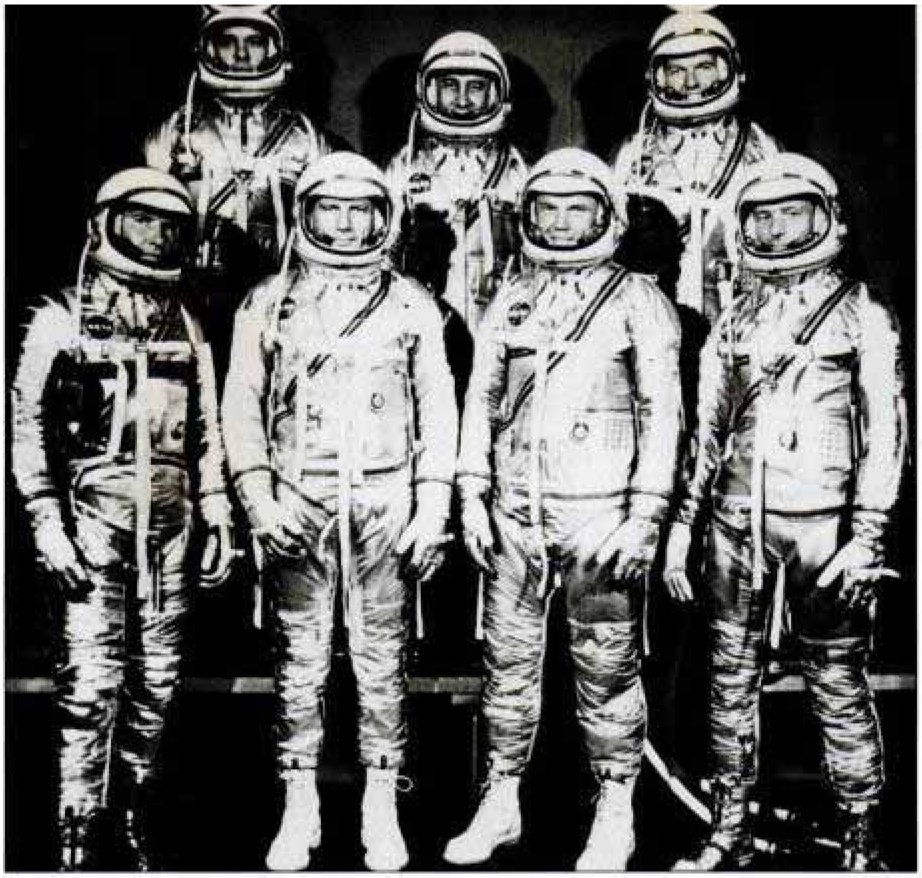
Since 1981, when the *Columbia* com-

FACING PAGE: CLIFF HESS IN A MANNED MANEUVERING UNIT/PHOTO BY BRIAN R. WOLFF
OVERLEAF: PHOTO FROM NASA/HASSELBLAD









The Atlas booster rocket (left) first carried the Mercury 7 astronauts (above) into space. Since the success of the 1969 Apollo 11 mission (right), the goal of the space program has been to keep man in space indefinitely.

The New York Times

MEN WALK ON MOON

ASTRONAUTS LAND ON PLAIN; COLLECT ROCKS, PLANT FLAG

pleted its maiden flight, NASA's most visible activity has been the development of the Space Shuttle. The development of a reusable spacecraft is a giant step toward changing space travel from the possible to the practical. It is now feasible to travel back and forth between orbiting satellites and Earth.

NASA's almost unbroken string of successes over the past quarter-century lulled many into a false complacency.

The tragic explosion of the Shuttle *Challenger* earlier this year is a grim reminder that the leap to space is a complex and difficult one. But the steady progess of man toward the stars promises to continue for many years to come.

IF PRESIDENT REAGAN AND the aerospace industry get their way, space itself will become a tool in the development of an airliner that can carry passengers from New York to Tokyo in two hours. The Trans-Atmospheric Vehicle, now in the early concept stages, will borrow technologies from the jet age and the Space Age to take a 400-passenger airliner over the atmosphere, where it can reach speeds approaching 20 times that of sound. The jet age contribution is the ram jet, a turbofan engine powered by forced air. NASA has taken the technology a step further to produce early concepts of the scramjet, which combines high-speed hydrogen-powered fan blades with forced air to generate tremendous power.

The Space Age contribution will be in the combination of ceramic tiles and strong aerospace plastics to form aircraft bodies that can take the friction of reentry without weighing too much. Those aerospace plastics have already made possible great leaps in aircraft that fly closer to Earth.

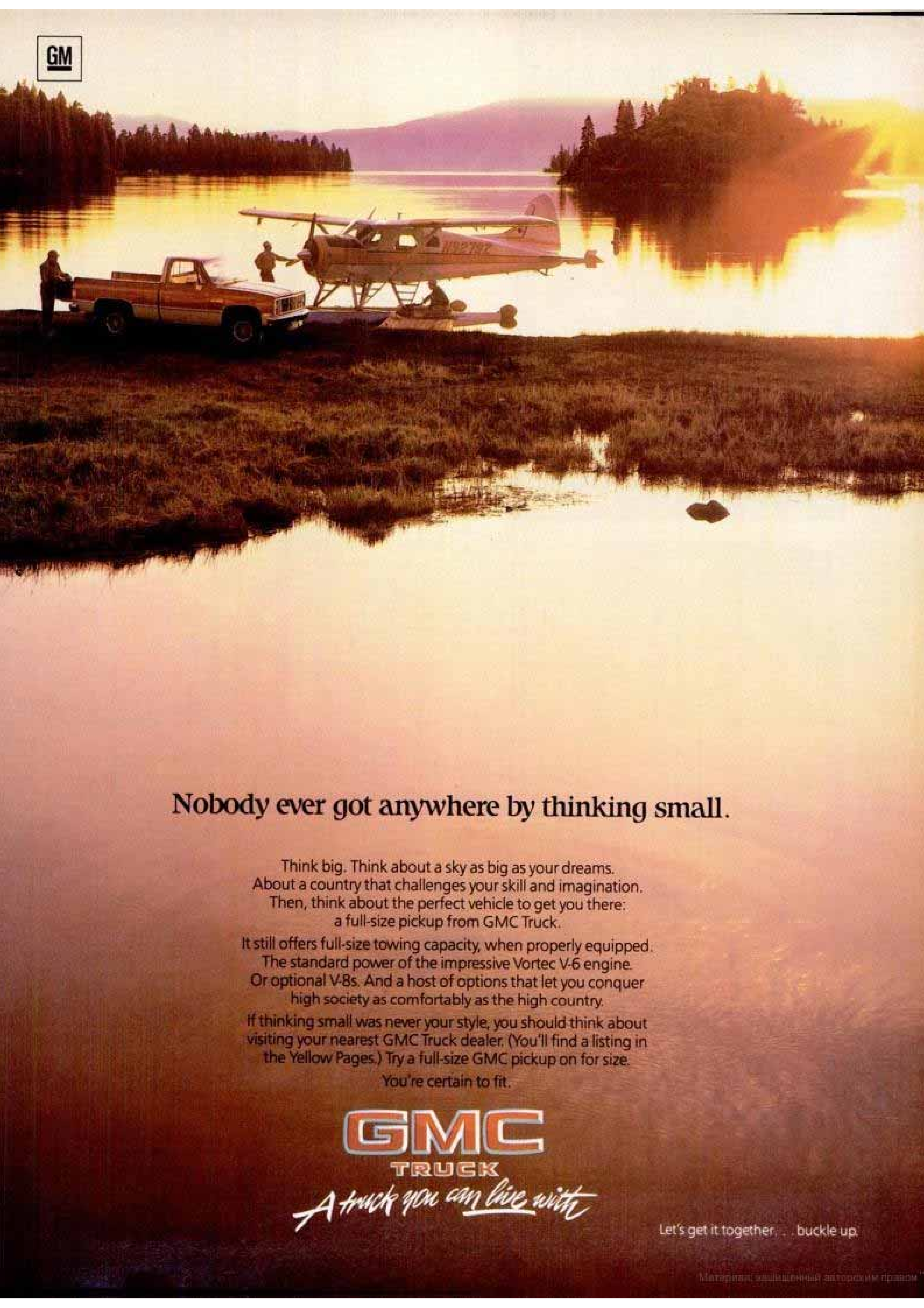
Thanks to materials like Kevlar, Nomex, graphite and epoxy resin, airframes have grown feather light. Just one look at any of Burt Rutan's patented sport planes with the canard noses will reveal the enormous advances made even in the small-aircraft market. The Rutan planes can add square feet to their lifting surfaces without adding weight. Fewer than 20 years ago, adding lifting surface meant adding weight to the heavily laden metallic airframes. The advantage of greater lifting was then lost.

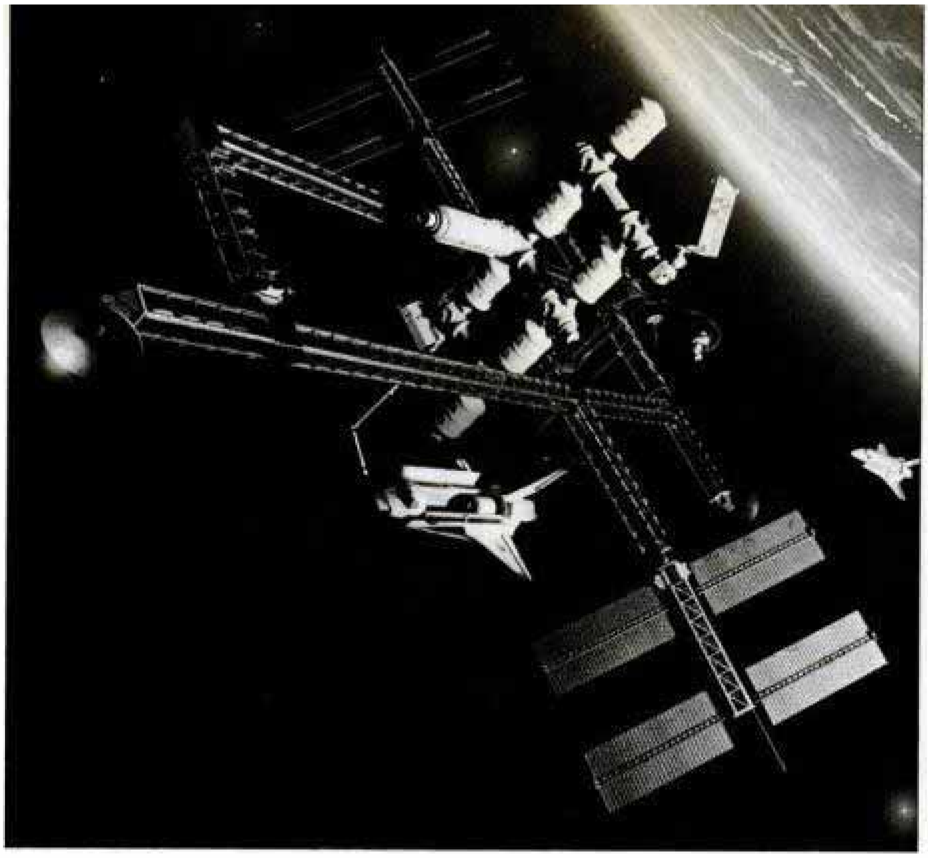
Advanced aviation materials have led to the development in the last decade of downsized airliners. These 2-engine, twin-aisle airplanes carry up to 200 passengers—more in the updated stretch versions. The Boeing 737, 757 and 767 and McDonnell Douglas twin-aisle passenger jets have become dominant.

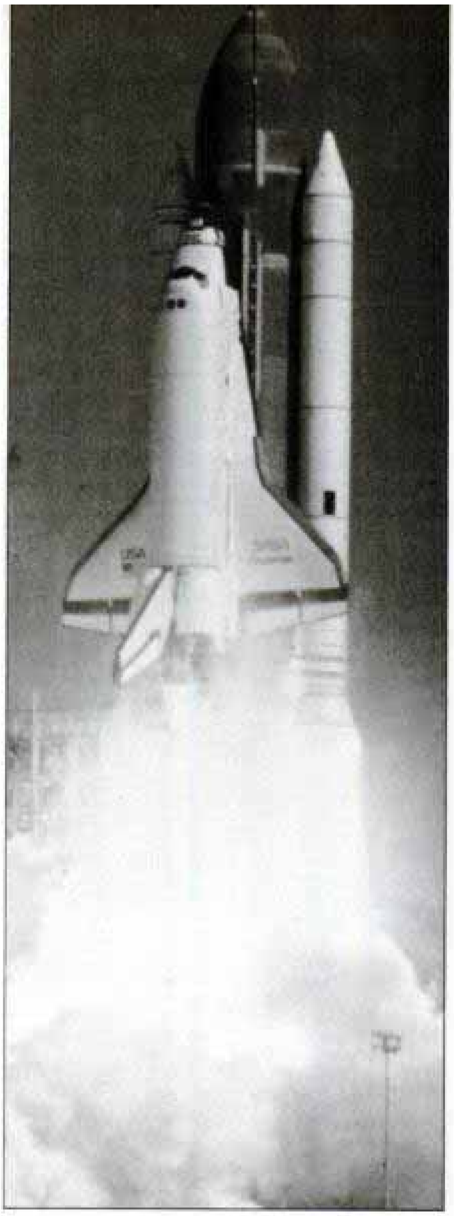
Having convinced the airlines and the flying public that lighter is better, both Boeing and McDonnell Douglas are moving ahead with larger versions. Boeing has on the drawing board a model dubbed the 7J7 and McDonnell Douglas is working on the MD-11x. Both will approach jumbo size, but with the advent of new General Electric and Pratt & Whitney engines, they will remain as fuel-efficient as their downsized ancestors. The new engines take advantage of advanced aviation plastics to form discs and seals that can withstand extreme temperature differences experienced at varying altitudes and super speeds.

All the technology is geared toward something man has become quite at home with in nearly a century of flying—short-duration trips above the clouds. Earth may seem like a big place to us, but it

LEFT AND TOP RIGHT PHOTOS FROM NASA


GM
Nobody ever got anywhere by thinking small.
Think big. Think about a sky as big as your dreams. About a country that challenges your skill and imagination. Then, think about the perfect vehicle to get you there: a full-size pickup from GMC Truck.
It still offers full-size towing capacity, when properly equipped. The standard power of the impressive Vortec V-6 engine. Or optional V-8s. And a host of options that let you conquer high society as comfortably as the high country.
If thinking small was never your style, you should think about visiting your nearest GMC Truck dealer. (You'll find a listing in the Yellow Pages.) Try a full-size GMC pickup on for size.
You're certain to fit.
GMC
TRUCK
A truck you can live with
Let's get it together . . . buckle up.





Despite tragedies, the "right stuff" of astronauts like Neil Armstrong (left) has kept the space program on track. Reusable Space Shuttle (right) is the key to establishing a permanent presence in space. Space stations (above) will house labs, observatories and factories for manufacturing in weightless and hard-vacuum conditions.

grows absurdly smaller as we look out toward the expanses of space.

For the most part, U.S. spaceflights have been short ones, measured in days. What is needed next is something that will allow human beings to make a more or less permanent home in space.

The solution is a true space station, something that is more elaborate than anything the United States or the Soviet Union has put up. It must be in high enough orbit to remain in space for an indefinite period. And it must be continuously occupied.

Naturally, the occupants of a space station will not remain there indefinitely, at least during the early years of such structures. Prolonged exposure to zero gravity induces some distressing side effects. Bones and muscles weaken, so that cosmonauts who have stayed in space for half a year or more have had some trouble re-acclimating themselves to normal Earth conditions. A 3-month stay, however, can be handled fairly well, particularly if the astronauts exercise regularly.

Plans are therefore under way now to have a space station in orbit at a height of not less than 300 miles above Earth's surface. The living and working quarters may consist of four or five large cylinders held together firmly. Such a space station should house eight astronauts under shirt-sleeve conditions, each of them serving a 3-month shift and each being replaced when the shift is over, so that the space station is continuously occupied.

The value of such a space station is manifold. For one thing, long-range experiments can be carried out. Materials can be processed. Welding and purification procedures can be tested on a large scale and in detail.

Then, too, Earth can be kept under continuous observation. For that purpose, the orbit of the space station would be tilted markedly to the equator (28.5° is the degree of tilt often mentioned) so that the tropic zone and both temperate zones can be viewed with ease.

The space station will be large enough to store satellites for future launches and to have facilities for the servicing and maintenance of satellites already in orbit. The space requirements for all this will expand with time, of course, but the space station will be so designed that it can be expanded by hooking on additional units.

The space station can also serve as a base for the building of still larger structures that would be too large and massive to launch into orbit if they were constructed on Earth. Instead, the smaller components will be brought to some point in space that can be reached by astronauts from the space station, and there they will be put together.

NATURALLY, SPACE stations will be expensive to maintain. Workers and supplies will have to be brought in and wastes will have to be removed.

One obvious way of making the space station cost efficient is to have it collect the energy it needs from space.

This is not difficult, in principle. The station is bathed in sunshine during half its orbit about Earth—sunshine that is constant and is not absorbed, to a greater or lesser degree, by an atmosphere. The space station being planned now, therefore, will be equipped to exploit solar energy. The current space-station design includes banks of photoelectric cells that will convert sunlight into an electric cur-

PM ILLUSTRATION BY BRIAN SULLIVAN; LEFT PHOTO FROM NASA; RIGHT FROM SOUTHERN STOCK PHOTO

Boeing 7J7 will use advanced plastics in engines and be more fuel-efficient.

Rutan-type canard-wing plane.

rent. Such photoelectric cells are routinely used for some energy-gathering purposes on Earth right now, and even in space, though always in small-scale installations. The solar array used in connection with the space station would be a more ambitious and larger installation than anything we now have.

Not only would the solar arrays meet the station's requirements, but they would charge storage batteries. During the portion of the orbit that passes through Earth's shadow, the stored electricity can be used.

ANOTHER WAY TO make a space station more self-sufficient, and to cut down the transportation requirements from Earth's surface, involves the matter of food.

When food is eaten, its components are combined with oxygen to form waste material, including carbon dioxide. In the process, energy is produced that serves to maintain the life of the eater. Plant life can be grown, making use of the carbon dioxide and the waste to form food and oxygen anew, provided sufficient energy, in the form of light, is supplied.

A greenhouse, then, will be built in conjunction with the space station. It will be lit by electricity drawn from the space station's solar array, and in it a variety of fruits and vegetables will be grown. Such a greenhouse might well supply 50 percent or more of the food eaten by the personnel at the station.

There is no reason (we can hope) that the facilities and capabilities of the space station cannot be open to all nations even if it is built (as would appear most likely, at the moment) by the United States alone.

The work that the station does in repairing, maintaining and relaunching satellites may serve as a preparation for the construction and launching of new types of satellites designed to serve new purposes. Thus, it is certain that scavenger satellites will have to be developed. These would remove the kind of space debris that has been steadily accumulating in orbit about Earth in the 30 years of the Space Age. Even small bits of matter, when moving at orbital speeds, can do measurable damage on collision.

Then, too, all the work performed by the astronauts on the space station will teach us how best to make use of the special properties of space—zero gravity, hard vacuum, energetic radiation from the sun, and so on—for industrial purposes.

Special structures—factories, not to mince words—can be built to take advantage of these properties to produce, in quantity, such objects as electronic components and microchips. In such structures, purification and welding procedures can be carried out, too, as well as an unlimited quantity of other industrial steps limited only by human ingenuity in designing the necessary devices for the purpose.

What's more, the use of automated procedures and robots would make unnecessary the continued presence of human beings in these space factories. They might show up only occasionally for some necessary piece of repair or maintenance.

This might be the beginning of the transfer of much of the industries of Earth into orbit. It would relieve Earth of some of the disadvantages of industrialization, since some factories would be removed from Earth's surface, without depriving us of the advantages, since those same factories might not, after all, be more than a thousand miles away.

NATURALLY, PEOPLE would want to be able to move to and from the various structures built in space. For this purpose, special vehicles such as the Orbital Transfer Vehicle, or OTV, are being planned.

The OTV will be reusable and space-based. Once built in space, it would be beyond the atmosphere and would already be moving in orbit with a speed approaching five miles per second. It would have to add only a small amount of speed to move into a higher orbit, even a considerably higher orbit. For this reason it would require much less fuel than vessels that must start from Earth's surface. It, therefore, would be able to carry proportionately larger payloads.

The OTV would greatly increase the ease and efficiency with which astronauts might reach the particular height of 22,300 miles above the surface of Earth. At this height, an object would orbit Earth in 24 hours, the same amount of time it takes Earth to turn on its axis.

If a ship at this height were in a circular orbit and moved in the plane of Earth's equator, it would move about Earth's axis in lock step with Earth's surface. Someone on Earth's surface looking upward would see the ship remaining directly overhead indefinitely. The ship is then in geostationary orbit and it is *only* in that orbit that an object could be maintained over one spot on Earth's surface without the continuous use of energy. (Such an orbit can also be referred to as a Clarke orbit, after Arthur C. Clarke, the well-known science-fiction writer, who, back in 1945, showed how useful such an orbit could be in connection with communications satellites.)

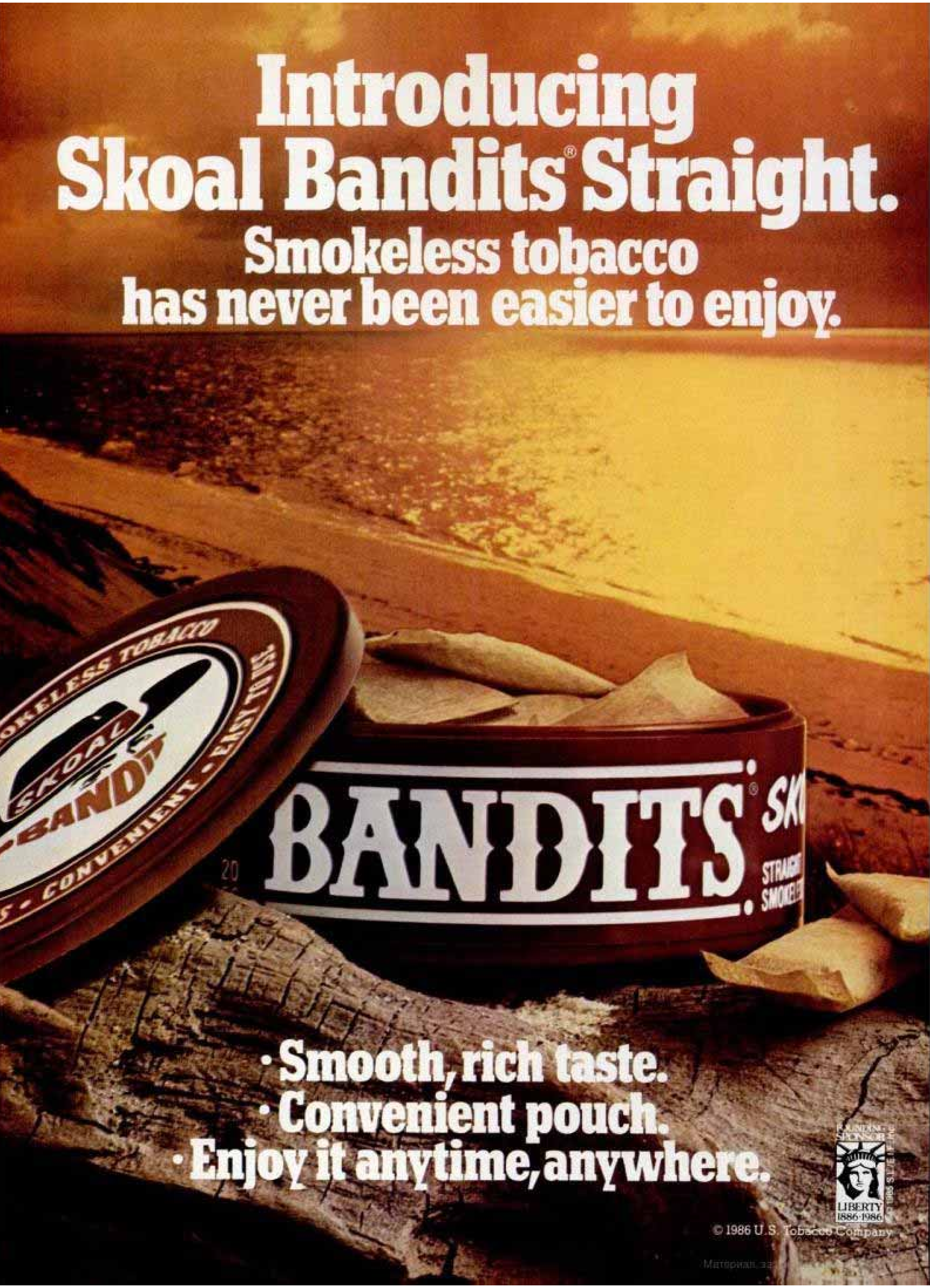
The combination of space stations and OTVs would make it possible to build structures in geostationary orbit. A series of communications satellites at different places in this orbit means that signals sent to the satellites could be sent back with less difficulty than if each satellite were moving relative to Earth's surface.

IT SEEMS CONCEIVABLE that solar arrays, miles across, might be built in geostationary orbit. Where such arrays on Earth's surface, or even on the space station, would be in darkness for half of the time, an array in geostationary orbit would usually miss Earth's shadow as it turned (due to the tipping of Earth's axis). The arrays would enter Earth's shadow for only brief periods during the days in the neighborhood of each equinox. Such an array would be exposed to sunlight for 98 percent of the time altogether.

Combined with this is the fact that solar arrays in space can receive sunlight across the entire spectrum of wavelengths, thanks to the absence of atmosphere. It is therefore estimated that an array in geostationary orbit will pick up 60 times as much energy as that same array on Earth's surface.

A series of such arrays spaced about Earth could convert sunlight first to electricity, then to microwaves. The microwaves could then be beamed to a receiving station on Earth (with added simplicity, since the array would be motionless with reference to the receiving station). At the receiving station, the

ILLUSTRATION FROM BOEING.
PHOTO FROM OMAC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microwaves could be reconverted to electricity and distributed over the world.

Unfortunately, however, the geostationary orbit is a limited resource, for it is only 165,000 miles long, and only so many objects can be fitted into it. It will have to be wisely exploited and with forethought. Clearly, the nations of the world will have to collaborate on its efficient use.

PM ILLUSTRATION BY PAMELA LEE

Joint space expeditions will discover mineral resources in the solar system.

WHERE DOES ALL the material come from to build the various structures in space? Earth's resources are being stretched thin for the needs of Earth's own population. And even if enough can be found for delivery to space, the act of delivery would be very expensive.

Fortunately, there is an enormous piece of real estate that we can reach, real estate that we already *have* reached with old-fashioned, nonreusable spaceships. It is the moon.

Once we have space stations in orbit, it will be only a matter of time before we return to the moon. This time, it will not be for temporary visits, but to stay—at least in relays. Once we have a permanent lunar presence, we will be able to study the moon in detail and use it as a stable, airless base on which to establish a huge astronomical observatory.

More than that, we can establish a mining station there. Detailed studies have been made concerning the gathering of ore from the lunar surface. It could be hurled into space electromagnetically (not difficult, since the moon's escape velocity is not much more than one-fifth that of the Earth's), and there, in space, it could be smelted with the use of solar energy.

Lunar material can serve as a source of structural metals, cement, concrete, glass and even oxygen. With the sun supplying energy and the moon supplying material, it will be possible for human beings to build space structures without calling upon Earth itself for excessive supplies of energy or matter.

One might argue that Earth would have to supply people, but even that is not necessarily so.

Among the structures that will be built in space might be space stations so large that they could hold thousands of people, rather than a dozen; so large that rotation at a not-excessive speed would supply a centrifugal effect that would prove an adequate substitute for gravity. This would avoid the deleterious effects of zero gravity. In such stations, human beings might be able to live life-long, generation after generation.

The space settlements could control the quantity of sunshine they receive and would be free of bad weather. They would keep out deleterious life forms (at least to a greater extent than we can on Earth). Conditions on space settlements might thus prove ideal for farming.

Using the knowledge gained when greenhouses were added to the original space stations, the settlements could make use of adequate cycling procedures and minimal supplies of fertilizer from Earth to produce plants and even small animals in supplies far greater than they themselves would need.

Furthermore, space settlements would offer an ideal inducement for space travel. At their distance from Earth, the escape velocity would be very low. Between that and the omnipresent vacuum of space, fuel requirements would be moderate, and advanced methods of propulsion (ion-drive, solar wind sailing) might be made practical. The space settlers would be far more suited, psychologically, than Earthmen would be to the undertaking of long flights. The space settlers would be more accustomed to space and to living inside artificial structures on cycled food, water and oxygen.

It is they who might make the routine flights to Mars and the asteroids by the mid-21st century. The asteroids, in particular, would offer mining possibilities even beyond those of the moon.

By the end of the 21st century, humanity might, in this way, be ready to penetrate the vast spaces of the outer solar system, and, eventually, to move even beyond—to the stars. **PM**

Our armed forces use the latest technologies to help guarantee a peaceful future.

In Defense Of A Nation

BY RICHARD REEVES

Recommend 25 knots, sir," says Lt. j.g. Scott Larsen on the bridge of the USS *Mississippi*. He focuses his binoculars across 8 miles of the Caribbean, locking on a dot on a ridge of the Isla de Vieques. An armored troop carrier. "Agreed," says Capt. Phillip Olson. The *Mississippi*, 585 feet, 11,000 tons and about $2 billion worth of guided missile cruiser, seems to sit back in the water, accelerating like a sports car as she runs for the beach. The forward 5-inch gun begins firing at the troop carrier. Each shot pains my jaw and teeth, like a punch in the mouth. At 8000 yards, the ship wheels to the right and parallels the shore with both the forward and aft guns punching shells into the hills with rapid bursts of smoke and flame. Then she cuts hard right again and wheels back out to sea, the rear gun continuing the cannonade.

Six minutes of support fire for landing troops. The official U.S. Navy designation for the maneuver is Z-40-G (modified). Larsen and any other sailor who's done it in the last 40 years call it "The John Wayne."

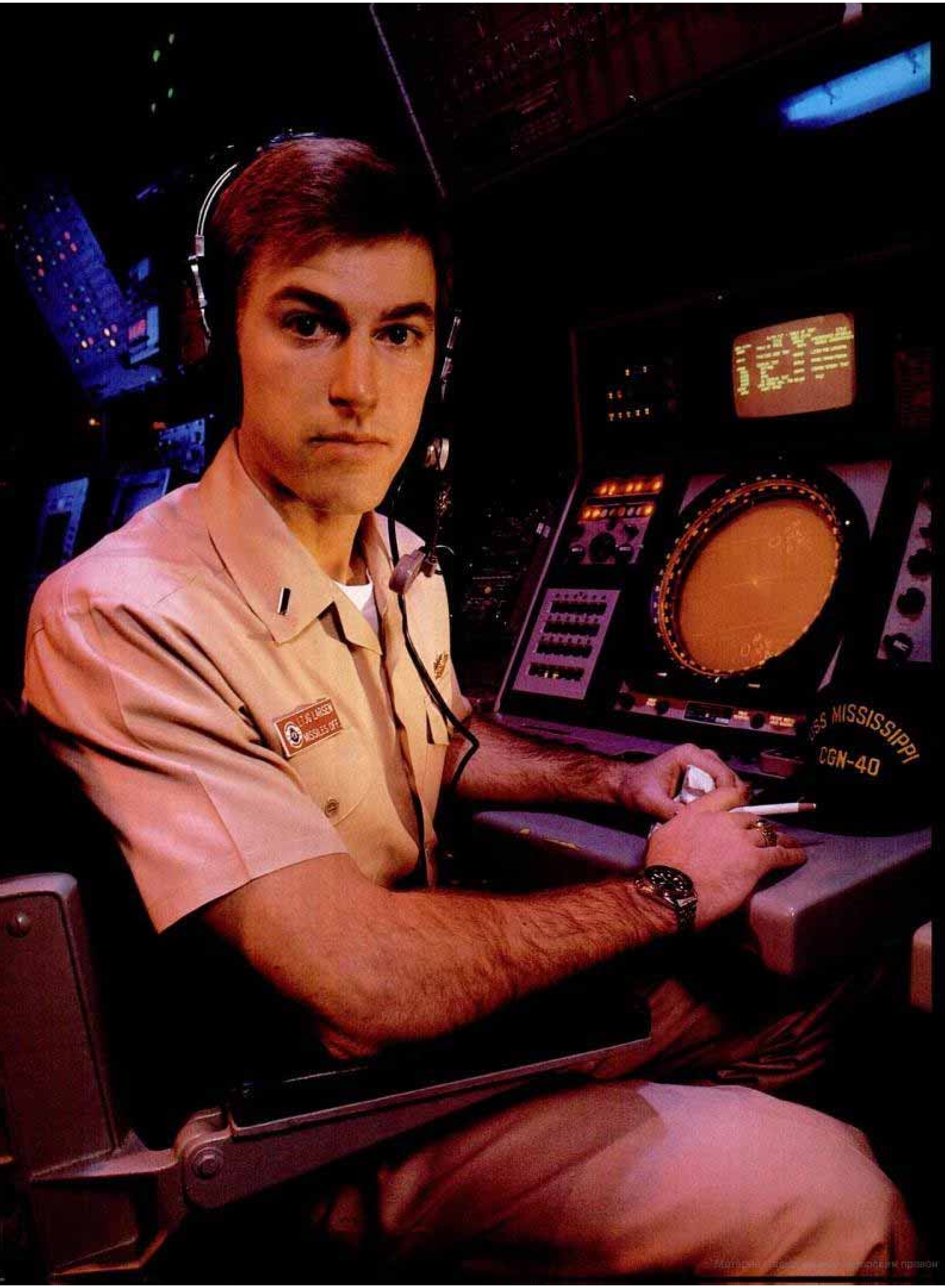
From officer-of-the-deck duty, Larsen, 26, from Doylestown, Pennsylvania, and Annapolis, goes down into the restricted twilight of the ship's Combat Information Center. "The Arcade," he had thought the first time he saw the low-ceilinged 25-by-50-foot cavern. The center is lighted by the red and green glows from 25 computer and radar consoles. In one corner, gunnery officers are controlling the firing on Vieques, the small island off Puerto Rico used to "qualify"—or test—men and equipment before ships of the line are deployed.

The gunnery officers huddle around their consoles and map tables, watching on television screens as their shells explode. Adjusting, adjusting. "Marine ground observer reports 40 yards long!" New information is punched into the combat computers.

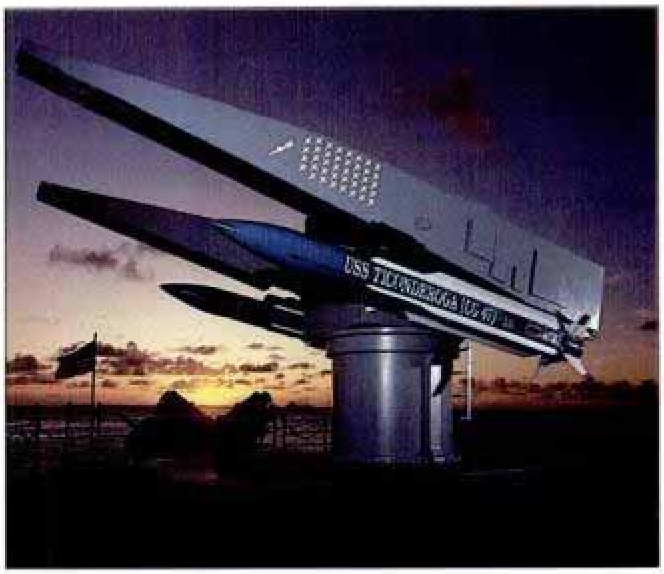
Gunnery radar is locked on a cluster of rocks off Vieques. Using that landmark, computers control the guns, constantly adjusting for wind and the ship's pitch, roll and speed. The computers can find any square meter on the island. In fact, with the grid maps prepared and fed into computers over the years by the Defense Mapping Agency, the guns and missiles of the *Mississippi* can find almost any square meter on the planet.

Larsen's job is more complicated. As missiles officer, he has to worry about hitting moving air and water targets. His two consoles are located between gunnery and the Relative Threat board, a 10-foot-wide electronic scoreboard that shows and describes anything in the air and on or under the sea within 500 miles of the *Mississippi*.

B-1 BOMBER/PHOTO BY GEORGE HALL


USS MISSISSIPPI
CGN-40

"We won't hesitate to do what has to be done," says Navy Lt. Scott Larsen.



On the **Ticonderoga***: new generation in anti-air warfare.*

Four decks below the young lieutenant, two GSMs (gunnery mate missiles) sit in a small booth almost surrounded by a forest of surface-to-air and surface-to-surface missiles. There are more than 200 of them—the exact number is classified—in what looks like the world's largest automatic vending machine. The Navy describes it as "the most sophisticated robotic system yet built." It can fire two birds every seven seconds.

They are tactical weapons, designed for protection against enemy planes and ships. Torpedo missiles are also on board for antisubmarine warfare, as part of the *Mississippi*'s prime mission—protecting the aircraft carrier in one of the Navy's 13 battle carrier groups. But by early next year, the ship will have a strategic role as well, with the installation of eight Tomahawk cruise missile silos under the old helicopter pad astern. Then the CGN-40—cruiser, guided-missile, nuclear-powered *Mississippi*—will itself be a strategic weapon. A floating platform, requiring fuel once every 13 years, with the nuclear weapons capability to take out eight Soviet cities within 1000 miles of the world's oceans.

Scott Larsen and the 580 other men on board the *Mississippi* are part of the 2.1-million-person, $320 billion American military machine. They are on picket duty at the frontiers of American power, defending our nation against aggressors and ready to strike back if we are struck first. The surface navy, 550 ships, operates outside the nation's nuclear triad of land-based intercontinental missiles, Air Force strategic bombers and nuclear-powered, nuclear-armed submarines.

The strategy and the mission of the surface fleet are built around the 13 giant aircraft carriers and their battle groups—13 mobile American air bases, nuclear platforms "showing the flag" around the world, ready to sail "in harm's way."

"We're ambassadors," says Larsen. "We deliberately display our missiles whenever we're in port anywhere. A big ship, a beautiful ship, an American ship, pretty much going anywhere we want to go."

The cruiser was built in 1978 as part of a group supporting and protecting a carrier. The surface-to-air missiles, antisubmarine weapons and electronics are all part of creating defensive envelopes of up to 1000 miles around the carrier.

While the battle group is still the core of any naval or tactical strategy, the Central Command is clearly the task force concept for the future. It was originally conceived as the Rapid Deployment Force during a Mideast crisis several years ago, but the name was changed to Central Command as the philosophy of the task force evolved. When the Central Command structure is completed a few years from now, it will be able to answer calls anywhere in the world and be in combat in less than a week.

Headquartered at MacDill Air Force Base in Florida, the Central Command will ultimately be split into several 2-, 3- and 4-ship units scattered around the Atlantic, Mediterranean and Indian oceans.

Supercarriers, support ships and aircraft form a contemporary U.S. naval armada, part of the Navy's rebuilding program.

FACING PAGE: LT. J.G. SCOTT LARSEN/PHOTO BY BRIAN R. WOLFF; THIS PAGE: TOP PHOTO BY BRIAN R. WOLFF; ILLUSTRATION BY ATTILA HEJJA; OVERLEAF: USS NIMITZ/PHOTO BY FRED MAROON

Apache AR-1 (left) is an anti-tank gunship. Pilots will wear look-and-shoot helmets (above).

LHX helicopter-fighter may use technologies made for supersonic jets.

Built around the *Nimitz*-class nuclear carrier, the command will include conventional frigates, battleships, cruisers, landing craft and other vessels. But new speed and strength will come from ships like the surface-skimming landing craft nicknamed JEFF-B and the *Aegis*-class cruiser, both now in the experimental stages.

The command's mission is not simple: Clear the sea lanes to a troubled area. Establish a presence off the coast. Move into one or more trouble spots and provide safe airfields and seaports for landing troops and supplies.

Size, speed and stamina start with the *Eisenhower*, a 1095-foot-long floating city powered by a pair of nuclear reactors that can bring her up to 30 knots.

The supercarrier supports an air wing of 95 planes and can house more than 6000 men. It has 4½ acres of flight deck, four aircraft elevators and a hefty 93,405-ton displacement.

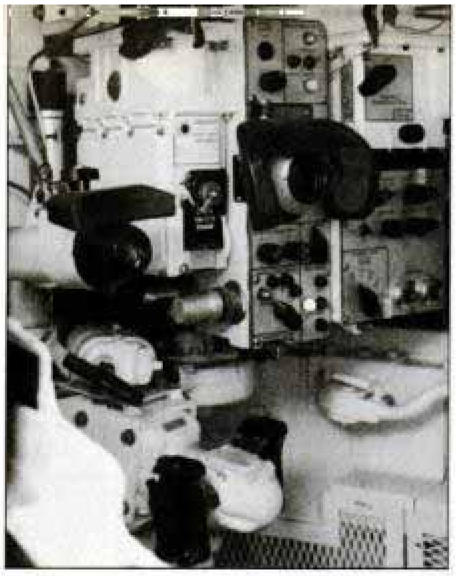
Backing up the big carrier by the end of this decade will be the *Aegis*-class, or the *Ticonderoga*-class, guided-missile cruiser. It is similar to Larsen's *Mississippi* in concept. Founding vessel of the *Aegis* family, the *Ticonderoga* is a 563-foot gas-turbine ship that cruises at more than 30 knots. Current plans call for construction of 15 more *Aegis* ships by the turn of the century. The armaments undoubtedly will evolve as new ships are built, but the vessel is lethal even with its conventional 5-inch, 54-cal. MK-45 guns that back up the surface-to-air Standard missiles. A pair of MK-15 automatic gun systems is designed to knock out sea-skimming cruise missiles that fly like the Exocet, which sank the HMS *Sheffield* during the 1982 Falklands war.

The *Ticonderoga* is closely related to another controversial ship in the Central Command's future: the yet-unnamed DDG-51. This guided-missile destroyer was planned to be a less costly and slightly smaller version of the *Aegis*-class ships. Smaller was the easy part. A classified congressional audit last year predicted the DDG-51 will cost half a billion dollars more than the $1.2 billion *Ticonderoga*.

While the *Aegis*-class ship was built to stand offshore and knock air-to-sea mis-

TOW (above) destroys enemy armor from the back of a Jeep. Six kinds of missiles can be fired from mobile multiple missile launcher (left).

TOP LEFT PHOTO BY MI SEITELMAN; TOP RIGHT PHOTO BY KERBY SMITH; MIDDLE ILLUSTRATION BY HUGHES HELICOPTER. BOTTOM LEFT: U.S. ARMY PHOTOS, BOTTOM RIGHT BY RICHARD SCHRADER



M-1 tank interior (above) is high tech. U.S. land operations are based on the M-1 and Bradley Sighting Vehicle (right). Both boast powerful arsenals.

M-249 Squad Automatic Weapon (above) will be used by all four services. It fires up to 700 rounds a minute or can be used as a rifle with an 800-meter range.

siles out of the sky, the DDG-51 is seen as a supersurvivable vessel that can get in close to the beach and give Marines strong artillery and missile support. The 466-foot DDG-51s will have steel hulls and steel-plated superstructure.

Getting troops ashore is the job of standard landing vessels today. But by the end of the decade, the JEFF-B surface skimmers will be launched from huge vessels that can support more than 1800 men, or from smaller and faster landing-ship docks that can carry slightly fewer than 1000 men.

Why not airlift the initial force? The Marines estimate it would take 252 C-5 aircraft, 829 C-141s and 166 cargo 747s to deliver 30 days' worth of supplies for an amphibious brigade. Assuming there are no major equipment breakdowns, the cargo planes would take 19 days to accomplish what the pre-positioning arm of the Central Command could do in a week.

SOME MAY CONSIDER THE Navy's rebuilding program overly ambitious. The goal is to complete the Central Command as part of a 600-ship fleet by the 1990s. In testimony before the Senate Armed Services Committee, Vice Adm. Robert Walters estimated the Navy will spend almost $93 billion over the next five years to update the total fleet. A cost-conscious Congress has been questioning the extent of the spending. But no one is questioning the wisdom of creating the Central Command and its new concepts of speedy delivery and support.

The Central Command, and for that matter the rest of the Navy, is but one of the financial pressures on a Congress not lately in the mood to continue spending huge sums on a military buildup. The Army, too, is a service going through a huge transition as our country's ground force changes its nature from one of a "grunt" foot soldier orientation to that of a highly specialized, highly mechanized, high-technology presence in the world.

What can be seen can be hit. What can be hit can be killed. That best sums up the realities of the battlefield of 1986 and beyond. Whatever is visible or emits noise, light, heat, odor, electrical energy or vibrations can be detected by modern technology and quickly destroyed—often with a single projectile at long range, in the dark and in adverse weather.

The move to high tech in the 1980s has come about in response to the numerically superior, armor-heavy forces of the Warsaw Pact on one hand, and Soviet-equipped forces in the Third World on the other. As the Army adopted mechanization in World War II, it has adopted high technology to meet the challenges of the present and future.

While modern technology is the key to neutralizing the advantages of potential adversaries, the Army remains essentially an organization of people. Gen. Creighton Abrams, former chief of staff of the Army, said, "People aren't *in* the Army. People *are* the Army." That simply means that sophisticated technology has always served the soldier, and not vice versa.

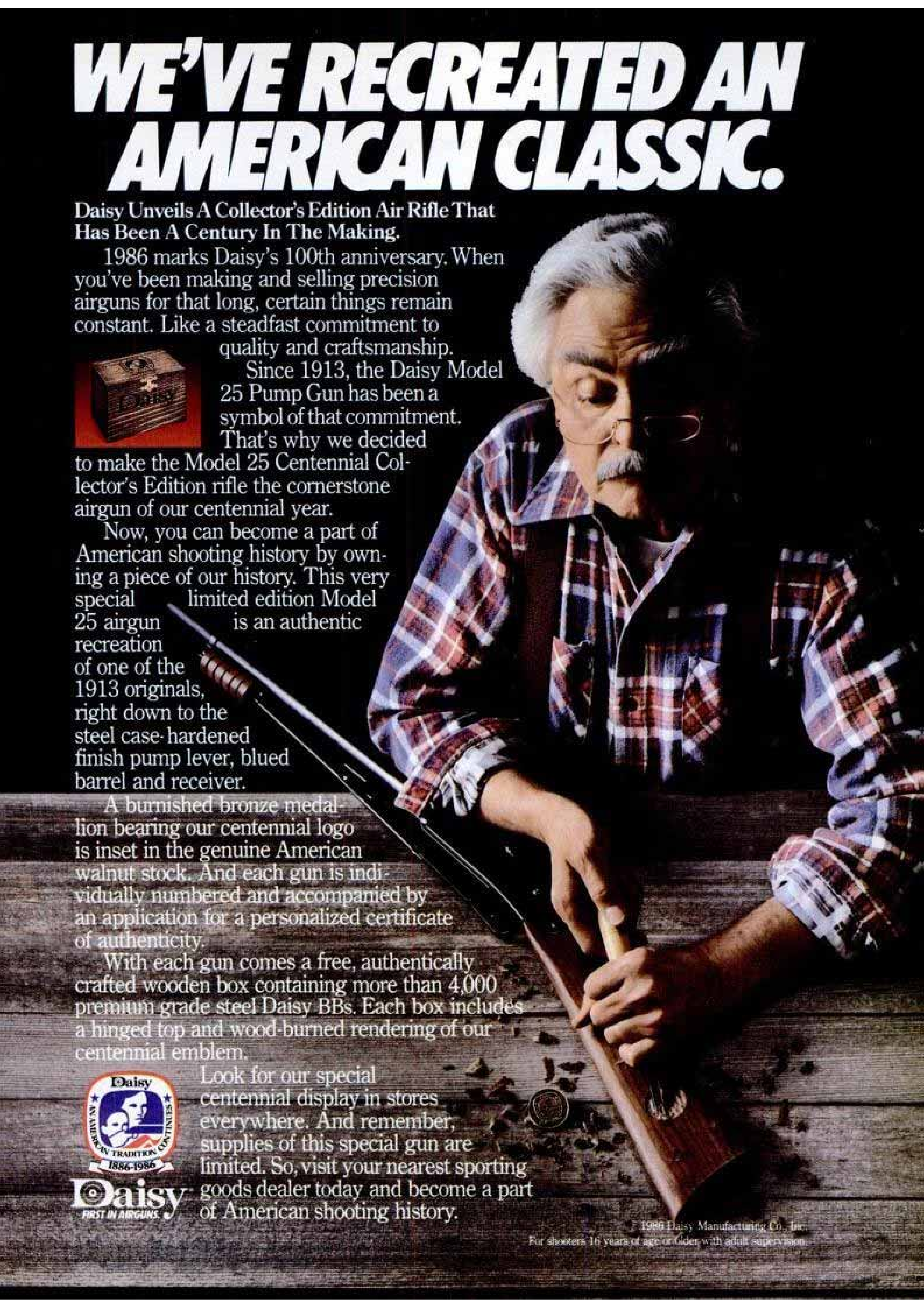
Missiles entered the Army inventory for beyond-artillery-range missions and bore names such as the Jupiter, Redstone, Corporal, Sergeant, Honest John, Little John and Pershing. Air-defense missiles such as the Nike-Ajax, Nike-Hercules and Nike-Zeus protected not only the Army in the field but U.S. metropolitan areas from air attack. The HAWK (Homing All the Way to Kill), Chaparral and Redeye missiles complemented anti-aircraft guns in the field.

But the major emphasis of the Army was fighting guerrilla or brush-fire wars in which conventional, lightly equipped forces could respond rapidly. To find and defeat the guerrilla, the Army developed new weapons and adopted the helicopter for wholesale battlefield mobility. As the Jeep was to World War II's GI Joe, the helicopter was to the grunt.

In Vietnam, the infantryman was re-equipped. His M-14 rifle, essentially an upgraded M-1 adopted in 1957, was replaced by the lightweight M-16. It fired a highly lethal, high-velocity 5.56mm bullet. The soldier could carry and expend much more ammunition in battle. The squad carried Claymore mines, easily placed antipersonnel devices that were very effective.

Even the combat uniform has evolved. Dubbed battle dress, it is camouflaged and protects against infrared detection devices. The old steel pot is giving way to a new Kevlar-laminated helmet with im-

TOP LEFT AND RIGHT: U.S. ARMY PHOTOS. PHOTO ABOVE BY ROBERT BRUCE



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The combat aircraft of the future will be able to monitor a pilot's vital functions and make its own repairs while in flight.

proved ballistic protection. Field equipment from tent pegs to packs is being improved. By next year, another Army institution may give way to technology. New computerized dog tags are being tried by some units. The tags contain a microchip that encodes name, rank, service number and medical history. They have a 1K memory, about the same as a hand calculator.

Recent improvements in weaponry are even more remarkable. For example, the venerable Colt .45 pistol is being replaced after almost 75 years of faithful service to the armed forces. The new double-action Beretta 9mm pistol has twice the ammunition capacity of the Colt. The combat-proven M-16 rifle is being upgraded for greater accuracy and stopping power at longer ranges. The World War II rifleman reloaded after eight shots. Today's M-16 rifleman need reload only after four times that amount.

Tankers today ride to battle in the M-1 or M-1A1 tank. The tanks are powered by 1500-hp turbine engines and protected by an advanced armor. The M-1 mounts a 105mm cannon, while the M-1A1 mounts a 120mm version. Both fire accurately on the move in all extremes of weather.

Tomorrow's tanks will have a self-loading, rapid-fire cannon, a crewless gun turret and a control cab so exotic it will resemble the cockpit of a modern fighter plane. A self-loading cannon not only increases a tank's firing rate, but it eliminates the need for a manned turret, thus removing crewmen from a vulnerable position on top of the tank. This, in turn, permits a lower vehicle silhouette, making a tank harder to see and hit. Views of battlefield terrain, target-tracking plots, radar images and other vital maneuvering information are displayed on TV screens in the cockpit so the crewmen are never directly exposed to enemy fire.

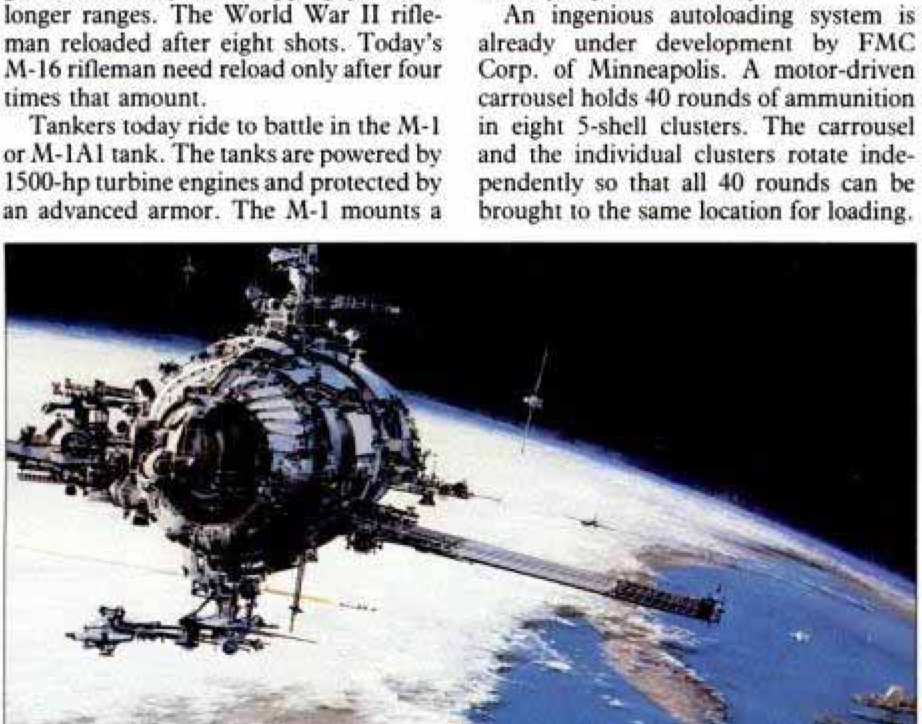
An ingenious autoloading system is already under development by FMC Corp. of Minneapolis. A motor-driven carrousel holds 40 rounds of ammunition in eight 5-shell clusters. The carrousel and the individual clusters rotate independently so that all 40 rounds can be brought to the same location for loading. A pivoted transfer tube picks a shell from the carrousel, flips it over, slides it sideways and rams it into the cannon's breech. After each firing, an extractor tube removes the empty shell casing while the transfer tube returns to the carrousel for a fresh round. The reload sequence is so fast it can fire 120mm rounds at the rate of one every five seconds.

THE ARMY'S HELICOPTER of the future is the LHX (Light Helicopter Experimental). It will revolutionize the concept of a helicopter, making it virtually a fighter aircraft. Since prototypes are still being worked on, we can only speculate on what the final configuration will look like. However, designs being developed by contractors include one made of composite material bonded together with adhesives, one with conventional bearingless rotor systems and one with swivel-nozzle engines without rotors. Some can fly at twice the speed of sound and all have reduced-pilot-workload cockpits.

Even the helmets worn by chopper pilots are something out of science-fiction movies. The latest development is a helmet-mounted gunsight. All a chopper pilot has to do is look at an enemy target. The guns will automatically follow his line of sight no matter which way he moves his head.

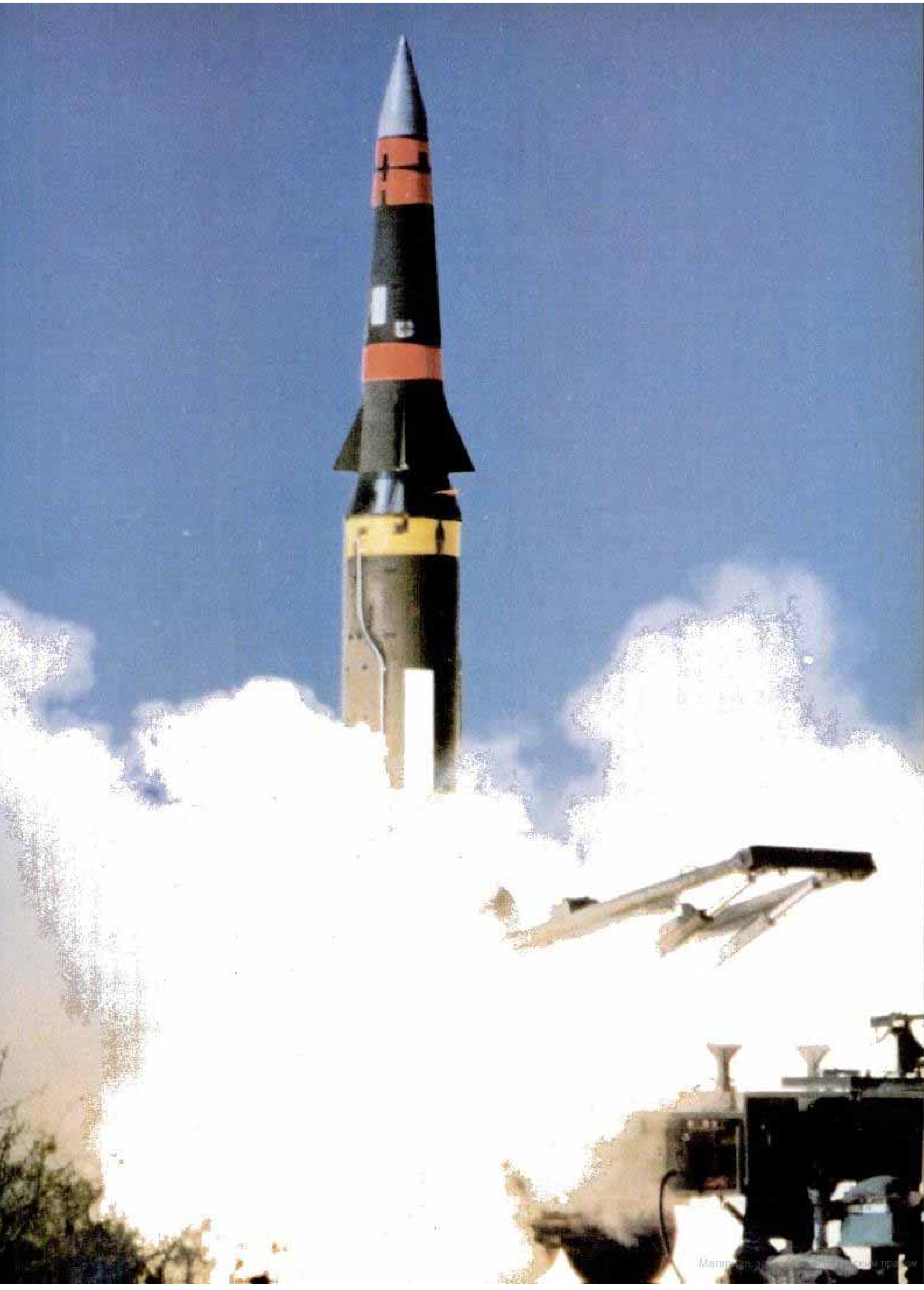
The heart of this remarkable system is a tiny, transparent eyepiece attached to the pilot's helmet so that it covers his right eye. The eyepiece is electronically coupled to a servo-driven optical scanner held in a movable gimbal mount in the aircraft's nose. The scanner, either a TV camera for daylight use or an infrared sensor for night vision, follows the movements of the pilot's head, looking wherever he looks. The cannon, located under the nose in a similar gimbal mount, is servo-slaved to the scanner so it points wherever the scanner is aimed.

Called IHADSS (for Integrated Helmet And Display Sighting System), the Hon-



"Big Bird" watches over the Soviet Union from space like a huge global lie detector.

TOP ILLUSTRATION BY ATTILA HEJJA; BOTTOM ILLUSTRATION BY JOHN BERKEY; FACING PAGE: PERSHING MISSILE, U.S. ARMY PHOTO



eywell look-and-shoot sight was designed especially for the new Apache antitank gunship, but is adaptable to other combat helicopters.

The Army missile inventory also has been upgraded. The Patriot medium- to high-altitude missile provides the main defense against high-performance aircraft. The Pershing II ground-to-ground missile has double the range and greater accuracy than earlier models. The Lance, with a range of 75 kilometers, is targeted against missile sites, airfields, troop concentrations and transportation centers. It has nuclear and conventional warhead capability.

The Army is honing to a high state of readiness at the National Training Center in the desert of California. Using the latest computerized techniques and laser technology, "friendly" and "enemy" forces go head-to-head in free-maneuver combat. Sometimes the good guys win and sometimes they lose. But everyone learns lessons that are normally paid for in blood during the first battles of war.

To get the most training for the dollar, the Army also has adopted simulators. Tank crews, for example, maintain a high degree of gunnery skill without the expense of firing live ammunition. Researchers are finding uses for computer technology for everything from communications, gunnery and maintenance to data linking combat vehicles on the battlefield.

JUST OUTSIDE DAYTON, Ohio, stands Wright-Patterson Air Force Base, a sprawling complex of buildings, tarmac, barracks, labs and an Air Force museum. You pass the museum first on your way to the gate. In front are a B-52, a B-1, an F-15, a C-130 and a handful of other aircraft from our past and present. But you have to wander farther down the road to come to the future.

That's where the Aeronautical Systems Division is located. In a complex of vaguely marked buildings, the ASD is working today on the jet fighters, and even the Army helicopters, of the 1990s and beyond.

Down one corridor, there's a discussion going on about artificially intelligent aircraft. A team of Air Force scientists is working on the Pilot's Associate, an electronic brain center expected to go inside a future jet fighter as well as the Army's LHX helicopter.

Up a flight of stairs, where civilians don't go without an escort, is a corridor of labs where researchers are working on making the pilot one with his machine. A team of scientists and Air Force personnel is working with a helmet that would scare the wits out of Darth Vader from the outside, but fill a pilot with confidence from the inside. The inside of the helmet contains a set of ⅛-inch (diagonal measure) TV screens. The pilot doesn't see screens. He just sees scenes. A computer shows him a 3-dimensional picture of the land over which he is flying. The picture is taken by cameras placed strategically around the aircraft.

A computer speaks to the pilot in gentle tones, telling him to turn his head this way or that. Coming up over the horizon is an enemy aircraft. A bell goes off (a chime, really, like those you hear in a department store). A soft voice says, "Target to your right." The pilot looks down inside his helmet—it covers his entire face—and sees a set of instruments. As his eye makes contact with the laser missile command, he presses a button. Then he turns his gaze toward the enemy plane and shouts: "Fire!" You can't count to 10 before the enemy aircraft blows up and disappears from the screen.

In the briefing room, a team of ASD scientists talks about the fighter of the future—the Advanced Tactical Fighter. The aircraft chosen will ultimately replace the current McDonnell Douglas F-15 Eagle and General Dynamics F-16 Fighting Falcon sometime in the mid- to late '90s. The contenders include McDonnell Douglas, General Dynamics, Grumman, Boeing, Northrop, Lockheed, Fairchild and Rockwell, most of whose entries are still under wraps.

The ATF will be able to do amazing things. For instance, the Pilot's Associate will be able to monitor a pilot's vital functions. At present, it is known that most pilots begin to black out when a plane goes over 9 Gs, or nine times the force of gravity. In the twilight before blackout, the pilot doesn't always know he's about to fade away. If he knew he were about to black out, he could pull away from the G-turn and reduce the force working against his body. The Pilot's Associate will be reading his vital signs. It will know when the pilot is blacking out and will wrest control of the aircraft from him.

A THOUSAND MILES FROM Wright-Patterson base is the Grumman Aerospace Corp. headquarters, where work continues on the X-29, an odd-looking supersonic jet that uses graphite forward-swept wings and a canard to give it superlift and the ability to come in and out of previously impossible turns. The wings look like they are on backward. The advantages of the forward-swept wing have long been known, but until recently no one could make a wing strong enough to point into the airstream at supersonic speeds without tearing off. Now, high-strength alloys and graphite composites make the idea feasible. In conventional aft-swept wings, airflow migrates out toward the tips, imposing an outboard load that results in loss of lift and premature stall. In Grumman's wing design, airflow moves inward toward the fuselage, leaving the wingtips clear. The benefits are increased lift, reduced drag, less danger of stalling at low speeds and high angles of attack, and greatly improved maneuverability.

The B-1B is the newest bomber in the air. It's also expensive: The 100 production airplanes represent research, development, test, design and production investments of $205 million each. Critics think the B-1B will be detected and destroyed easily by tomorrow's defense systems. Others question the need for a manned bomber mission. Some want to bypass the B-1B in favor of Northrop's Advanced Technology Bomber with the latest stealth techniques. Northrop's ATB is in the testing phase.

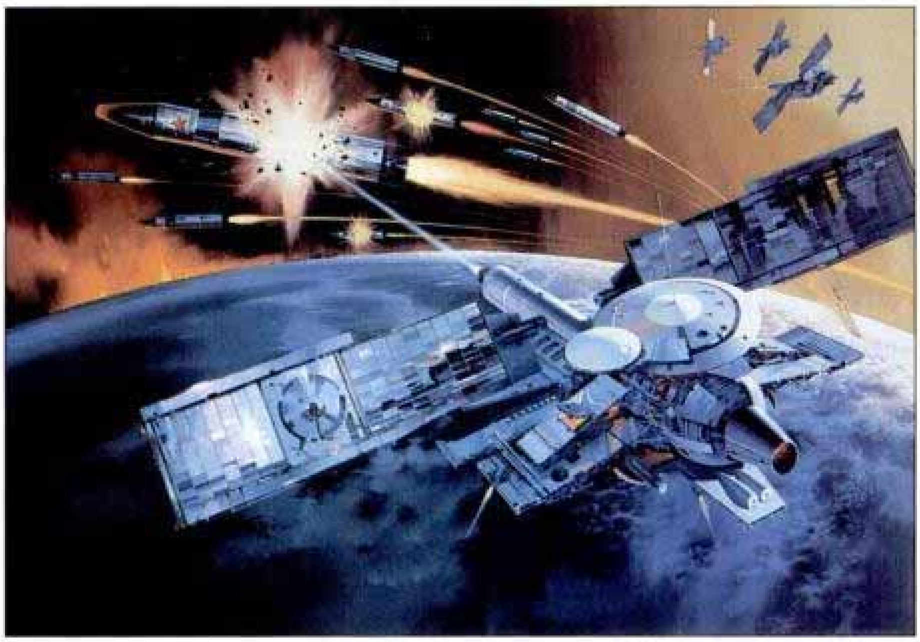
The B-1B's most conspicuous feature is its variable-geometry wing, blended into the fuselage for best aerodynamic performance. Its outer panels are pivoted on huge titanium-alloy pins nearly 20 inches in diameter. For takeoff, climb, cruise and landing, the wing swings forward to 15° of sweep-back angle. For low-level, high-subsonic speeds and supersonic flights, the wings sweep to their 67° maximum. The wing design reduces takeoff distance and time dramatically compared to that of the B-52.

The B-1B has three bays that can load 125,000 pounds of weaponry: long- and short-range air-to-surface nuclear-warhead missiles, such as 24 SRAM (short-range attack missiles), or free-fall bombs, either nuclear or conventional (up to 84 Mk. 82 iron bombs). Also, 14 cruise missiles can be carried on belly stations.

The B-1B is crammed with the black boxes of modular, self-checking offensive and defensive avionics systems, each system operated by a single crew member.

THE LEADING EDGE OF our defense systems of the next century will most certainly be airborne. In fact, the Air Force's supersecret Space Division is now charged with nothing less than developing, launching and maintaining satellites that have one mission—to keep an eye on Earth.

From 100 miles above Earth, a multi-faceted "Big Bird" satellite keeps watch over dozens of Soviet military installations, crossing over Russia every 90 minutes. Its cameras can be programmed from Earth stations to zoom in and out, photographing wide fields of view or moving in so close that a trained photo-



The "Star Wars" concept: airborne defense to shoot down enemy missiles in space.

graphic interpreter will be able to identify individual vehicles on the ground.

Like a global lie detector, America's system of sensing devices in air and space, and on land and sea, picks up and relays data to skilled analysts. This allows the United States to determine whether the Russians are living up to a treaty.

Satellites will form the core of what has been called the "Star Wars" defense system. It is still being developed, even in basic format.

The general idea of the system is a series of satellites that immediately detect an aggressor's actions—such as the launch of a missile toward our country. A satellite would relay the information to computers, which would in turn relay the information to defensive satellites strategically placed in Earth orbit. The defensive satellites would be armed with lasers or other advanced weapons and would knock out the incoming missile well before it had a chance to reach U.S. territory. Or the computers would alert defensive ground-based missiles to be launched to destroy the incoming missile. In either case, computers—machines—would bear the brunt of our defense.

TODAY, HOWEVER, MOST of the U.S. defense is still in the hands of people, not machines. People like Lt. Scott Larsen aboard the *Mississippi*. And Larsen is gung ho. "If you snooze, you lose," he said to me once as we hurried between decks. "What?" I said. "Oh," he smiled. "It's an Annapolis expression. I use a lot of them."

He does. He reminds me a lot of John Glenn. Not the senator of today, but the young Marine captain of yesterday in the film "The Right Stuff." Larsen has it. He served a hitch as an enlisted man in the Marines before going to the Naval Academy. And I'm glad he's on our side.

"I love the military," he says. "I love discipline. There is more responsibility and opportunity here than on the outside. The harder you work in the Navy, the more work they give you."

The loyalty of the men I spoke with on the *Mississippi* was, depending on their rank, to their buddies, their department,

NORAD Command Post: Deep in Cheyenne Mountain a sophisticated defense system watches for a possible attack.

ILLUSTRATION BY PAUL ALEXANDER; PHOTO BY JEFF SMITH the ship, and most often to the Navy. Only Capt. Phillip Olson mentioned the country, and then only after the Navy. Controversies and doubts in Washington about the cost and potential vulnerability of carrier battle groups—or even the chance that surface navies might be irrelevant in nuclear exchanges or limited land wars—are not part of the conversations over the coffee endlessly brewing on board the *Mississippi*.

Olson, Larsen and the rest are intelligent and dedicated men sent out to do a difficult and dangerous job, and no temporary shipmate can fail to be impressed with how they do it. If the job is not new, the way it is done is constantly changing.

"We used to do mule work. Now the seaman is a technician, sitting at a panel watching lights go on and off," says Chief Petty Officer Duane Johnson, the senior enlisted man on board. "Orders used to be orders. Now they sound like suggestions because each man's job is important."

"Technical background and the hand-eye coordination learned in video-game parlors are becoming more and more important here," Olson says as we walk the deck toward the Maypole antenna on the bow that connects the *Mississippi*'s computers with other Navy battle computers over thousands of miles. We are talking about how technology and technique have changed since each of us graduated from college as engineers 25 years earlier.

We pass a couple of sailors—sonar technicians—and Olson says: "Those young men know more than we did when we graduated. In fact, they know more than graduate electronic engineers did only 10 or 15 years ago."

MANEUVERS ASIDE, there are few John Waynes in the Navy anymore. The talk in Officer's Country—the wardroom—and the corridors where seamen sleep in stacks of four is not of God, Mom and country but often of salaries, promotion and "re-up" (re-enlistment) bonuses. Larsen is paid more than $30,000 a year. The average pay for the enlisted men on the ship is $14,000. In the 7-foot by 10-foot cabin Larsen shares with another junior officer, his side is lined with technical manuals and photographs of missiles, not of his wife, Susan, branch manager of a bank back in Norfolk, Virginia, or their year-old son, Gregory.

The *Mississippi* and the United States of America depend now on men like Scott Larsen. "We are here to maintain what you have at home," says Lt. Larsen, who was away from his own home for all but two weeks of the first year of his first son's life. "We won't hesitate to do what has to be done. Not in the U.S. Navy. We're ready." PM

Land Of Eden

With agriculture in the doldrums, farmers are turning to new technologies to increase profits and harvests.

BY JANE HOWARD

You see it on Scott Tollefson's face when he guides you on a pickup truck tour of his partnership's drip-irrigation system and minimum-tillage machinery—thought to be the most advanced equipment in the world—on 4500 acres of cotton fields outside Casa Grande, Arizona. You hear it in Larry Traubel's voice when he describes his computer-controlled sprinkling system for 640 trellised acres of Granny Smiths and three other varieties of apples near Bonita, Arizona.

In the most discouraging times American agriculture has faced in decades, these young farmers, who look as resolute as astronauts, are determined to keep their place on what Tollefson calls the cutting edge of technology.

"Back in the boom days," Traubel says, "anybody could make a buck." But of the 650,000 Americans who now farm full time (half a century ago the figure was every other person), 20 or 30 percent will be forced to find some other way of life within two years. "Our production and efficiency are haunting us, biting us, so to speak," one farmer says. "The economy's like a balloon filled with water. You can just squeeze the water around so many ways. In a world market there's no getting around it: American farmers are competing not

PHOTO BY MICK ROESSLER, FOUR BY FIVE INC.

In a wheat field in Arizona, Scott Tollefson of Sundance Farms shows his newest farm tools: PVC piping and a computer. The drip-irrigation system allows Tollefson and farm owner Howard Wuertz to automatically apply fertilizer, weed killer and pesticides.

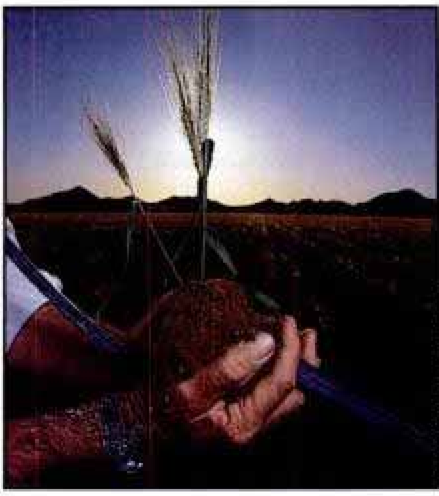


PHOTO BY BRIAN R. WOLFF

Newfangled methods of farming combined with old-fashioned resolve are producing more crops for less.

with individuals in other countries, but with governments. America is going to have to learn to produce more for less."

Producing more for less is what Traubel, Tollefson and other farmers throughout the country are struggling to do. "We were kind of renegades. Everyone thought we were crazy," says Tollefson, a former entomologist, of the early days of drip-irrigation technology. "But we kept on testing new ways of doing things." Testing also agrees with Traubel, who says, "Computers are really neat. With fine-tuned irrigation practices like temperature sensors in the ground, you can start at midnight and arrange any repetition you want for the sprinklers, depending on what season it is. If I was on my own, I'd have to get up at three in the morning and change the water."

That is the romance of farming, and perhaps it is a contributing factor to the problems in American farming today. America knew the romance—clean living, early rising, do-it-yourself everything—was coming to an end two decades ago. At first, farmers started to sell off leveled land to real-estate developers. The late Sen. Everett Dirksen of Illinois bemoaned the fact that "land is bringing greater profits than labor."

In recent years, farm equipment, taxes and other costs have risen meteorically, while world competition has kept prices down at the farm. Last year, a group of folk, country and rock musicians banded together to put on the Farm Aid concert to raise funds for farmers whose land was threatened with foreclosure. In 1984, farm foreclosures were up 60 percent over 1983. They were up 80 percent over the period 10 years earlier.

Is farming going the way of the steel industry? Many experts say it is. Outmoded methods and international competition seem to be reducing our power as a producer nation. But, as with steel, farming may be in a period of change rather than one of total defeat. In 1880, there were a little more than 4 million farms in America on about 840 million acres of land. By 1945, farm acreage had grown to 1.1 billion acres, but it was held by only 5.8 million farmers. The American farm was changing from the single-family operation to the corporate megafarm.

Starting in the 1960s, the decline in family farming accelerated and the acreage itself stopped growing. By last year, just 2.5 million owners were controlling fewer than 1 billion acres.

While the numbers are depressing to the romantics, they do not tell the whole story. For instance, while sale of traditional farm machinery (tractors, back hoes, reapers and pickers) is down, whole new fields of technology equipment have opened up. These have attracted a new breed of entrepreneur farmers working as family businesses and in partnerships with co-ops.

PHOTO FROM COMSTOCK INC

PHOTO BY ALVIS UPITIS, IMAGE BANK

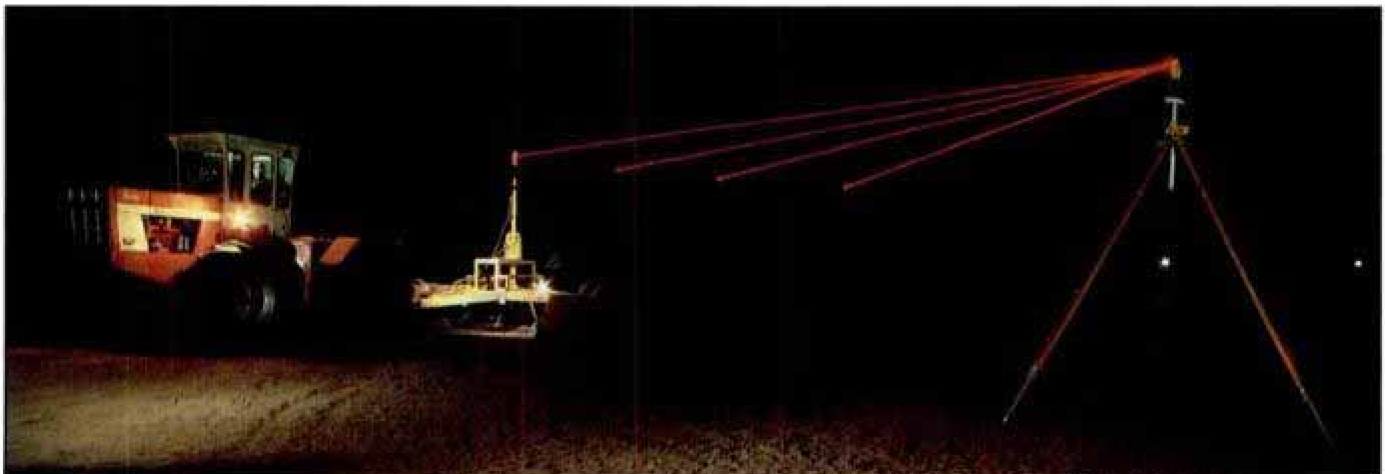


PHOTO FROM U.S. DEPARTMENT OF AGRICULTURE

Specialized machinery (top left), hydroponics (top right) and laser-guided levelers (above) help produce record harvests.

FACING PAGE PHOTO BY BRIAN R. WOLFF

One farmer can't afford a new laser-guided tractor rig. But Southern California co-ops have been gobbling up the new breed of farm implements at a quickening pace in the past five years. Laser-guided tractors are used by lettuce farmers to level land with accuracy to thousandths of an inch, often doubling productivity at a single farm. Laser-guided devices are also being used for irrigation projects and other precision farming chores.

DURING THE FUEL crunch of the 1970s, tractor manufacturers followed the lead of the big automakers and downsized their rigs. For the small-farm operator and the greenskeeper, smaller was better. But for the midsized farm and the megafarm, the results were disastrous. Now tractor manufacturers are looking to larger-sized rigs with high-tech engines that are efficient and powerful. Ford Tractor has on the drawing board a big-horsepower rig that by the next decade will be able to haul major new technological advances like the lightweight laser-levelers with great fuel efficiency being developed by the U.S. Agriculture Department.

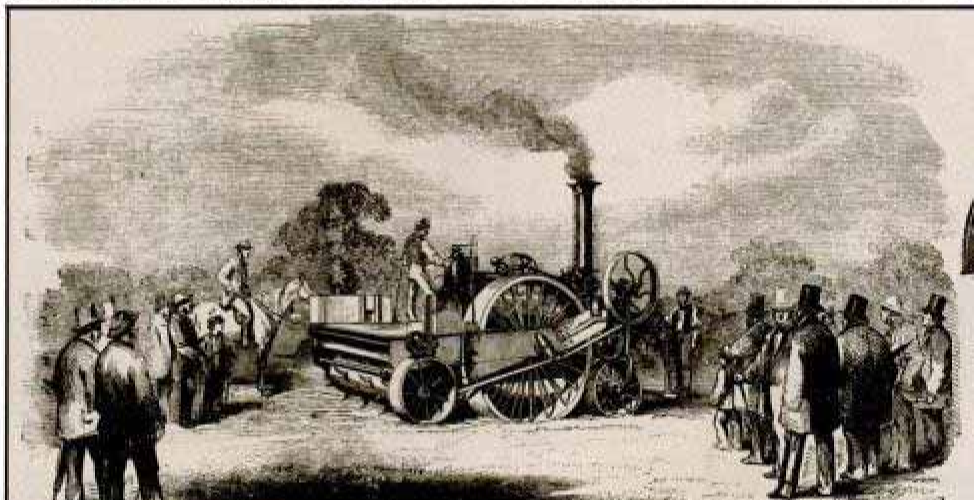
Tollefson and Traubel aren't farmers because their fathers were—they weren't—but because they have chosen to be. So has Bill Crane of Arthur, Illinois. Crane spent his first 15 years in Springfield, Massachusetts, where his mailman father raised him in a tenement and bequeathed to him the "r" he still adds to the word "idea." Then, at the end of a summer vacation on his maternal grandparents' farm in Iowa, he decided to stay put instead of going back East with his parents. "I chored," he says, "for my room and board."

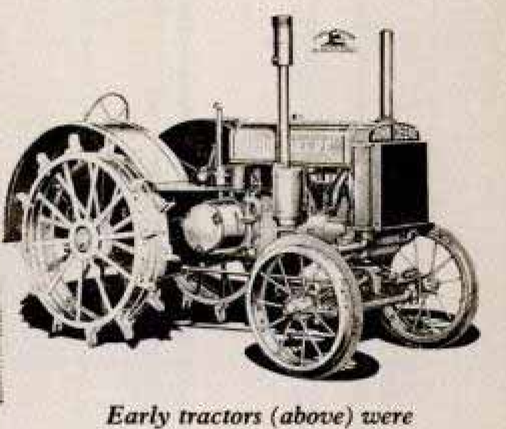
By the time he graduated from an Iowa high school in 1958, he was hooked on rural life, if not on full-time farming. Today, tending 80 acres of corn and soybeans as one of this country's 1.7 million part-time farmers, he is also an entrepreneur whose ideas about drainage and irrigation are regarded as among the most innovative in modern agriculture. He has developed an irrigation system that in 20 years' time, he believes, may prove as important as the development of hybrid seed corn and the use of fertilizer. "I don't know where I picked up the habit," Crane says, "but I like to think in the abstract, turn things inside out. Most farmers don't do that." More farmers are going to have to.

"Welcome To Arthur," say billboards in this town of 2122. "You're A Stranger Only Once." In a $32-per-night room at the Arthur Country Inn, a sign says, "Please Treat Our Towels Respectfully." Arthur could hardly be more reassuringly quaint. Amish and Mennonite families from outlying farmsteads park their horse-drawn carriages across from the Old Heidelberg, where dinner, served at noontime, rarely costs more than $2. Men are bearded, women wear bonnets and their laundry—all decorous blue and gray and white—is hung to dry on clotheslines even in the coldest weather; these sects have no use for washers, dryers, cars or other signs of worldliness. When an Amish girl went with an "English" family on a shopping trip from Arthur to Decatur, a city 40 miles away—which her people equate with Gomorrah—her parents were appalled to learn that she had been for a ride on an escalator.

Bill Crane is Methodist, not Amish, and very much a man of the modern world. Nobody questions his place as one of the more imposing citizens of Arthur. He has been to West Germany several times on business and seen most of the United States. "I guess I could live any place I wanted to," he says, "but I don't know where I'd rather be than Arthur." The town's calm tempo suits him, and his house, on the road just north of town, is as good a headquarters as any for W.E. Crane Inc.—Farm Drainage and Water Management Systems.

His business is, as he sometimes puts it, ditch digging. Using elaborate machinery of his own design, he digs trenches in the rich black soil surrounding Arthur and installs slotted pipes on slopes where layers of soil 2 to 12 feet deep allow artificially maintained water levels, supplied from wells, streams, ponds or irrigation ditches. Water control devices,

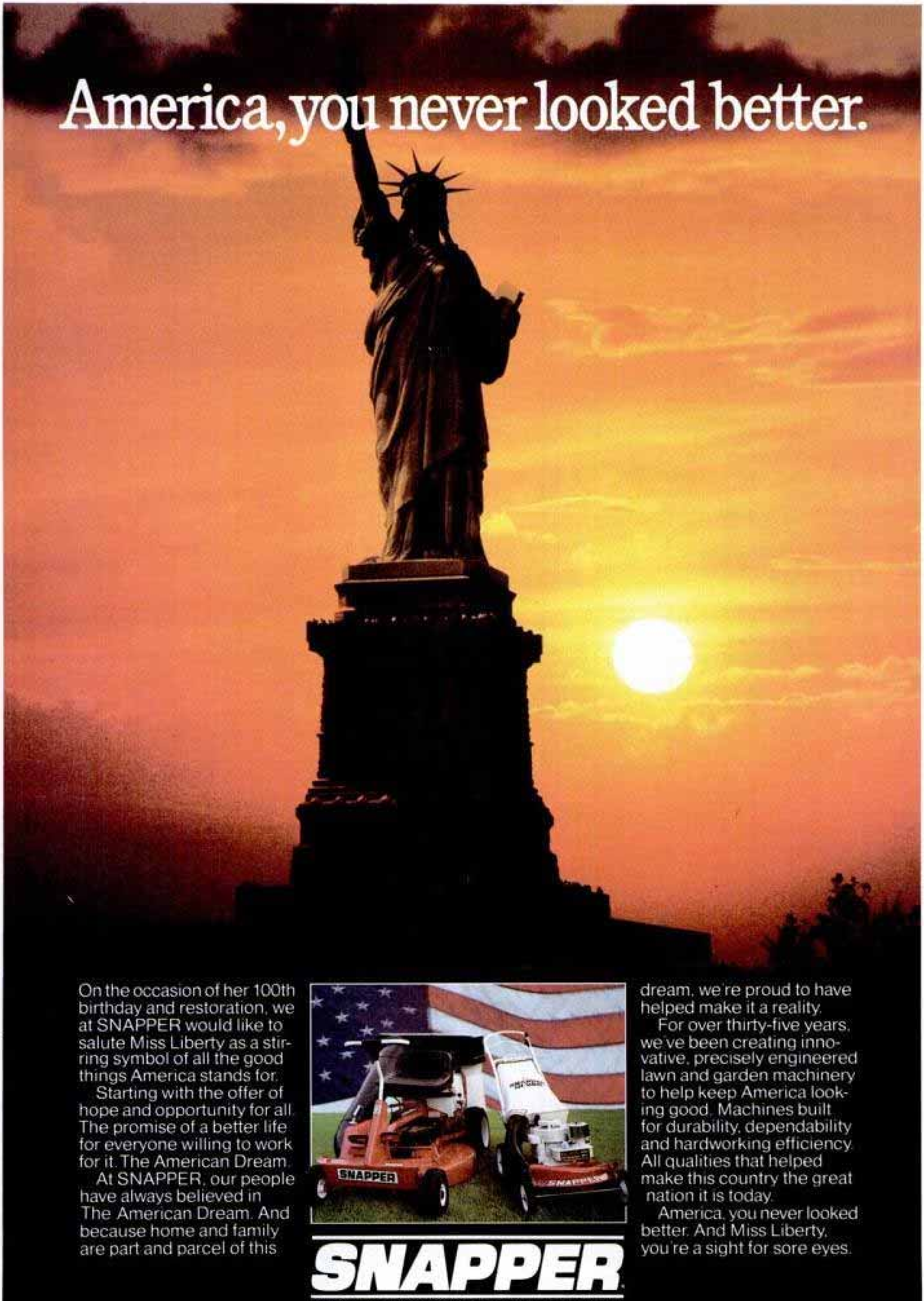




Early tractors (above) were powerful and tireless, but too expensive for most farmers.

Most important farm invention since the plow: mechanical reaper (right), introduced in 1830s. Crude steam engines, like rotating tiller (above), began to replace the horse.

ILLUSTRATIONS FROM THE NEW YORK PUBLIC LIBRARY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placed every 1½ or 2 feet of elevation difference, drain water from the ground and save it there until it is needed for irrigation. Then the devices force it to rise and seek its level. Sometimes Crane decides which fields to drain on the basis of infrared photographs that he takes from rented airplanes. "Infrared," he says, "cuts through the haze real good, gives more control, sharper definition, can spot disease and determine whether something is over- or underwatered."

The "ditch-digging" business has become much more complex than any of its participants let on. In Greeley, Colorado, for instance, USDA ditch diggers have constructed a network of drip-irrigation devices linked to a computer and a series of sensors called "mass-flow porometers." The pinky-sized porometer is so sensitive it can register the opening and closing of the stomata cells in a plant's leaf. When the microscopic cells close, the plant is in need of water. That fact is transmitted to a computer that starts water flowing down the line where the thirsty plant lives. When the stomata cells open again, the water is shut off automatically. Virtually all the water is used up by the plants. Not many drops are lost to vaporization.

A new device that can produce fertilizer on the spot can be expected to be in operation in large dry areas of the country by the end of the decade. Aeronautical engineer Moshe Alamaro's device is mounted on a light truck. As one field is harvested, the remaining parts of the plants are shunted into a tiny furnace whose indirect heat starts a rapid and continuous fermentation process. The result is nitrogen-rich filler that is then pumped with water into a waiting field to make a healthy bed for the next crop. Adjacent fields can be used instantly to fertilize one another.

The purpose of the new technology is to make each farmer's field highly efficient. One might call them food factories in future years.

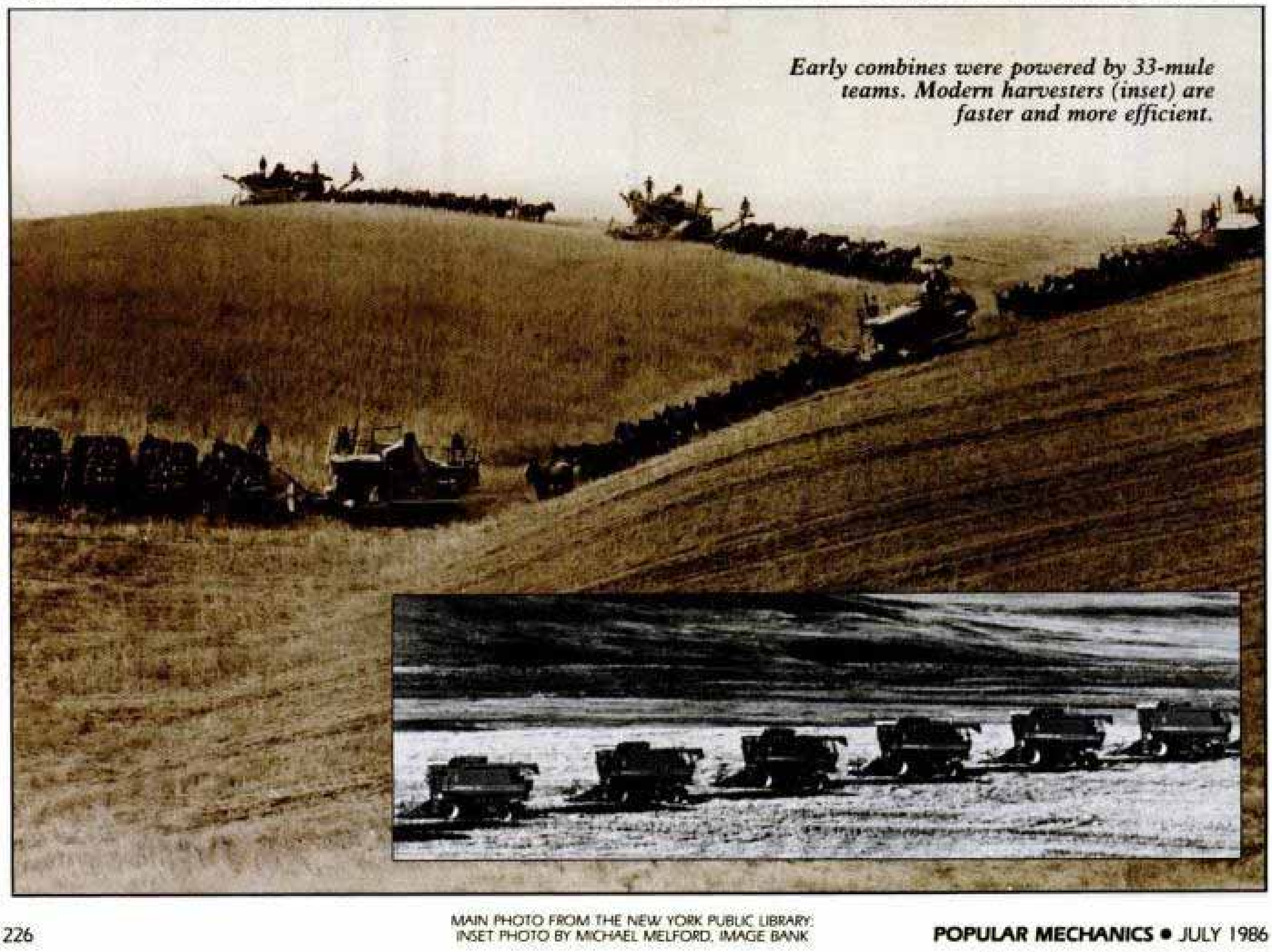
Irri-Drain, as Crane calls his system, uses the same pipes to drain fields when the soil is too wet, as it often is in east-central Illinois, and to irrigate them, from below the surface, when the soil is too dry—as it often is. "We're doing what the weatherman is failing to do," says Crane. "A farmer can have the best seed corn going, but if there isn't enough rain, he's out of luck. Modern machinery, hybrid seeds, insecticides, germicides and the ability to harvest are all very well, but not when you can't control the weather.

"It's a cruel paradox," he says, "when you have wet fields in spring, when every planting delay reduces yield, followed by drought during important stages of plant development, when yield is further reduced by lack of moisture. It's worse when falls are wet, with difficult harvests and yields reduced still further."

With Irri-Drain, a system that costs $600 to $700 per acre to install and is now being used in 26 states, the farmer can adjust precisely the water table he wants with completely buried, remotely controlled and monitored automatic devices. "The system," says Crane, "uses much less water and horsepower than conventional overhead irrigation systems, with no evaporative loss. It allows earlier spring planting dates."

Crane is also nationally recognized for work in another realm. His only advanced diploma is a certificate from the Closed-Loop Earth-Coupled Heat Pump Workshop, conducted by Oklahoma State University in February 1983. Earth-tube air tempering systems, which Crane works on during his off-seasons, bring cool air from the ground in summer and warm air in winter through a system of 15 pipes. Condensing water—accumulating at a rate of as much as 12 gallons an hour—runs into a sump at the bottom of the well.

"It's 10 times more cooling than air-conditioning systems, pumping air up and running a fan, allowing the earth to act as a heat transfer," says Crane. "There's a lot of mass down there. People in the heating and air-conditioning business know absolutely nothing about trenching and geothermal heat underground and vice versa." Earth-tube heat exchangers, he says, are a cost-effective, feasible supplement to ventilation systems. They can replace most or all of the average ventilation heating fuel needed,



Early combines were powered by 33-mule teams. Modern harvesters (inset) are faster and more efficient.

MAIN PHOTO FROM THE NEW YORK PUBLIC LIBRARY; INSET PHOTO BY MICHAEL MELFORD, IMAGE BANK

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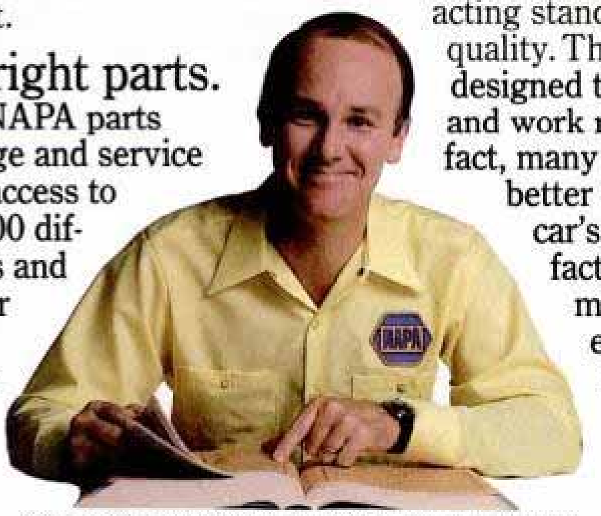

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as well as provide substantial summer cooling for animal housing. These systems relax sows, induce them to nurse better and increase the weaning size of their young. They also are useful for bull semen collection: "When you're collectin' it, you want to make sure they're feelin' good," says Warren Goetsch of the state university's agricultural engineering extension service.

"Bill," says Goetsch, who has worked closely with Crane, "is not a flimflam artist. He's genuinely interested in making a living and making sure his services will enrich the business as well as the personal lives of people he works for." Professor Carroll J.W. Drablos of the agricultural engineering department of the University of Illinois also has strong praise for Crane's work. "We in the university are not always able to jump as fast as we might like, but we feel we have a lot to gain from watchin' Bill real close."

America's rural universities started out as colleges of agriculture and engineering. In the post-World War II years, they added schools and became universities. Two forces have driven the rural schools back into serious farm research: greater competition for the best students and a fresh call for new farm developments.

Since the 1960s, viniculture and viticulture, the sciences of making wine and growing grapes, have blossomed at schools across the nation. At the University of California at Davis, researchers are cranking out new grape-picking machines that destroy fewer grapes than their predecessors while picking at a faster pace. The advantages are many, including a key point: Wine grapes should be picked on the day when they are perfect for making wine. High-speed picking makes better wine and more of it. Similar work at Cornell University has led to the development of specialized harvesting machines that have doubled the New York wine-grape harvest since the end of the war.

More obscure research at these schools has led to new developments in microclimatology, the study of climate changes in small areas, such as the grape-growing valleys of California. Today, scientists using computers can predict minute weather-pattern changes and save entire crops from frost and disease.

University researchers have reached into other areas of science and engineering to produce equipment for the 1980s and 1990s. At Syracuse University, Professor Lawrence P. Feer helped start a veritable tractor revolution two years ago with the introduction of his 1200-pound Grizzly tractor. It has 16 soft rubber tires that help it move over a variety of terrain almost on cat's paws. Again, the result is more crop per acre.

Bill Crane's Irri-Drain draws water from fields when they're too wet and stores it.

PHOTO BY HUMPHREY SUTTON

Arizona State University researchers have used advanced aviation materials to construct an open-air greenhouse for desert farming. The experimental farm station in the Arizona desert is designed to overcome the major temperature shifts of the region and to conserve water. In the daytime, the desert's temperature can rise above 100°, while at nighttime the air gets chilly and sometimes even forms a frost.

With the open-air greenhouse, researchers have been able to work the desert soil, plant legumes, water them and keep in the sun's indirect heat while reflecting away direct heat. At night, when temperatures plunge, the air inside the jet-age plastic canopy stays warm and moist. The development may open thousands of new farming acres in the Southwest in the next decade.

"Have you had supper yet?" a visitor arriving at the Crane household at 5:30 p.m. is asked. The visitor, who hasn't, is at once seated with her host over plates of pot roast, baked potatoes, home-canned beans, apple pie and iced tea. The rest of the family has already eaten. Rita, who canned the beans and who teaches typing and business at the Arthur High School, is off to cheer the Arthur Knights J-V basketball squad, which includes her son Jim. Jim plays the trumpet and may become a draftsman. "There's a lot of him in me," Bill Crane says. "He's my replacement, that's for sure." Jim's sister Susan, a saxophonist who may teach botany, has gone out to earn money babysitting. For Christmas, the Crane kids got a $1500 computer— "a bunch less than the $10,000 we spent on our own first one," their father says. Crane is convinced that today there are two kinds of kids growing up, those who understand computers and those who don't.

Across the room are Compact Discs of Ravel's "Bolero" and Bach organ preludes played by E. Power Biggs. "All my life I've wanted to hear that majestic sound of the Trinity Methodist Church."

Crane doesn't want to take too much credit as an inventor. "A lot of what we do is merely fine-tuning ideas from guys who were truly the leaders, guys who lived a long time ago and gave us such a vast knowledge to draw on. I'm not sure people who had the toughest job weren't the originals with horse, chain and crude surveying equipment in Lincoln's time. And let's not forget—we're amazingly dumb sometimes—that tile for drainage was used before Christ.

"Technology is good," he says, "but it can be a mixed bag. The fanciest tractors with the most gadgets won't be cost-effective unless they're truly needed. Otherwise they're just gadgets, a mockery, a joke." For all the aerial photography he does, making infrared pictures, he has no

wish to possess his own airplane. "Small-business men who do," he says, "in my experience, almost always go under. There are more urgent things to worry about. Getting technology to the marketplace is hard, especially when technology is so much ahead of itself. You have to sell all the time. Sellin', as someone said, is a little like shavin'—if you don't do it every day, you become a little bit of a bum."

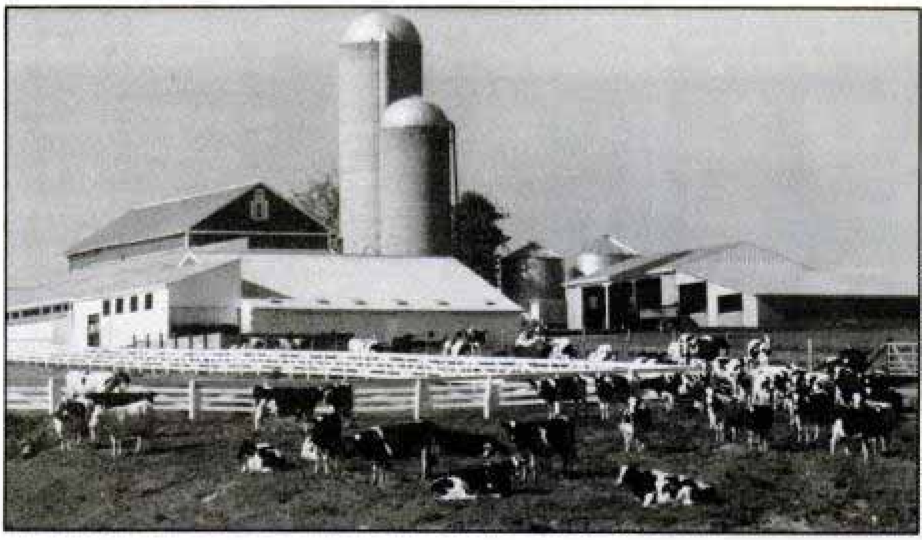


PHOTO BY ALVIS UPITIS, IMAGE BANK

The U.S. farm may look the same, but technology is changing its operation.

THE JOB OF SELLING technology has fallen on the government agencies that fund development, perform research and then field-test the new devices. A new tractor for the megafarm, called The Spanner, is coming within five years. The machine, currently being tested by the Agriculture Department's Research Service, has a 30-foot-wide frame that can till five times the number of rows as the traditional single tractor. Several American manufacturers are toying with the idea of The Spanner, but first they'll have to see it catch on. That job will fall on select agricultural extension services working with farmers to improve productivity.

At West Virginia University, an engineering team recently completed work with the Agriculture Department on an apple picker that has a robot arm capable of grabbing a tree, shaking off the ripe apples, catching them as the picker rolls down the grove and dropping them daintily into a storage bin. The device was first used at the experimental station, then at a handful of extension service locations, and is now on the market.

Until recently, farmers were slow to grasp the meaning of leaps in genetic engineering and the sell fell once again to the USDA. But once the farmers are sold, the technology flies faster than even research bureaucrats can comprehend.

Take the rapidly growing industry of eugenic cattle development. Thanks to the 1970s development of frozen embryos, the beef industry is suddenly finding a new source of profit. Frozen embryo entrepreneurs pay high prices for a bull with a well-documented family line—one that produces fast-growing offspring with excellent beef-bearing characteristics. An embryo from a desired mate can be frozen until the sample of prize-bull semen is purchased from any one of the growing number of banks. The results have been felt in the pockets of cattle ranchers.

In plant genetics, the new buzzword is "tissue culture." Take a tiny cutting from a desirable tree and place it in a gel with the proper balance of nutrients and you have a plantable sprout within weeks. Within a year, the sprout becomes a hearty sapling. Within five years, it is yielding fruit. Farmers have been slow to adopt the tissue culture revolution. But the USDA recently announced its first crop from a grove grown from cuttings started in a single jar. The grove produced 125 pounds of apples five years after the cultures were placed in the gel.

It doesn't take a genius to do the arithmetic. USDA scientists predict entire new fruit-producing farms will begin to emerge within the next five years, some of them becoming highly productive in the mid-1990s on land that is vacant today. When the lumber industry accepts the tissue culture phenomenon, things can be expected to improve in an industry that is hurting at present.

"A man only has 20 or 30 crops in his life," Crane says. "You're only going to harvest so many crops." He would agree with Larry Traubel, whose Granny Smith apples flourish in the desert, irrigated by computer-run overhead sprinklers, that "outdoors is the place to work. I decided that when I was a little guy." He would also agree with Scott Tollefson, whose cotton-growing techniques are admired, and imitated, by visitors from Israel, Haiti and Australia, that "we can't wait for new developments to come down the pike. We have to start now."

FOR AMERICA, NOW IS the time to start in two other areas loosely related to agriculture: hydroponics and mariculture. Hydroponics was resisted by farmers back in the 1970s when the USDA began to make new strides in the development of chemical mixtures that could grow bumper crops in water. It was the wave of the future. Farmers would later run to embrace the technology, which lets them grow crops vertically on small patches of enclosed space. But it didn't catch on like fire until the early part of this decade, when a number of nonfarming entrepreneurs began looking at the possible profits. Today, the USDA counts 900 purely hydroponic farms across the nation.

In mariculture, sea food is grown in artificially constructed environments. In the Bahamas, the U.S. Geological Survey has helped fund an Alaska king crab ranch as a demonstration project. It is built upon an artificial reef where the crabs can be grown under strict control in underwater compartments that keep predators out. The University of California at Davis is working a shrimp ranch on the California coast. There, a perfectly balanced brine filled with nutrients is used to raise a bumper crop of shrimp. It reminds one of Ben Franklin's vision of a trout farm "where a man-made brook can be kept under control for the raising of fish for commercial purposes." Franklin's trout farm was just a dream. Its reality is replayed each year in Washington state and in eastern Connecticut, where man-made salmon hatcheries are replenishing an almost dying population of food fish, making Franklin's dream words to live by. That is fitting in the American farming community, where words to live by are cherished.

In Tollefson's living room, on an end table next to his wife's trampoline, is a Bible. On Traubel's kitchen wall hangs a sampler that says, "Who plants a tree in the sod and waits to see believes in God." On Crane's wall, next to his home photocopy machine, a sampler says, "To a friend's house the way is never far." The unassuming pioneers who choose these unassuming sentiments are proving, by their mastery of technology, that farmers need not be a vanishing breed. PM

Space Age materials and sophisticated design are changing the way we travel the oceans.

The New Man And The Sea

BY WILLIAM F. BUCKLEY JR. AND CHRISTOPHER BUCKLEY

He scheduled a lunch and got quickly to the point, spending only 10 minutes on the maladministration of the economy by Congress, the Fed, the Executive and the Supreme Court. He wanted a sailboat. "I don't mind telling you that what I want isn't exactly conventional. I want the *best*. I want room to move around in. I want to be able to live in that sailboat. And I want to *sail* in that sailboat, not putter around."

William Simon, former treasury secretary, was actually asking for advice. We told him that we had reduced our own ambitions and now owned only a little 36-foot sloop. Never mind. He had read our books and he knew that we liked as much comfort afloat as a true sailing boat can get. "I want that, plus."

We met a few times on the subject and, as inevitably happens any time sailors sit down to talk about a project, what materialized was: a list. This list went on at considerable length. The boat would be—"what would you think of 150 feet? A thoroughly modern vessel, everything in it that one could want for a long, comfortable life at sea and in port."

For the first time the subject of cost came up, and he asked what we thought it would require to maintain such a boat as he had in mind. We asked him, did he know the law of Rusher's Gap? Well, we said, it's easier to explain *a posteriori*—by giving an example.

You want to build a swimming pool and the pool construction agent makes a few calculations and tells you he figures it will cost $10,000. But *you* are a man of the world. You do not get deceived by these seductive improvisations. You know perfectly well it will end up costing $13,000. Rusher's Gap is the difference between $13,000 and what it *actually* ends up costing.

At which point, trying to act like men of the world (though come to think of it, in respect of a knowledge of the expense of maintaining boats, we guess we qualify), we said: "Put it this way: Figure it comes down to about the same as maintaining a Learjet."

PHOTO BY PETER RUNYON, IMAGE BANK

The state of the art in high-powered luxury yachts: Wellcraft's aerodynamic Italia 50.

He liked that. He has a Learjet.

We recommended Sparkman & Stephens as designers, and gave him the name of the finest sailing captain we've ever been at sea with, specifying only that if they liked each other and made a deal, our captain would not be available during the month of June 1985. "We're going to cross the Pacific together."

SOMETIME AFTER MIDNIGHT, A COUPLE of hundred miles southeast of Hawaii, Capt. Allan Jouning, a New Zealander, climbed up on deck of the sailing ketch *Sealestial*. We were adjusting the down haul on the spinnaker boom, the wind was steady at about 15 knots, the sky was brazenly clear. He pulled out a beer from the deck cooler, and we spoke of the new boat being built in Italy, under his supervision, for our new friend. We asked how many crew would be needed to sail the 124-foot beauty (the overall length S & S persuaded our friend was right for the boat he wished), and the astonishing reply to that question tells most eloquently the story of the modernization of sailing craft. Answer: five.

If he had said 15, we would not have been surprised. For years we raced a 40-footer, a crew of eight a near-absolute requirement. Our cruising 60-foot schooner *Cyrano*, obliging charterers, required a crew of four.

The world had changed: Simon's boat would sail with one captain, one engineer, one mate, one hand, one cook. They would take her anywhere in the world, sailing day and night.

"The most automated bugger," the captain classified it, he had ever imagined, let alone laid eyes on. Aluminum hull, two 56-kw. generators, nine sets of 8-volt cells (3700 pounds of batteries for more than 2000 amp-hours), 4500 gallons of fuel (figure 25 gallons an hour for engine plus generators; they'll need charging only four hours per day). You have 200 at 10.5 knots, roughly L.A. to Honolulu. But it's a *sailboat*, which means you don't have to worry, really, about fuel going anywhere, from anywhere.

"Of course," the captain said, "every couple of months we'll need to bring people in at port and do our heavy revarnishing, that kind of thing. There's going to be a lot of wood on her, and you'll need outside help to take care of that." But at sea, just five people. That's all. The engineers will have spent a week or more at each of the firms they're buying

Aquasport's Osprey 196 is the latest in center-console fishing boats.

FACING PAGE: FORMER TREASURY SECRETARY WILLIAM SIMON/PHOTO BY HUMPHREY SUTTON. TOP PHOTO BY WELLCRAFT; BOTTOM PHOTO BY SKIP GANDY the big units from: the engine, the refrigeration, the electronics, the generators. "We'll be pretty much self-sustaining," said Jouning, who has never been known to err about anything, save the date at which his daughter would arrive on Earth (two days after this conversation, three weeks late).

We asked him the following afternoon, when our whole crew was sprawled about the cockpit in the tropical, steady, downwind breeze, enjoying drinks before supper, to tell our friends the amazing details about the boat.

"Tell them about the sails, Allan."

Well, the captain said, put it this way: To get any of the sails to do anything—to go up or come down, to contract in size to exactly the desired area or to expand—all you'll have to do "is press a button." Chris Buckley, sipping a margarita and wearing dark glasses, to mute his insolence, observed, "What's so new about that? Press a button is all Pop ever does to manage the sails on this boat." We are embarrassed to admit that some members of our crew were amused by this.

How, we asked William Langan, the principal designer at Sparkman & Stephens, does he explain the paradox that soon after the time sailboats ceased to be utilitarian, rapid progress was made in their design?

"It has a lot to do," said Langan, who at age 30 presides over a staff of 13 designers, succeeding the legendary Olin Stephens in his title as chief designer, "with the huge change in materials." Both fiberglass and aluminum are lighter than wood. The advent of dacron, as a replacement for heavy cotton, made sailboats far less labor-intensive. And, of course, there was the development of the roller furling gear, which changed sailing forever.

Communications? Our friend considered, but finally rejected, a $40,000 satellite system. This is, as yet, an unsightly colossus sheathed by a huge dome, within which gyroscopic compasses keep their eyes trained on the relevant satellite. True, the results are miraculous: You get to use your telephone as you would the phone in your home.

However, Simon will settle for the conventional Single Side Band, plus, of course, teletypes (great energy consumers, by the way), and around the corner there is GPS (Global Positioning System). Meanwhile, there is SatNav and Loran and radar and (we know because we've sailed the oceans with him) Allan Jouning's sextant.

It does not do today, anymore than during the golden age of J-Boats, to count dollars dismayingly while satisfying the compulsive desire to sail grandly. The miracle is that—always excepting those distempers of ocean that, when they come around, simply move modern technology out of the way and take over—contemporary materials provide what for so long seemed impossible: The combination of 1) a lot of room, 2) stowage for everything you need or want, including a pipe organ and a jacuzzi, 3) propulsion mostly by sail and 4) only five people running a boat longer by 34 feet than the *Mayflower*.

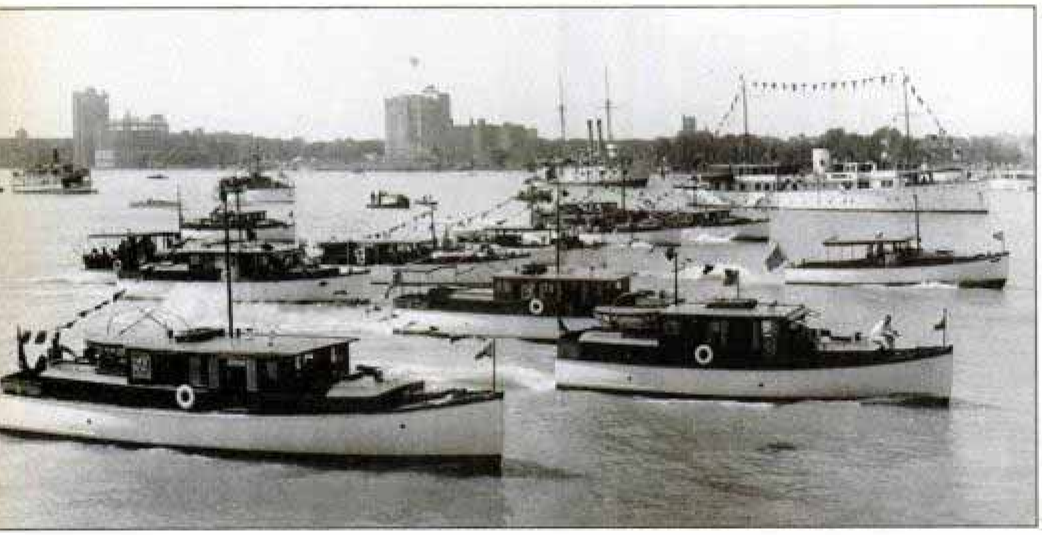
We do not need the word of the National Marine Manufacturers Assn. to confirm the evidence of our eyes, which is that boating is growing as never before. The buying public is—buying.

And it's more than accessories. The industry has come up with new hull designs, new materials and improvement of heavy component parts of boating, like motors.

Package boats are big. They are the easy-go approach to boating. Buy the package and take off. They include, as a rule, the boat, motor, trailer and drive-away accessories. Many packages are less than $10,000, with $9995 seeming to be a magic number.

If you are a sailor in the tomorrow-we-may-die mood, have a look at the new Hatteras 41, a large fiberglass sportsfisherman fabricated from high-tech lightweight materials. Inside the luxury model is a queen-sized master stateroom, a guest room with upper and lower berths, a galley with full-size refrigerator, freezer, range and microwave oven and the latest stealth technology to evade your banker when he comes chasing you in his Mosquito.

If speed, not luxury, is what you want, have a look at the new Cigarette 38; or the Chris-Cat, with speed up to 100 mph. Or the Fountain 12-Meter, with its twin 330



Power in the past: a pleasure boat regatta in 1932 (above). A crew of five kept the sails taut on this 1938 staysail schooner (right).

LEFT PHOTO BY MOTOR BOATING AND SAILING; RIGHT PHOTO BY NEW YORK YACHT CLUB

Wise Buy

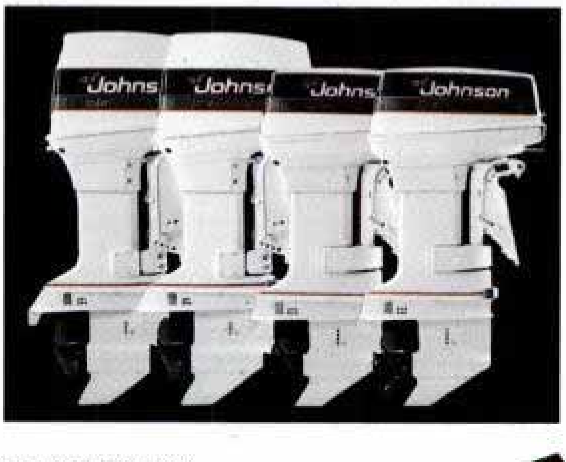
When you match an outboard to your new boat, go value shopping, not bargain hunting.

Your outboard is an important part of your boating investment, so be sure you get the best value.

That means getting an outboard that's technically advanced, like a Johnson®, to give you more important features now, better resale down the line.

And it means not settling for anything less than an outboard that performs like a Johnson. Fast. Strong. Smooth.

The outboard you choose should have a simple and precise oil-injection system, a rugged single-piece crankshaft you can count on, and full corrosion protection. Like a Johnson.



And value means an outboard with a reputation for dependability, one that's backed by a nationwide network of servicing dealers with parts in stock when you need them. Like — you guessed it — Johnson.

Truth is, you're going to find that no other outboard comes close to measuring up to Johnson value. And that's why, throughout the world, more boaters run Johnson outboards than any other brand.

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Ask about the optional OMC 1 + 2™ Extended Protection Plan available from your Johnson dealer. For the name of your nearest Johnson dealer call 1-800-255-2550.

Johnson
Number one in the world

Retractable hydrofoils speed this powerboat of the future (above). Pool and helipad are optional.

Sailboats (left) will have self-steering and computer-adjusted wing masts of carbon fiber.

engines. Look, and lust.

Even if you're not among the family members of "Dynasty" and can't see yourself spending so much on a plaything such as a boat, remember that you can have fun at sea on a dinghy, an inflatable and even a canoe.

But the seas and lakes and inland waterways of America are not just for pleasure, although of all the uses we make of them, pleasure is surely the greatest.

Commerce, however, is what makes our country run, and commerce has been responsible for so much of its growth since the aforementioned *Mayflower* crew threw the anchor overboard at Plymouth Rock.

"Technology," the critic John Leonard once wrote, "is the enemy of grace." Nowhere is that statement more lugubriously true than in America's most graceful field of endeavor—the merchant ship.

WE ARE NOT ANcient mariners. But when Chris Buckley first went to sea, as an 18-year-old deckboy, ships still looked like ships. Container ships were still in their adolescence then, the Ultra Large and Very Large Crude Carriers (tankers) were in their infancy and our beloved dry cargo freighter was entering old age. She was only about 15 years old but, generically speaking, her days were already numbered. We knew it was only a matter of time before her owners sold her to the Greeks.

She took us around the world in just under four months—to Hong Kong, Manila, Singapore, Bangkok, India, Ceylon. Her holds were filled with cinnamon, tea, tin, coconut shell charcoal, sparkling wine, liquid latex, machine guns, apples. There were helicopter blades, frozen lobster tails, shrimp, raisins, a limousine, a truck, color TVs, toy models, bags of penicillin, several thousand paperback copies of the works of Guy de Maupassant.

There were only five or six containers aboard, and we resented them fiercely. They were impersonal. You couldn't tell what was inside them. We were glad to see them go. It was remarkable, on the other hand, how quickly they could be offloaded, put on waiting flatbed trailer trucks and driven off. Good riddance. We could use that space for *real* cargoes.

Sixteen years later, we are in Savannah, Georgia, a long way, in every sense, from that Far Eastern winter of 1970. Savannah has its charming parts, but the container port at the Georgia State Docks is not among them. It smells of sulfur and looks like a parking lot for 7000 or 8000 containers, those 40-foot-long rectilinear things you try to avoid on our nation's highways. It is late in the afternoon, and the M/V *American California* is making her lines fast to the quay.

From a distance you would be forgiven for not recognizing her as a ship. The containers are stacked five high on her decks. There are about 1000 of them on deck, another 1200 or so below. She and her 11 sister ships can carry more containers than any other vessels afloat.

Did we say *she?* Okay, a ship is a ship is a ship, and no matter how ugly she is, she at least deserves the traditional female pronoun. She is, in fact, an *econoship*. The designation is apt. Nothing wasted here, not even two letters of the alphabet. As Bob Cutler, Savannah marine manager for United States Lines, the company that built and owns her, describes this state-of-the-art vessel: "They were built as large as possible, to carry as much as possible, with as little crew as possible, with the most efficient engine possible, so as to make as much money as possible."

We start up the gangplank, and after 50

PM ILLUSTRATIONS BY M. BLASER

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MAXIMUM PROTECTION: Against friction, corrosion, excess engine wear. Maximum performance—for maximum confidence.

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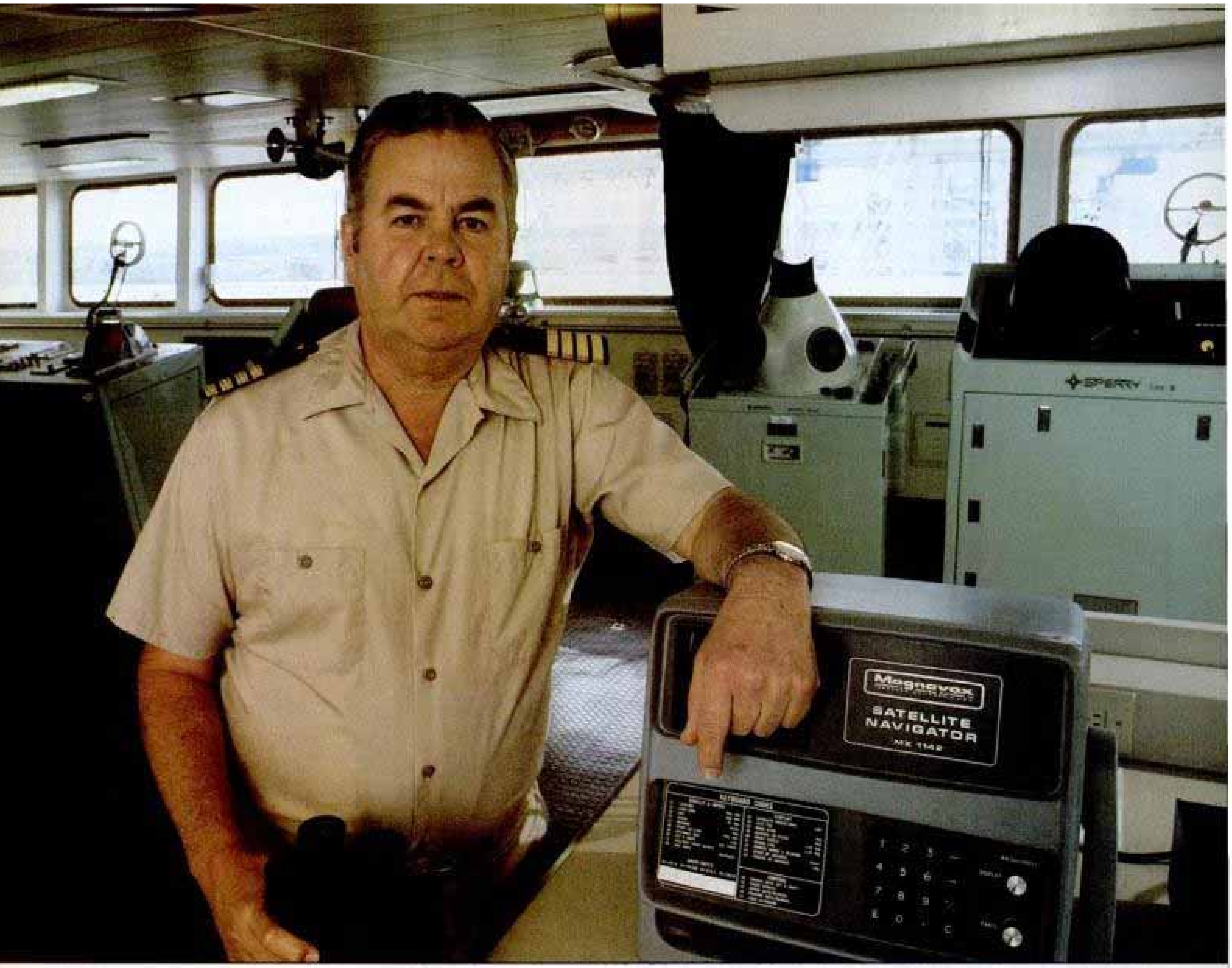


Capt. Ed Newman on the bridge of the* American California. *The instrument under his arm allows him to pinpoint the position of his ship anywhere on the globe.

steps or so realize we are now a good distance off the dock. On our first ship, you could practically leap overboard if you really had to. Then it's into the elevator—*elevator?*—for the 6-level ride up to the bridge. Having reached the bridge, we walk outside and peer out over the acres and acres of containers, look straight down and are hit with a momentary dose of acrophobia. We are now 10 stories over the water.

THIS IS A BIG BABY, ALL RIGHT, 950 FEET long, 106 feet wide. The latter is "Panamax," meaning that if she were any wider she'd need to be greased with Vaseline to get her through the Panama Canal, a prospect no one would relish, given how much of her there is.

For those who spend many an hour in small sailboats trying to keep from being run over by such as the *American California*, there is datum. From where we are standing, we cannot see anything less than 1000 feet in front of her bow. Apropos of this, the captain joked to his third mate, "We just watch 'em disappear on one side and hope they come out on the other." We give a little shudder. It would take 8 minutes and 50 seconds for

Containers cover the deck of the 950-foot ship (above). They're even stowed behind the main house (left).

PHOTOS BY HUMPHREY SUTTON

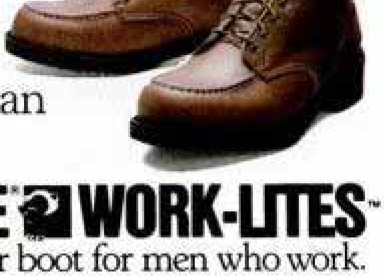
It's guys like you who built this country.

Every morning you're up at dawn. You put your boots on, and haul yourself to the job site.

Inch by inch the building goes up. And our country grows stronger because of it.

For over 100 years, we've been making work boots for guys like you. Our Work-Lites are strong enough to take the toughest work, yet light enough to be comfortable on your feet. No matter how many hours you put in.

If you don't own a pair of Work-Lite boots, all we can say is this. Why make this job any tougher on yourself than it has to be?



WOLVERINE® WORK-LITES™

A lighter, tougher boot for men who work.

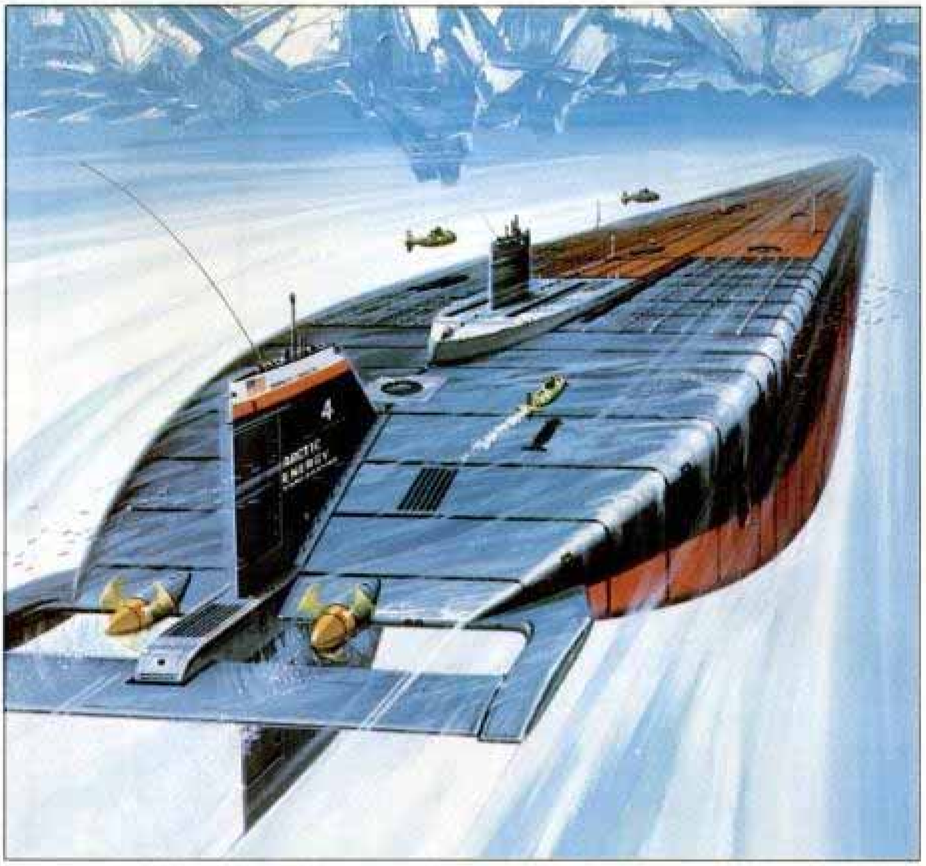
the *California*, fully loaded, to come to a full stop—3575.7 meters from the point where her engine were reversed. By then, we and our sailboat could be a fiberglass purée about 2 miles astern.

By now, it is a given that enormous ships carry tiny crews. There are 21 men aboard. That means a lot of overtime for the crew, most of whom work 14- to 16-hour days. The chief mate has to stand watch—on top of all his other duties. He is looking pretty bedraggled, having lost 20 pounds on this last trip.

Economy is also the enemy of grace. The smokestack is aluminum. To make it out of rolled steel would have cost more. No one could say exactly how much that saved. She was built in South Korea in eight months at a cost of $47.5 million, and we would guess less than $10 of that was spent on aesthetics. You want art? Go to a museum.

Ashore, we had been told with a wry smile that about the only thing American aboard the *American California* was the flag. Not quite true, as it turned out. Her engine is a 28,000-hp, slow-speed diesel Sulzer, built in South Korea under Swiss license.

The *American California* had steamed out of Savannah on Nov. 15. Then, around the world in 83 days, with stops at New York City; Rotterdam, Netherlands; Fos, France; Suez, Egypt; Jeddah, Saudi Arabia; Khorfallan, United Arab Emirates; Singapore; Hong Kong; Kaohsiung, Taiwan; Kobe and Yokohama, Japan; and Long Beach, California.



Nuclear-powered submarine tanker (above) would ship oil from Alaska year-round.

Future superships will hold 2000 containers and 600 autos.

Special ship is designed to carry only cars and trucks.

None of these stops took longer than 36 hours. "When these ships get in," said Jim Gillen, U.S. Lines' port engineer, "it's like a pit crew swarming around a racing car." That's one reason so many of the old sailor towns—the Motomachi district in Kobe, Baltimore's East Baltimore Street, Boston's Scully Square—have died out. Most of the great old seamen's haunts have been turned into hat boutiques, designer ice cream parlors and bars. *O tempora, o mores* . . . . Container ports, because they need so much space, tend to be a $50 cab ride from town.

THE ONE PART OF THE ship that did bristle with good old made-in-the-U.S.A. stuff was the bridge. We were agog. We might as well have been aboard the starship *Enterprise*, it seemed so sophisticated. The array included a:

- Computerized, dot-matrix Bell Logger, which records every instruction to the engine room (Siemens—West German);
- Raytheon D999 fathometer (U.S.);
- Sperry SRD-301 Doppler Speed Log (U.S.);
- Magnavox MX 1142 Satellite Navigation system (U.S.);
- Decca Radio Ranging system (British);
- Northstar Loran 7000 (U.S.).

One company was the hands-down winner. The gyro compass, repeater, Seathru radar, Collision Avoidance System and steering column were all made by Sperry. The CAS II, which identifies radar "targets" and plots them, emitting a sound alarm when a target comes within a certain distance, was perched atop an enormous console. Asked why it was so large, the radio operator, Barry Hamilton of Nantucket, Massachusetts, grinned: "So you can crawl inside and hide if you've got trouble."

The steering column, a Sperry SRP 2000, is an intriguing piece of high tech. A video screen tells the helmsman everything he could possibly want to know, and more—speed, heading, rudder angle, rate of turn, shaft speed, slip ratio, fuel flow, fuel usage, to name a few. The helm is generally only on manual while entering

TOP ILLUSTRATION BY ED VALIGURSKY. LEFT ILLUSTRATION BY ATLANTIC CONTAINER LINES. RIGHT PHOTO BY HYUNDAI

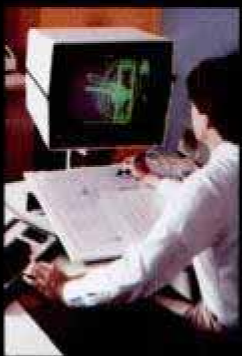
EVINRUDE

OUR TECHNOLOGY KEEPS US FIRST

BORN IN THE USA.

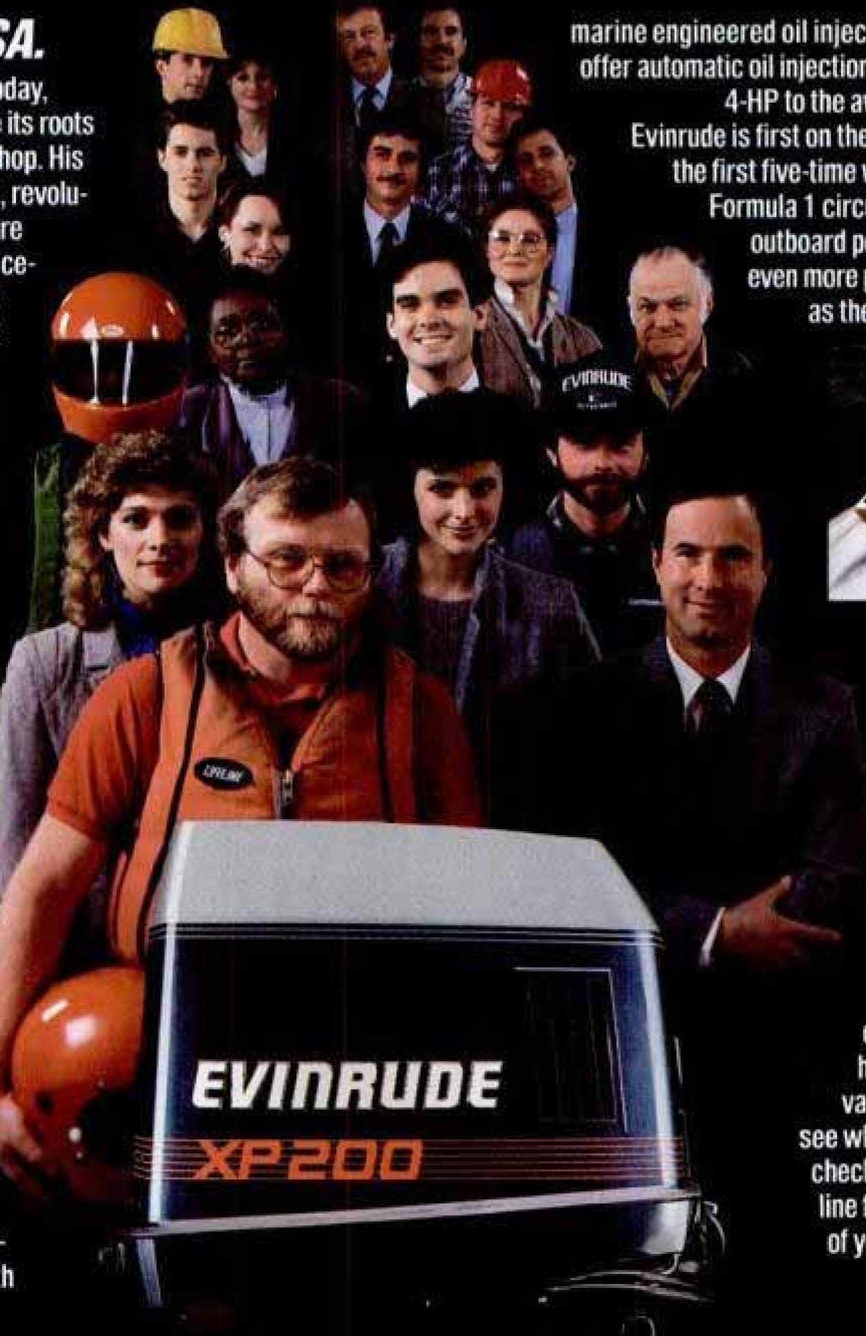
Every brand of outboard today, domestic or foreign, can trace its roots back to Ole Evinrude's workshop. His 1909 design, the world's first, revolutionized boating. But even more important, every major advancement in outboard technology since then has also borne the Evinrude name.

We not only invented outboarding, we also introduced



the first electric, remote steering and aluminum block outboards. And we led the pack with the first V-block design, including the first V-4, V-6 and V-8 outboards.

Evinrude invented counter-rotating props for outboards. Then we topped that with the first automotive-type power steering system. We were first with



marine engineered oil injection, too. And now we offer automatic oil injection on all outboards from 4-HP to the awesome 3.6 XP™ V-8. Evinrude is first on the race circuit, too, with the first five-time world champion on the Formula 1 circuit, the ultimate test of outboard performance. But we're even more proud of our reputation as the world's most durable

outboard. It's the kind of exceptional durability that makes the optional 1+2™ Extended Protection Plan the best protection plan in the industry. High technology. Performance. Durability. Three reasons why Evinrude® outboards traditionally have the highest resale value of any brand. You'll see what we mean when you check out the new Evinrude line for 1986. For the name of your nearest dealer call **1-800-255-2550.**

Expanding the limits of outboard performance.

EVINRUDE

A PRODUCT GROUP OF OMC OUTBOARD MARINE CORPORATION or leaving port. The steering column is integrated with the SatNav, which automatically guides the ship from one "waypoint," or preprogrammed coordinate, to another.

All pretty heady to a former deckboy who used to steer by a liquid compass. We did see one familiar sight: two chrome-plated voice tubes (*Phoooo-wheeet!* "This is the bridge. Gimme more steam, dammit!") alongside the steering column. They seemed to be the only nostalgic touch aboard the whole ship. The captain said they were never used, and we understood why. Anyone over 5-foot-5 would have to crouch to blow them. There is something ironic about a gigantic ship being built by short people.

And gigantic seems to be the watchword for the maritime future. Gigantic transports and tankers will get larger yet. It's the econoship syndrome at work again. More payload per trip means more cost efficiency.

In addition to gigantic, the trend will be to specialization. Already, we see this developing as large transports are designed to handle dedicated payloads or to accomplish very specialized tasks.

POSSIBLY THE MOST FAScinating proposal for a dedicated maritime vessel is a design for a huge tanker submarine that would operate below the ocean surface and even be able to go under the polar ice cap.

Imagine a submarine with a hull 90 feet deep, and 140 feet wide for most of its length, which is, maybe, a little more than a quarter of a mile. Fill it with enough natural gas, compressed into a liquid for cryogenic storage at temperatures below −260°F, to incinerate a medium-sized city in one instantaneous fireball. Like it so far? Then put in a methane-fired boiler, or even a nuclear reactor, to charge a turbine with enough superheated steam to drive two massive screws. Now, navigate the whole thing from Alaska to eastern Canada or Europe under the polar ice cap.

It's perhaps the most fascinating concept advanced as a solution to the major problem of the Alaskan North Slope: not how to produce oil or natural gas, but how to move the vast amounts already discovered to world markets.

Washington's favored solution, however, takes the form of a proposed 4800-mile pipeline branching off in Canada to terminuses in Chicago and San Francisco. It would be the largest private construction project ever undertaken, at an astronomical cost of $43 billion.

By comparison, General Dynamics calls for a fleet of 17 submarine tankers, each costing about $700 million to produce, plus another $3 billion to $4 billion in shore facilities. Reactor-powered versions of the sub—the "nuke option"—would cost an additional $25 million apiece to build.

Besides costing almost $30 billion less than the projected pipeline, and being much preferred from an environmental standpoint, the submarine tanker offers the flexibility to react to marketing, which, in terms of petroleum, usually means political conditions.

Liquid natural gas handling, of course, involves more critical systems than does transportation of heavier petroleum products. The LNG sub would have six 340-foot-long cylindrical cargo tanks. Inside the steel pressure hull of each would be a layer of insulation identical to that lining the spherical tanks of LNG ships now operating: mechanically attached isocyanurate (foam) panels. This system has a designed boil-off rate of about 0.2 percent per day. An air-filled space between the insulation and the pressure hull would allow for inspection and repair access. The tank material inside the insulation would be nickel steel, built to withstand the extra pressure should malfunction prevent venting of boil-off gas.

A main variable-ballast tank running down the center of the submarine would provide the necessary seawater ballast for submerged running with or without cargo (LNG tanks cannot be contaminated while deadheading). General Dynamics believes the general undersea operating routine would involve nothing outside the realm of current military submarine operations. A heavy array of electronic and sonar sensing instruments, however, would be necessary for detection of undersea obstacles.

ARCTIC SEA ICE-PRESSURE ridges extend more deeply below the surface—as much as 150 feet—than they do above it, and would provide a primary navigational hazard. The tanker is designed to operate at a maximum depth of 600 feet. The pressure hulls would have a collapse depth of 1000 feet. Normal cruise would probably be at about 300 feet, depending on available depth and presence of surface obstacles. It wouldn't pay to run deeper, since a midwater layer, extending from about 600 feet down to 3000 feet in Arctic oceans, is actually warmer by several degrees than the 29°F surface layer, and this would only work against the cryogenic cargo insulation. Sudden or massive release of LNG into the much-warmer seawater might result in a spontaneous explosion—nobody is exactly sure.

The nuclear-powered version of the tanker, while speedier and more economical to operate, would require some backup source of propulsion in the event the reactor had to be shut down for emergency reasons while the ship was submerged under ice.

General Dynamics engineers believe a storage-battery system could suffice, although an auxiliary diesel engine, fueled by LNG and liquid oxygen, might be preferable.

It is estimated that a seabed cargo-transfer facility would give individual tankers no more than a 24-hour turnaround time in Prudhoe Bay. The proposed fleet (17 non-nuclear or 14 reactor-powered) would have a cargo-lift capability of 2 billion cubic feet of natural gas per day—every day.

IT WAS DARK NOW, AND the stevedore gangs had arrived to begin the offloading. It would take four gangs of 28 men about 24 hours to do the job. That may sound fast, but apparently it isn't. Charley Rhodes, the *California*'s 33-year-old chief mate, shook his head.

"This is bush league compared with Rotterdam," he said, where a total of six longshoremen unload the boxes at the rate of 40 an hour. Here they do 25 to 30—"if they're good."

Even so, it would take five noncontainerized freighters, each manned with five gangs, to offload and load as much cargo as these four gangs can on the *California* in the same amount of time.

Not surprisingly, containerships have changed the way of life for longshoremen as much as they have for seamen. Fifteen years ago, there were about 20,000 in this country. Now there are fewer than 10,000.

Of course, what makes it possible to offload and load the *California* with 600-odd containers is not the men. It is the machines. Four enormous cranes roll up alongside the ship. At night, with the cranes' bright arc-lights blazing, it is a tableau straight out of *War Of The Worlds*. These German container cranes are immense machines, dwarfing even the *California*'s superstructure.

A little over 24 hours after she pulled in, the *California* is back out to sea, being guided by satellites to the same ports from which she had come.

"One most perilous and long voyage ended," wrote Melville in *Redburn*, "so begins a second. And a second ended, only begins a third, and so on, for ever and for aye. Such is the endlessness, yea, the intolerableness of all earthly effort."

As the pilot boat pulled away and we watched her fade into the night, we noticed a wonderful thing. The containers that were stacked high on her deck had disappeared, and she looked, for the first time since we met her, like a ship, dignified, regal, even, yes, beautiful. **PM**


PHOTO BY V.G. SILK

Memories of a bygone era: Sailors adjust the rigging of the USS* Gloria *during the Bicentennial celebration.

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The desire for fun and the search for profit make America's way of play a billion-dollar business.

The Pursuit Of Happiness

BY JEFF GREENFIELD

"Americans," Mark Twain wrote in *Letters From The Earth,* "work harder at having a good time than at any other single endeavor."

If Twain ever came back to Earth for a visit on a sunny Sunday in Orlando, Florida, he might be forgiven for congratulating himself on his insight. The restaurants of Walt Disney World's Contemporary Resort Hotel are filled with families urging each other on toward a swift conclusion of the meal, the faster to jump aboard the Monorail, the faster to enter the Magic Kingdom, the faster to beat the crowds to major attractions such as Space Mountain and 20,000 Leagues Under The Sea.

Grown-ups—the fathers, generally—guide their platoons down Main Street, maps and guidebooks in hand, cameras at the ready for an appearance—live and in person—by Goofy, Pluto, Captain Hook and, first among equals, Mickey Mouse himself. The battle to place one's child in the friendly arms of a walking, breathing Disney creation would do credit to a Stanley Cup hockey final.

By the end of the day—as the crowds stream out of the Magic Kingdom for a Monorail ride back to a hotel or automobile, as the exhausted grown-ups sling their sons and daughters over their shoulders—a stranger might well wonder whether "leisure" is the right word to describe so frenetic an activity.

Yet, in a larger sense, "leisure" doesn't begin to describe the inventiveness, the energy and the remarkable economic power that an America increasingly obsessed with its after-hours life has injected into the business of play. In our time, "the pursuit of happiness" is not simply a line from the Declaration of Independence. It is an element of our society that is transforming where and how we live.

You can, if you choose, prove this fact with numbers: We spend some $200 billion a year rooting for the Mets,

THE PYTHON, BUSCH GARDENS, TAMPA, FLORIDA/PHOTO BY SKIP GANDY cheering on Rambo, weeping at *Carmen*, hiking through the Appalachians, motoring through the Rockies, finding the right tennis shoe, and otherwise diverting ourselves from the pressures of work, school and family. But America is a rich country; a $4 trillion-a-year gross national product leaves lots of room for diversions.

You can measure our love of play by other numbers: 50 million of us pay to watch professional baseball; 30 million cheer on the football teams of pro and college ranks; 60 million root home the horses every year; and a similar number thrill to the smell of burning rubber and exhaust at the auto races.

Other cultures, however, pack arenas for cricket, rugby and soccer, and for all the pop psychology about the uniquely American obsession with sports, no stateside passion can match the specter of a European soccer game turning into a fatal riot.

No, there is something else that marks the American way of play, and that is the astonishing interaction of the search for fun, the search for profits and the American capacity to invent new goods—and new ways of life—in pursuit of escape.

Cinderella's Castle towers over Walt Disney World in Orlando, Florida, where millions of people visit every year.

Houston's summer heat and rain are never a factor at the Astrodome, the first of a growing number of domed stadiums.

A TRIP TO THE LAKE OR MOUNTAINS, for example, hardly evokes visions of high technology. But high tech has had a marked impact on the outdoors. With 20 million Americans setting out each year to hike, fish, scuba dive and explore, it's not surprising that businesses of all sorts have taken aim squarely at the market.

For instance, one in every 10 U.S. auto sales represents a recreational vehicle. Automakers are not exactly inattentive to this fact. That's why Honda has come out with a 4x4 Fourtrax, an off-road All-Terrain Vehicle powered by a 350-cc engine and equipped with a 5-speed transmission, including reverse.

Or take the appeal of water. New materials have made possible sturdy, water-resistant, incredibly lightweight boats that can easily be tied to the roof of a car for a quick drive to the nearest lake. The Hobie 17, a 1-handed una-rig catamaran made of Mylar, sells for under $4000: That's probably less than the cost of lumber. If you can pay more—say, about $10,000—you can buy into a new class of bass boats capable of 80 mph, or buy a center-console power boat.

Even the simple fishing rod, once the symbol of a pre-technological Norman Rockwell America, has been revolutionized by the urge to turn someone's leisure into profit. Rods made of graphite and Kevlar have brought down prices, while giving a fisherman a far better "signal" from lure to rod blank. Rod grips have electric hand warmers, and reels feature programmable electronics. Daiwa produces a microcomputerized bait-casting reel, for example, that gives the sportsman an instantaneous reading of his retrieval speed on an LCD display, thus permitting him to duplicate his cast once he hits pay dirt.

These are small-scale examples of entrepreneurial dedication in the service of recreation. On a grander scale are the revolutions wrought by those determined to bring big-time spectator sports to their regions.

In 1953, the Boston Braves broke a half-century tradition by moving their major-league baseball fran-

TOP PHOTO BY WILLIAM ALBERT ALLARD, IMAGE BANK; BOTTOM PHOTO BY GULF

PHOTO BY TOM LIPPERT

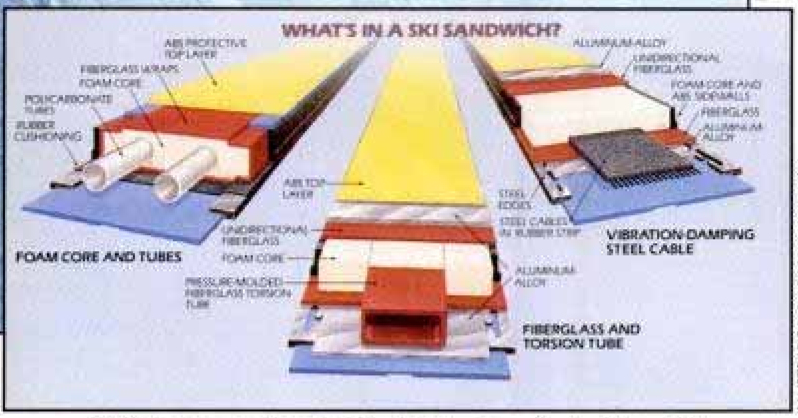


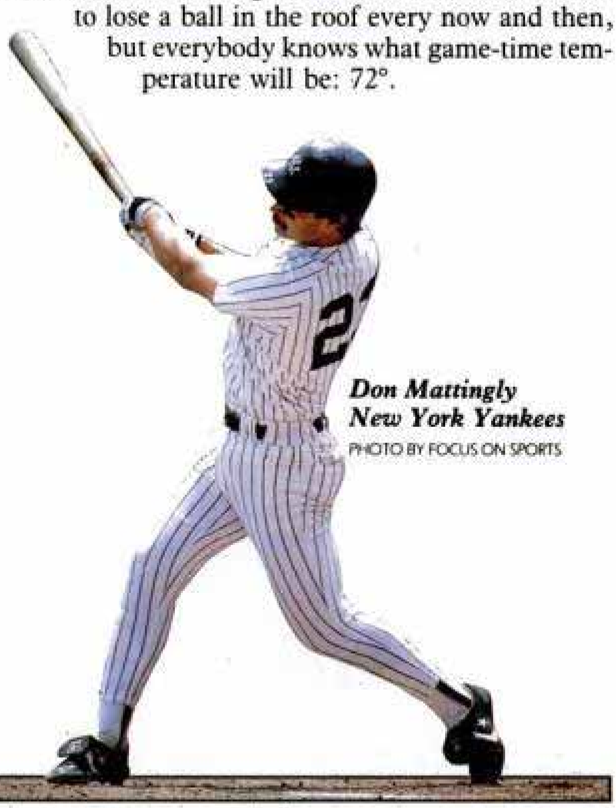
ILLUSTRATION BY GEORGE RETSECK

Skiing's increasing popularity has been fueled by rapid advances in the safety and durability of the equipment.

chise to Milwaukee. Five years later, the Brooklyn Dodgers and New York Giants broke the hearts of millions of Gothamites and moved to California—a move that, to many, symbolized the westward shift of power in post-war America.

In Houston, where oil was king and men liked to dream big, Judge Roy Hofheinz and his colleagues dreamed of major-league baseball for Texas. The population was there, and money was no problem. The weather, however, with its searing heat and enervating humidity, made the idea ludicrous—until Hofheinz decided to take a lesson from another aphorism of Mark Twain.

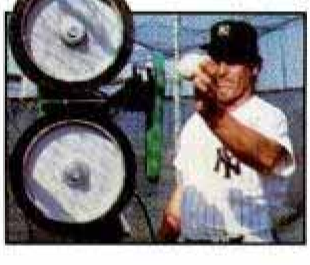
"Everybody talks about the weather, but nobody does anything about it," Twain once quipped. Hofheinz decided to do something about it. Twenty years ago, he built the Houston Astrodome—an indoor, air-conditioned baseball stadium where the Houston Astros have played ever since. Visiting outfielders have been known to lose a ball in the roof every now and then, but everybody knows what game-time temperature will be: 72°.

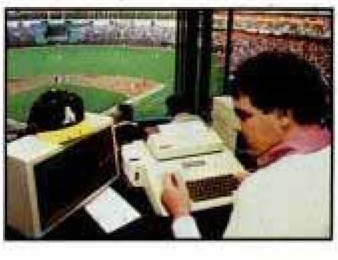


Don Mattingly New York Yankees

PHOTO BY FOCUS ON SPORTS

Mechanical arms fill in for human ones when the demands of hitters temporarily exceed the supply of pitchers. Baseball has also entered the computer age, with a number of teams now using their own computer systems.





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That gave ideas to other cities climatologically unsuited for baseball. Now the Seattle Mariners and the Minnesota Twins play the summer game indoors. Meanwhile, from New Orleans to Pontiac, Michigan, pro football has found itself protected indoors from the ravages of winter, and New York City may well find itself with a domed stadium before the decade is out. Why? Because sports fans have to eat, drink, park and find a place to lodge themselves when they come into town for a big game. Conservative estimates indicate a major-league franchise can add tens of millions of dollars to a local economy every season.

IF YOU NEED THE ULTIMATE PROOF OF how leisure can literally change the map, go back to where we began: to the harried parents and supercharged children at Disney World. What Mickey and Friends have wrought in central Florida is nothing short of incredible.

Fifteen years ago, Orlando was a town that few outsiders paid much attention to. It was a largely agricultural community of orange groves, pine forests, cattle farms and swamps. Barely one in 20 visitors to Florida ever made his way from Miami, the Keys and the Everglades to visit the region.

Then Walt Disney bought 27,500 acres of land 20 miles southwest of Orlando for a total of $5.5 million. Fifteen years ago, the Magic Kingdom opened.

It was Disney's dream to surround the Magic Kingdom with a kind of technological utopia: a carefully planned community that would avoid the ravages of urban sprawl, pollution and unguided growth. Instead, in a typically American fashion, the forces of free enterprise produced an unplanned, unguided explosion whose magnitude we are only now beginning to gauge.

Today, 15 million tourists visit Disney World each year, and 10 million more visit Epcot, the scientifically oriented theme park a few miles away. That crush of tourists had to stay somewhere, so a hotel-building boom began. The Orlando community has more than 55,000 hotel rooms available or under construction, making it the sixth-biggest hotel city in America.

That, however, is only the first link in the chain. Disney World brought a world-class airport to Orlando, one that last year served more than 10 million visitors. That, in turn, made the community the center of a major transportation hub, which in turn made it more attractive to business. Further, all those tourists included people who found the relatively cheap land and pleasant climate of central Florida an attractive place to relocate, for work or for retirement.

Such major employers as AT&T, General Electric and Westinghouse put new high-tech businesses in the

It's still football, but the New York Jets' Joe Klecko gets ready for the game by donning modern, lightweight gear that's far removed from his predecessors' leather helmets.

Super Bowl Sunday is the holiest of holy days for the pro football fan. This year's game between Chicago and New England drew a sellout crowd and record television ratings.

TOP PHOTO BY BILL ASHE; BOTTOM PHOTO BY FOCUS ON SPORTS

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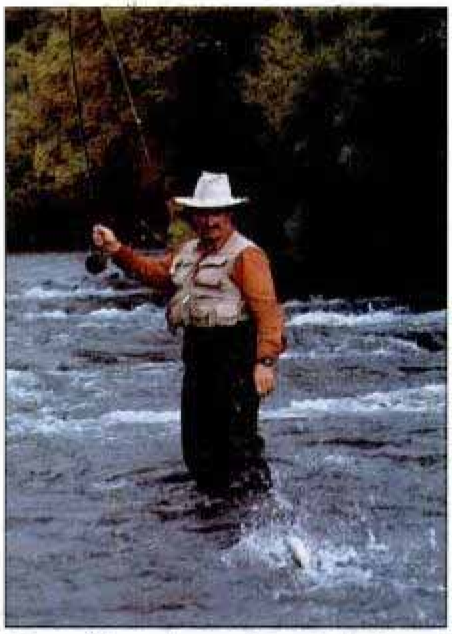
Orlando area, including AT&T's $400 million integrated-circuit plant. Longtime New York book publisher Harcourt Brace Jovanovich relocated to the Orlando area—and found itself saving $15 million in costs in its first year there.

All this growth, in turn, made downtown Orlando a natural environment for a boom. It attracted the attention of William du Pont III, great-grandson of the chemical magnate, who has put together a $450 million development on a 14-acre site. It will feature a hotel complex, an office tower and retail shops. Sun Bank has a $150 million development. All told, there is more than $1 billion in construction under way in the city, and across central Florida the total of new construction is an incredible $17 billion. Once-sleepy Orlando is now the fastest-growing community in the state of Florida.

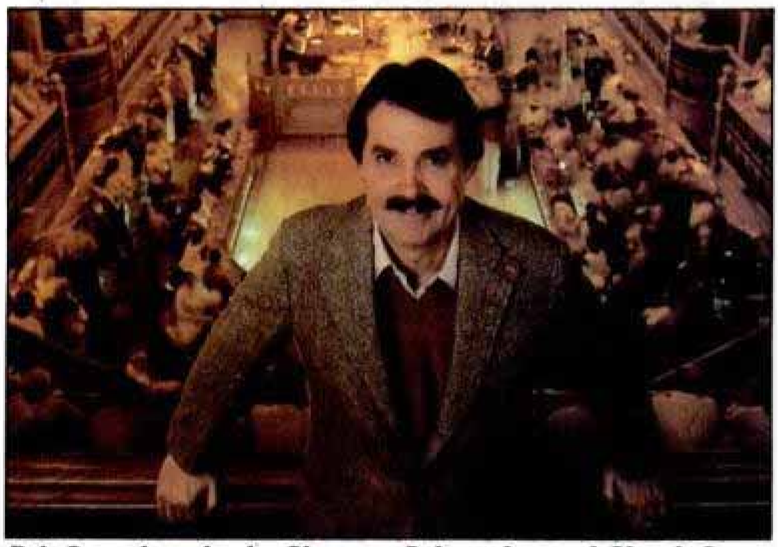
To get some sense of how a Mickey Mouse operation—literally—could influence so much, I recently drove from Disney World along Interstate 75 to Orlando. Every inch of scenery along the way was crowded with signs of development, and with billboards advertising other attractions that had found Disney World an incredible magnet for business.

Here was a new Marriott Hotel, with 1500 rooms; there, a Hyatt, a Wyndham, a Knights Inn, a Quality Inn, a Ramada, a Super 8, a Days Inn. Here were the calls to Sea World, Circus World, Gatorland Zoo, Wet 'n Wild, Cypress Gardens, Emerald World and Gold Museum, Malibu Grand Prix/Malibu Castle, Flea World, Seminole Greyhound Park, Kennedy Space Center's Spaceport USA, Busch Gardens, Xanadu.

Coming into downtown Orlando, I saw a skyline that did not exist a decade ago: modern glass and steel towers with the insignias of the new economic giants of the region. Names like Sun Bank, Atlantic Bank, Coral Gables Federal, CNA. Along Pine Street is the spanking-new Orange County Administration Building, erected with tourist dollars that have come to Orlando in the time since Disney World.



Even with modern equipment, in the end it's still a contest of man vs. fish.



Bob Snow brought the Cheyenne Saloon, heart of Church Street Station, to downtown Orlando.

Yet perhaps the most striking development of all was the remarkable center of nightlife in downtown Orlando—Church Street Station. The man who made the dream come true is Bob Snow.

Imagine a city block with nothing but restaurants, saloons, a shopping arcade and a restored railroad station. An ironwork bridge spans the street. There are no cars, just an antique fire engine and a horse-drawn carriage—and every now and then, a real train, courtesy of the Seaboard system, rumbles down the railroad track that borders the complex. At night, the Cheyenne Saloon, Rosie O'Grady's restaurant and the Bumby Arcade are ablaze with decorative lights. Dixieland bands play. Music, food and drink are everywhere. Stained-glass windows decorate the old buildings, at least one of them a century old, now lovingly brought back to life. And at the center of the action is 43-year-old Snow, whose handlebar mustache symbolizes the times-gone-by atmosphere of Church Street Station.

When Snow came to Orlando at the start of the 1970s, it must have taken a man with an extremely high sense of adventure to see any possibility in the motley collection of wig shops, used-clothing stores, winos, beer bottles and Manpower temporary-work centers that was Church Street Station. But Snow, who had fished and played his saxophone across Alaska, flown Navy jets around Pensacola, and turned $400 and a used Porsche into a highly successful Pensacola night spot, had the vision.

"I knew it was going to be an exciting, growing market," he says now, shouting over the noise of his packed Rosie O'Grady's restaurant. "It had beaches, it had the right climate—and there was Disney World, which is a whole world of its own."

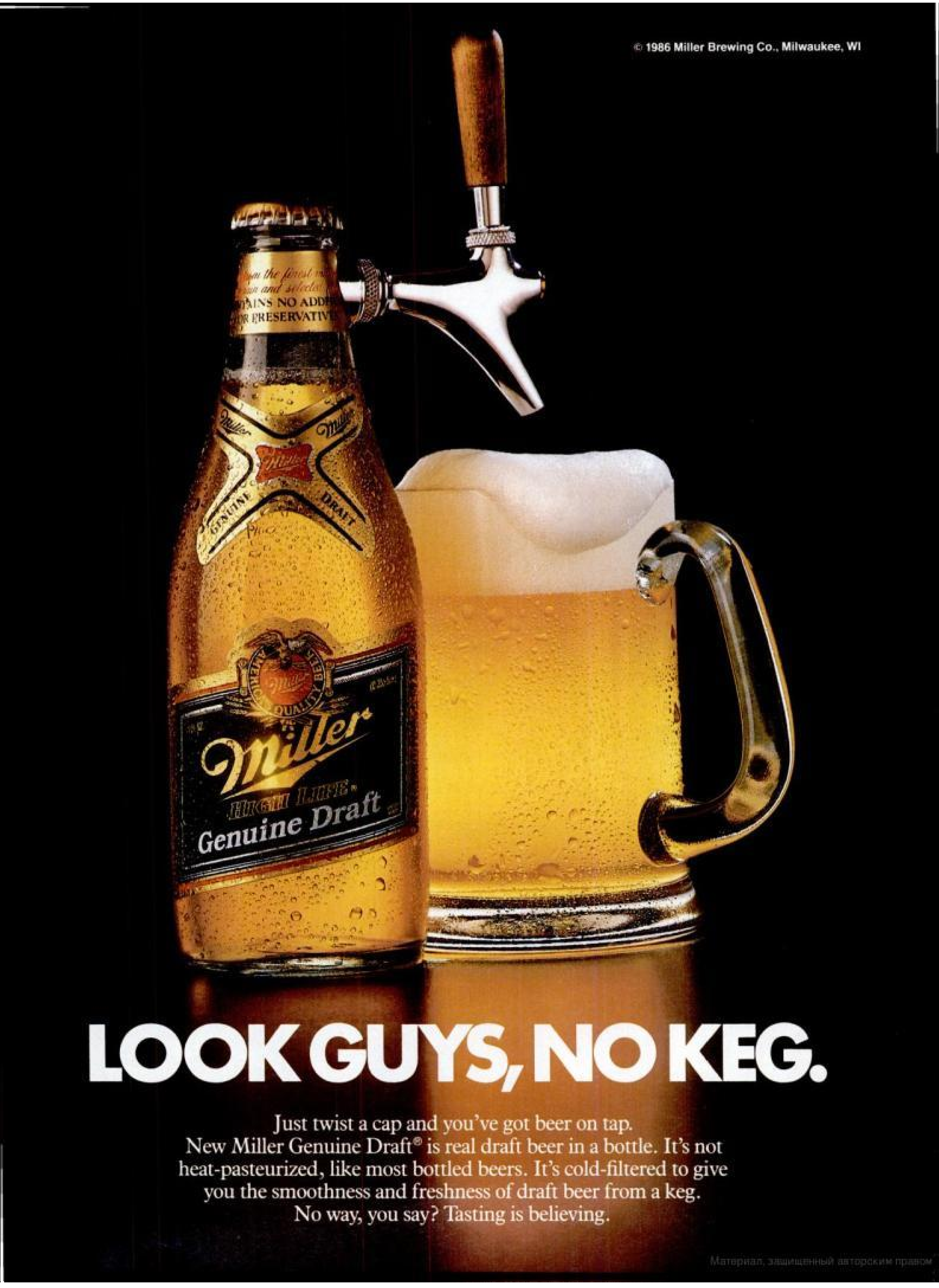
Today, Church Street Station is a $20 million-a-year operation, employing between 700 and 1000 people. Now Snow can envision not just a downtown fun spot, but the beginnings of a major metropolis.

"It's gonna be the greatest city in Florida, eventually," he says. "And the best thing is, we can still mold it; not like Miami, which just grew. We can have all the good things of a big city without any of the problems associated with a big city."

Snow pauses to puff on a good cigar, and then smiles.

"Tourism—it's such a clean dollar. A tourist dollar is the cleanest dollar there is. You don't have to build sewers, schools, roads. All you gotta do is smile and give 'em a good time. That's why I don't ever see Orlando as a huge city,

TOP PHOTO BY R. VALENTINE ATKINSON, FOCUS ON SPORTS;
BOTTOM PHOTO BY HUMPHREY SUTTON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because its base is tourism. There's no heavy industry. It's never going to be a blue-collar town. It's really more like San Francisco—a lot of culture, a lot of amenities."

Snow is on his way to making that vision a reality. He is working with James Rouse, the master developer of Boston's Faneuil Hall and Baltimore's Inner Harbor, to build a 100,000-square-foot Festive Market next to Church Street Station. It would feature a massive new hotel, high-toned retail shops, including the baked goods of famed French chef Paul Bocuse, and the biggest wine cellar in the state of Florida.

An arcade game comes to life: In Photon, played in a futuristic maze of neon lights, the object is to avoid "extinction" by shooting your opponents with a light beam from a laser gun.

Had you told an Orlando resident 15 years ago that such a complex would be coming to the city, "he'd have laughed in your face," Snow says. And, while it is clear he believes Church Street Station would have made it with or without Disney World, Snow credits the giant tourism complex for providing the magnet for the region.

"Forty percent of our business is tourist," he says. "And they're here for Disney. They don't fly into Orlando to see us—they're here for Mr. Mouse. Our size, Sea World and all of the others—it just never would have happened without Disney World."

How, then, to measure the distance from a tourist's search for family entertainment to a multibillion-dollar addition to the Florida economy? Joe Mettiga, special aide to Orlando Mayor Bill Frederick, talks about the three waves: first, tourism; second, new people relocating to central Florida, with "corporations following the people."

"Now," Mettiga says, "in the third wave, Orlando is emerging as a major convention center. We've also seen a major boost in residential developments, major businesses and commercial developments, and there are signs it will continue into the 1990s.

"We estimate that, 788 people a day are moving into the metropolitan Orlando area, and a city the size of Tampa is being added to the population every year."

What might be the ultimate consequences of the leisure-into-business equation? With Disney soon to begin work on a $300 million movie studio near Disney World, with high-tech industries continuing to move into the region, it is at least possible that Florida may become the California of the year 2000—with all of the social and political implications of a new megastate for America. Far-reaching as it may seem, 21st-century historians may someday write that what began with a theme park in the swamps of central Florida wound up helping to change the economic and political face of a region—and maybe even a country.

THE FUTURE OF AMERICAN recreation is measured in megabucks. A Dallas-based company, for example, is working on becoming the McDonald's of high-tech recreation in the next decade. Photon is an electronic game in which the players are human beings. The 10,000-square-foot game is played in a maze lined with neon lights and futuristic scenery. The players get a real laser that fires harmless light at sensors on robotic enemies. Hit the enemy's sensor and you score a kill, while also saving yourself from "extinction." Two years ago, there was just one Photon game in Dallas. But the developers have sold franchises to a half-dozen entrepreneurs for about a quarter-million dollars each, and you can already play Photon in New Jersey, just across the bridge from New York, and in the Los Angeles area.

Lasers and sensors may also find their way into professional sports. For instance, the professional boxer of the 1990s may be armored in Kevlar lined with light sensors. The equipment already is available. Inventor Byron Donzias has created the Kevlar flak jacket for pro football quarterbacks. And he is working with a boxing promoter to make lightweight gear that a boxer might wear to protect his face, head, kidneys and stomach. Add to the protective gear sensors that Xerox has developed for Army war games, and you have a whole new sport of boxing. The fighters would don their uniforms and enter the ring. The object would be to strike a blow against the sensors. Tiny lasers in the boxer's glove would register a score each time they contacted a sensor. A ringside computer would tally the points and the fight would end with the traditional knockout, TKO or points. Instead of human judges, the laser system would score the points. Boxers who strike dangerous blows would have their licenses lifted, an additional selling point.

Boxing enthusiasts know about Donzias's new designs and are divided on whether such technologies will ever be accepted in the ring. But many promoters believe that safety and scoring technologies will be the only things that can rescue boxing from a mounting public outcry against its casualty rate.

Other devices being developed for future sports include robotized refs for tennis and an electronic baseball that can change its center of gravity with a command from the dugout. All the technologies are far-flung but available right now. And there is big money behind them, held by backers who believe that wired sports—wired everything—is the wave of the future.

No wonder, then, that we work so hard at play. For we bring our national characteristic to our leisure as well as our factories, plants, farms and offices. And the ultimate irony is that we wind up reshaping America as much by our diversions as by our vocations. PM

Ellis Island stands as a symbol of our immigrant past. Plans for its restoration are just as cloudy as our policies regarding future immigration.

Ellis Island The Building Of A Heritage

BY ERIC SEVAREID

This summer the tall ships will once again sail around the tip of Manhattan and pass by the colossus holding the lamp, and Americans will again wonder at the story of their country's creation and continuity. The Statue of Liberty is now a hundred years old. The Constitution will be 200 next year. No piece of statuary has ever acquired a meaning and spirit of its own like Miss Liberty. No document for the governing of men has ever lasted so long, so effectively, as the Constitution.

The vast migration to the United States was almost biblical in its scope, its joys, its hopes, its heartbreak and its torments.

What was the dream of those millions? It came down to this: rebirth, the eternal, haunting craving of men to be born again, the yearning for the second chance. Rebirth occurred. America became the first new thing in history in the relations of man to man, on a mass scale.

The Statue of Liberty and Ellis Island lie close together, and we all think of them together. They were, indeed, officially put together by President Lyndon Johnson and are now administered together. But in the beginning of things, in the 19th century, the two had nothing to do with each other.

What attracts Americans right now is that the great lady has been shined up after years of neglect, and Ellis Island, through which some 17 million migrants moved to their new life, will be transformed to modern usages. The early Dutch picnicked on the island, the British hanged pirates there and the Americans fortified it, all before it became the funnel through which the immigrants passed.

What should be done with it now?

The debate over Ellis Island reopens the question of the purpose of historic preservation as well as the proper role of the National Park Service.

Ellis Island, between 1892 and 1954, was the nation's largest immigration station—millions entered the United States there. But most people don't even know that a debate is taking place. Had it not been for the firing of Lee A. Iacocca several months ago by Interior Secretary Donald P. Hodel from Iacocca's job as chairman of a Federal advisory commission on the restoration of the Statue of Liberty and Ellis Island, which has raised $230 million for the project, most of the debating would still be taking place behind closed doors.

The debate revolves around proposals to develop two-thirds of the island next to the Great Hall, where immigrants were processed. The hall is being restored and converted into a museum.

The island's southern 17 acres are dotted with small, decayed hospital buildings and other dilapidated facilities that only a few immigrants used.

In 1981, the National Park Service sponsored a competition for proposals for that part of the island. The agency selected a $60 million plan for a conference center and 300-room hotel.

The Center for Housing Partnerships proposed that the Sheraton Corp. operate the hotel. But Iacocca described the hotel as a luxury facility and dubbed the plan a commercialized "tax break for the rich."

Iacocca has spoken of establishing "an ethnic Williamsburg" on Ellis Island. Plans developed for Iacocca by architect John Burgee call for an exhibition center

FACING PAGE PHOTO FROM THE BETTMANN ARCHIVE

'What was the immigrant's dream? It came down to this: rebirth, the eternal, haunting craving of men to be born again, the yearning for the second chance.'

filled with displays of ethnic arts and permanent exhibits showing the contributions of various ethnic groups. But critics have derided the plan as "an ethnic Disneyland."

And Park Service officials said the new exhibition hall would dramatically alter the appearance of the island, which is still much as it was when many immigrants first saw it.

In 1983, Iacocca asked then-Interior Secretary James Watt for six months in which his commission could review the plan. Judgment is yet to be passed.

As Burgee has altered his plan, William Hubbard of the Center for Housing Partnerships has altered his. The Sheraton Corp. is no longer involved.

At this writing, 10 acres on the northern side of the island are undergoing $100 million in restoration work, which is being financed by the $250 million Statue of Liberty–Ellis Island fund-raising effort. The center of this work is the restoration of the immense Great Hall, and its conversion into a museum of immigration.

To me, the museum part of the proposal makes all the sense in the world. A museum, certainly, to tell the story in word, picture and sound of those who passed through, and what they made of themselves and their new home. It should make visitors think. It should make them laugh and make them cry.

It was a tremendous number of immigrants who came in the great waves in the latter part of the last century. But it is not quite right to say that we are a nation of immigrants. Even at the height of the incoming, a majority of the people in the country were native-born Americans and a big proportion of that majority had American roots going back to Washington's time—including, of course, black Americans. Strictly speaking, we are a nation *from* immigrants.

Italian immigrants arrive at Ellis Island.

The Statue came simultaneously with one great wave of immigration, in 1886. The target date was 10 years earlier—for the centenary of the Declaration of Independence. Twenty-one years had passed between the birth of the idea and the dedication of the Statue.

There was a wonderfully enthusiastic professor in Paris named Edouard de Laboulaye. He loved America, or the idea of America, which, in fact, he never saw in person. He was chairman of the French Anti-Slavery Society. What he and his fellow French liberals wanted directly was freedom from the rule of Emperor Napoleon III. What Frederic-Auguste Bartholdi, the sculptor of heroic statuary, wanted directly was freedom for his beloved Alsace from the Teutonic brutes who wrenched it away from France in their war of 1870.

De Laboulaye and Bartholdi talked endlessly about de Laboulaye's idea of a colossal statue in New York Harbor. On the eve of Bartholdi's first lobbying trip to the United States, he wrote to de Laboulaye and said the prospective monument was to be "in honor of American independence." It was to be called Liberty Enlightening the World. That is what the giant lamp was meant to represent. Apparently, there was no thought that it was to be a beacon welcoming newcomers from abroad. There was no "door" until the "golden door" appeared in Emma Lazarus's poem much later. "Give me your tired, your poor," she wrote, and poet James Russell Lowell told Emma that her lines had

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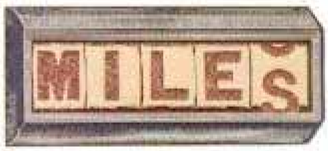

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Between 1892 and 1954, 17 million immigrants passed through Ellis Island. Now competing visions of its future have stirred a controversy.

WIDE WORLD PHOTOS

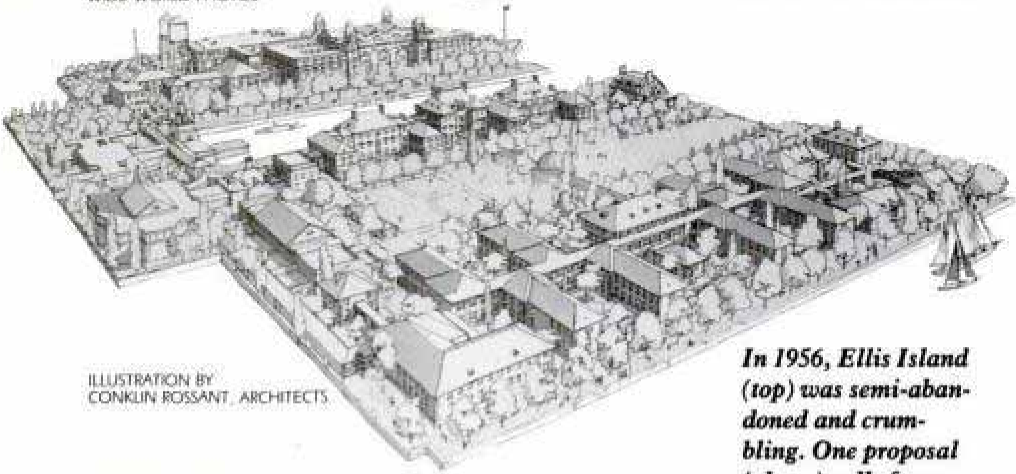


ILLUSTRATION BY
CONKLIN ROSSANT, ARCHITECTS

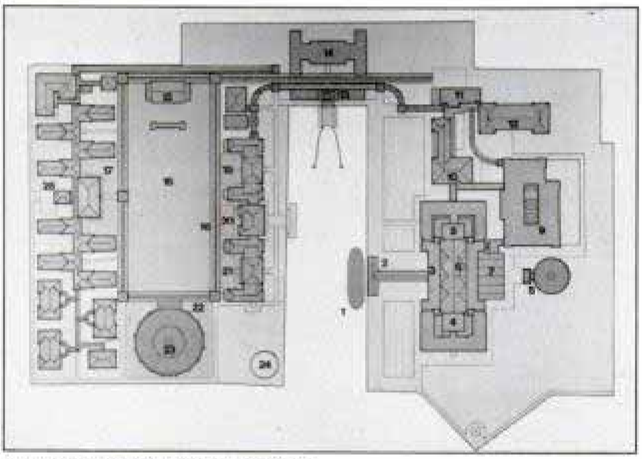
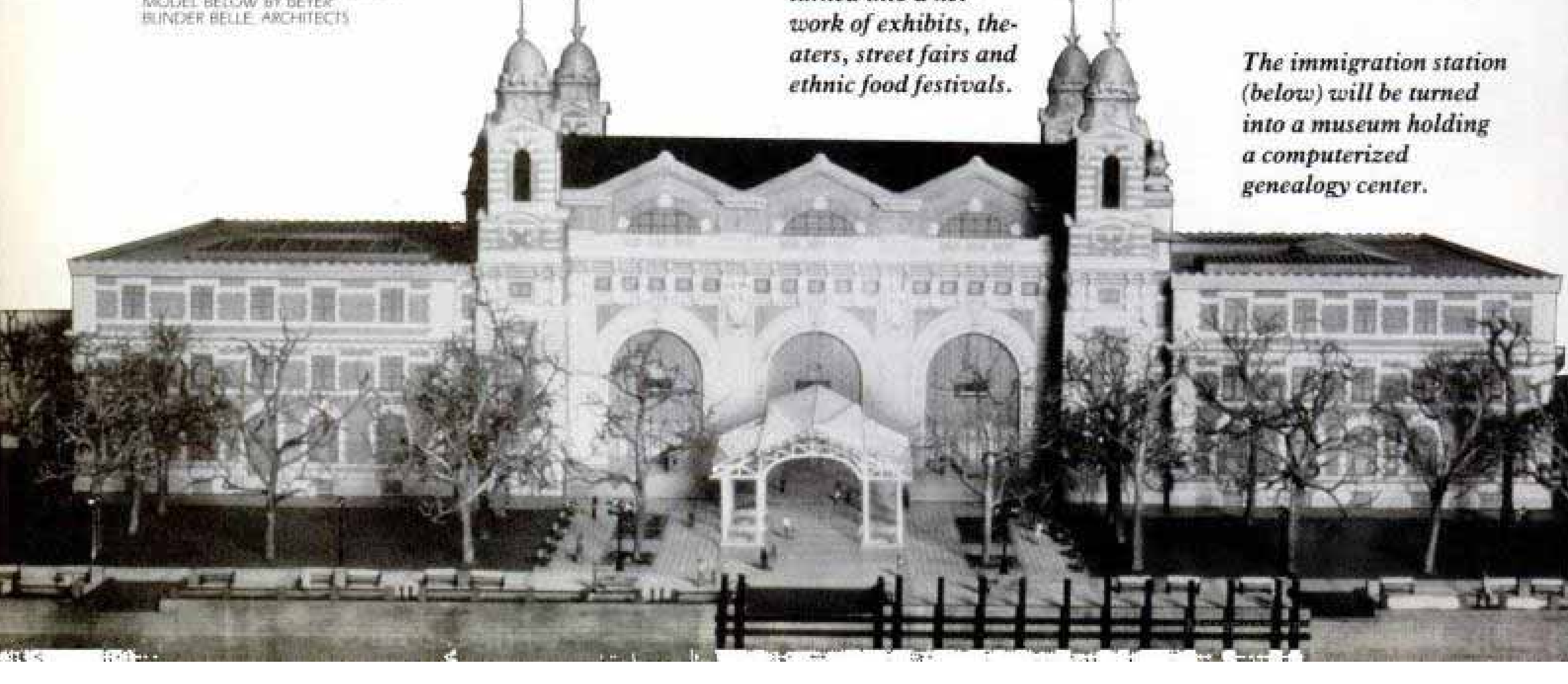


ILLUSTRATION ABOVE BY JOHN BURGEE ARCHITECTS WITH PHILIP JOHNSON
MODEL BELOW BY BEYER BLINDER BELLE, ARCHITECTS

In 1956, Ellis Island (top) was semi-abandoned and crumbling. One proposal (above) calls for a conference center, hotel and restaurant complex in the hospital building (foreground). The immigration station (rear) will hold a museum and a large meeting hall. A celebration of immigrants' contributions and our ethnic roots is the purpose of another plan for the site (left). The buildings would be turned into a network of exhibits, theaters, street fairs and ethnic food festivals.



The immigration station (below) will be turned into a museum holding a computerized genealogy center.

given the Statue a reason for being. Thus, Bartholdi's triumph of engineering (more than of art) became something less abstract, more human, something that evoked love and reverence from the native born as well as the newcomers.

So now, in 1986, Miss Liberty is refreshed, repaired and shining again and the island will be thronged with visitors from the mainland, not from the foreign ships. But much, if not all, has changed forever. This is a different America, and it may be that the Statue's symbolism will slowly revert to what Bartholdi and de Laboulaye had in mind—freedom for human beings everywhere.

Immigrants do not arrive in the steerage of great ships anymore. They fly in to a dozen airport cities from Boston to San Francisco. The huddled masses of today are Haitians huddling in rickety boats, Miami bound; or Mexicans huddling in the ravines and sagebrush south of San Diego.

But there are far more significant changes than those. In 1886, Lazarus's words of welcome were not only a deeply moving expression of compassion, they were a very practical argument. There were 58 million people in our country then and it urgently needed settling by people from anywhere. Today, we are four times that number and the open, arable land is gone. The overwhelming majority of immigrants are in the cities, forming new and rapidly growing communities with those like them.

I believe we are becoming a crowded country—surely a silly thought to a stranger looking at the map of America's expanse. But a vast proportion of our land is desert, forest and mountain where human communities can only be sparse. In five years, the total population has grown by some 12 million and immigration accounts for about 40 percent of that.

Playwright Israel Zangwill's melting pot did melt most of the ingredients in the pot, though not all. But now the lumps appear to be forming again. There now

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Ford · Lincoln · Mercury · Merkur · Ford Trucks · Ford Tractors seems to be a spreading movement, from ethnic group to ethnic group, supported by many well-intended native-born Americans, to actively resist melting, or assimilation.

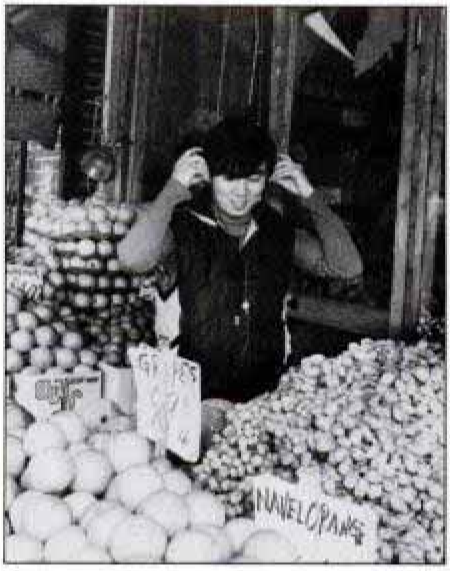
If I am biased about this, it would be, I suppose, because I grew up in the light of a different vision. I was taught that the idea was for everyone to become as American as possible, that a distinct American identity and personality would arise. Out of the many, one—as our coins say. But we were also taught, though mostly by politicians, that our national strength came from our racial and cultural diversity. I no longer think so. Diversity enriches the cultural landscape, but it does not make for social cohesion and thus national strength. Today, certainly, with these ethnocentric movements going on, social cohesion is getting weaker.

Two-thirds of the people in the world who are trying to migrate from their homelands are aiming at the United States. No nation takes in as many as we do. Entry has come to be, in the minds of millions, not a privilege, but a right.

I AM CONVINCED THAT THE immigration flow must be drastically reduced and the place to begin, of course, is with illegal immigration. No nation can readily be a nation without a border. And in effect, we have no borders.

No one is sure within millions how many illegal aliens are now in the country. Legal and illegal together, the total inflow must be at least a million a year. Most, of course, are poorly trained or utterly untrained, illiterate at least in English. How do we get on top of the poverty problem alone with this going on?

One vitally important aspect of the phenomenon is that we have never before



WIDE WORLD PHOTOS

South Korean grocers are the most visible and successful of recent immigrants.

had such a massive influx of people speaking foreign tongues.

But it goes beyond that. We now have a lobby of native-born Americans who fervently believe in bilingual education. These lobbyists and teachers are insisting on "cultural maintenance." That is, tax-supported public schools should see that the newly arrived children shall also be immersed in the culture of their homeland. That, surely, should be a matter only of later elective courses. Otherwise, one of the basic purposes of our public school system—assimilation—is being violated.

Those who deny the dangers in the present rate of immigration turn their minds away from one overwhelming fact—the rate will greatly increase. We haven't seen anything yet, compared to what is coming. The truth is that by the year 2000 the total population of Latin America is going to increase by 100 million to 150 million souls. The human pressures on North America will become enormous. It will be a sad day when we have to put an army on that southwestern border and hundreds of squads of special police and inspectors at our airports, seaports and highway points of entry.

I HOPE WE WILL NEVER shut our doors to those who are true political refugees, endangered men and women, though I also hope we will pressure other nations to do their part. The Japanese, whose nation was enriched by the Vietnam War, refused to take in more than a handful of their fellow Asians, the Vietnamese refugees.

In the long, mysterious process of assimilation, of becoming American, forces in our society seem bent on retracing their steps, on retrogression. More than ever, ethnic groups become not just cultural repositories and memory banks, but economic demand groups. It is a way to get things from government.

Does all this mean that a genuine, solid Americanism never did take hold, so that millions feel incomplete, emotionally lost, and are seeking to establish their own identity by clinging to or retreating to the culture of their origins abroad? If so, what I was taught as a boy is jeopardized, and, I believe, the cohesion of my country is threatened. Pluralism, which we ritually hail in our speeches, means weakness when carried to extremes.

There is no question in anyone's mind that immigration in the 16th, 17th, 18th and 19th centuries helped build America. Let's be sure that immigration in the 20th century doesn't tear America down.

VARIOUS INTELLIGENT friends feel I exaggerate these worries and I hope they prove to be right. But one thing I know. We cannot fool around on the question of language. I would support the proposed constitutional amendment making English the only official language. Language is heart and mind, values and visions of life. It is "the nerve of a nation," said Dr. Samuel Johnson.

America has been called "the last, best hope of Earth," but it ought not become the *only* hope. America has great muscles, but it is neither a Colossus bestriding the world nor an Atlas shouldering the world.

We, too, are only human, after all. PM

Thanks For The Liberty

BY BOB HOPE

What a wonderful sight. What a warm welcome she gives as she beckons you into New York Harbor. I'm talking about that great lady called Liberty, of course.

And let me tell you, she looks great. When Dolores and I returned home from our Sweden trip in March, nearly all the renovation scaffolding had been removed to reveal a rejuvenated and radiant Miss Liberty.

Word has it that the blueprints for Miss Liberty's facelift were provided by POPULAR MECHANICS. And by the looks of it, it's a job well done. Phyllis Diller is calling the magazine next week for an estimate.

Miss Liberty was a little more than a teenager when we met. I was 4 years old and 3 feet 2 inches tall, and she was 151 feet 1 inch tall. I was impressed! My mother, myself and five brothers (the seventh son was born in Cleveland a year later) were part of the "huddled masses" coming to America from England back in 1907.

The trip was an experience I'm sure I remember myself (and not something somebody told me). I even recall an incident that happened aboard ship while crossing the Atlantic. Everybody was lined up to be vaccinated. I was only two away from getting the scratch when I decided I didn't want it. I bolted and ran. Pursued by family and crew, I was cornered, captured and returned to the lineup where, amid a lot of hollering, I was scraped with a scalpel (that was the way they let you have it in those days).

After it was over, my mother leaned down to comfort me and wipe some of the excess vaccine away from my arm. She had a small cut on her thumb that reacted to the vaccine, and for the remainder of her life she carried a vaccination scar as a reminder of the incident.

All was forgotten when the ship entered the harbor and the lady with the torch guided our way to Ellis Island, prior to our destination—Cleveland, Ohio.

Such was my first encounter with Liberty, and I have been carrying the torch for her ever since.

But what is liberty to a 4-year-old? A statue in New York, a cracked bell in Philadelphia, a word on every coin minted in the United States. Then, little by little, the statue and bell become symbols, great symbols, mind you, of one of God's greatest gifts to mankind—freedom.

A gift so valuable that too often somebody tries to take it away from us. A gift that our forefathers bought and paid for. Freedom is a reason for thank-yous in our prayers but is also, when necessary, our battle cry. It is our past, present and future.

You can't travel the length and breadth of this nation without realizing that people are very conscious of the past, of where they've been, of what they've done, of how this land in 210 short years has rekindled mankind's perennial quest for liberty to the point where it's a blazing forest fire of emotion.

America is truly a blessed country. This nation has always had great natural resources of beauty. The golden plains of Kansas, the brawny mountains of Colorado, the vibrant green of Vermont, the sturdy coastline of California. Each state has a grandeur of its own.

It's not only the geography. It's also the people who give the United States this unique dignity. We've always found leaders with the strength to guide this nation when it has needed direction. We have had wise counsel in founding America, vigorous leadership throughout our history and promising young people to carry the torch for the future.

America, God surely has shed his grace on thee. Yet, all this would be nothing without liberty. What makes America great is not the blessing she has in such abundance, but the freedom of her people to enjoy God's gifts.

Americans can live in the mountains, the hills or the valleys in any state they choose. They work in their profession today and dream their dreams for tomorrow. They can vote for the representatives they want to run this government "of the people, by the people and for the people."

When Patrick Henry said, "Give me liberty or give me death," he was speaking for an entire nation. Without freedom, America cannot live or breathe. That's why the torch of Miss Liberty has to burn so brightly. She stands outside New York, but the light of freedom has to reach all 50 states. The glow from the eternal flame has to reach into every American heart and keep alive the truth that this is the land of the free and home of the brave.

In the words of a man named Lloyd George (no relation to Boy), "Liberty has restraints but no frontiers." And who am I to disagree? Especially when it proves my point. The official title of the Frederic-Auguste Bartholdi creation, that wonderful gift from the people of France to the people of the United States, is not Miss Liberty. Officially, and more profoundly, its title is Liberty Enlightening The World. Therein is the ultimate dream—liberty for all. **PM**

PM ILLUSTRATION BY DICK ANDERSON

Every American boy should own at least one of these during his lifetime.

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Then, opt for a set of dual-purpose radials on tough-looking 15-inch wheels. Choose your 4-speed or available automatic gear-box. With the assurance that our famed Dodge 4x4 transfer case offers low-range gearing low enough for the back country; and a high range ideally suited for the Interstate.

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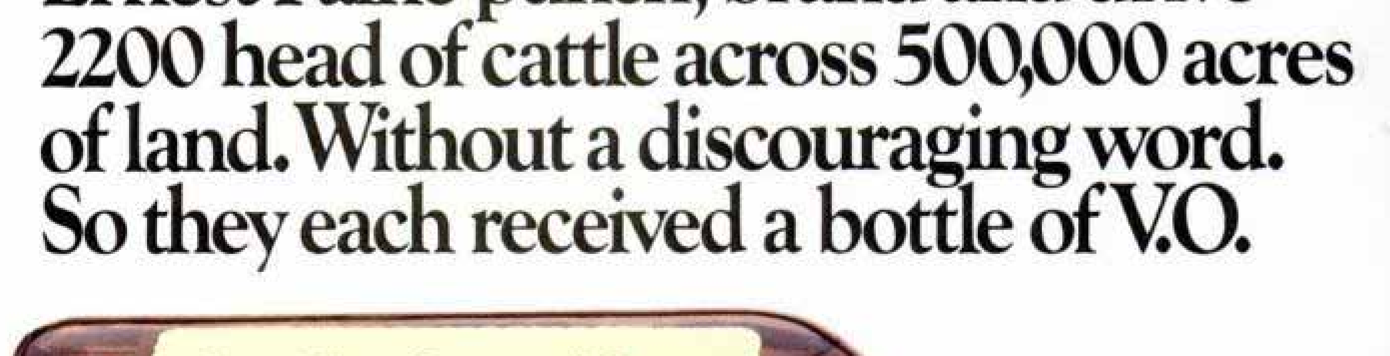


The reward.

THE BETTER HOME

How To Install A Brick-In-Sand PATIO

BY WILLIAM AND DIANE WINANS
Illustrations by George Retseck

The brick-in-sand patio, also known as the mortarless patio, will add lasting value and utility to your home. The color and texture of the bricks are pleasing and they bring a welcome relief from the monotony of a typical concrete patio or walk.

Also, the construction of a brick-in-sand patio requires less physical effort than its concrete counterpart, and it's more forgiving. Once concrete is poured, it's poured. With sand, if you make a mistake with a few bricks, all you have to do is take them out and replace them.

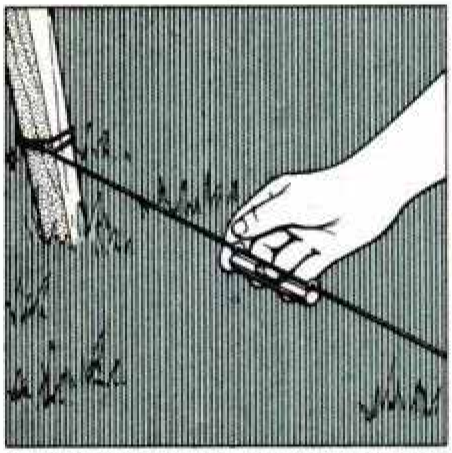
Most of the tools needed can be found in any homeowner's garage or basement. The only special items are a mason's hammer, brick chisel or wide-blade cold chisel, line level and a masonry blade for a circular saw.

Planning the patio

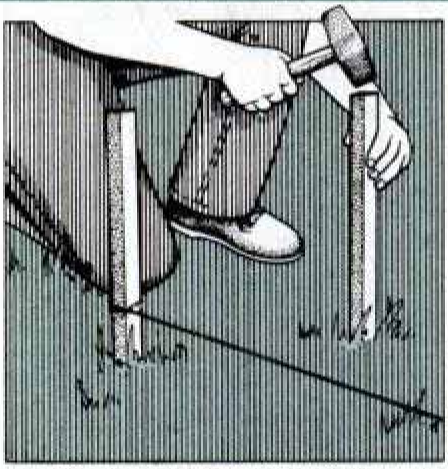
Start by surveying your yard for its best and worst features. Consider whether your goal is privacy, relaxation in the sun or shade or enjoying a view. Also keep in mind that you should not feel restricted to a simple geometric brick pattern if something else complements the surroundings better.

To help choose the overall size of your patio, roughly stake out the best area. Then check to see if it will comfortably accommodate what you'd like to do there: Is there enough room for a table, lounge chairs, a barbecue and so forth? Once you've determined where and how big the patio is going to be, you'll have to choose an edging.

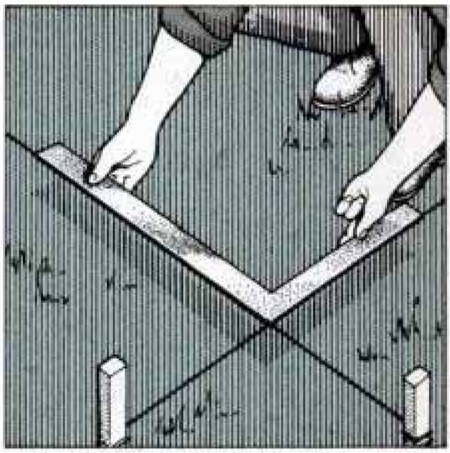
One option is a border of bricks placed on their ends, instead of flat on their sides. These are called soldiers and are especially suited to circular or



1 Lay out patio side nearest house first. Drive stake 1 ft. past both ends, then attach string and level it using line level.



2 Drive stakes for adjacent sides at corners of patio. Hang string on stakes and, again, level it in place using line level.



3 After all stakes and strings are in place, check each corner for square using framing square or by comparing diagonal measure.

gently curving applications. They require a deeper trench underneath because they must line up with the surface of the flat bricks.

If your soil has a good deal of clay in it, which leads to bad drainage, soldier bricks should rest on a 6-in.-deep bed of gravel. Otherwise they will heave when the ground freezes.

Another possibility is a concrete curb. This edging generally is poured in 6-in.-wide forms and requires the laborious mixing and handling of concrete. In our view this undermines the simplicity of the brick-in-sand construction and therefore is less appealing. Also, in cold climates the curbs will heave unless they are poured below the frostline, which can be over 4 ft. deep.

We feel the most practical edging is wood timbers, commonly 4x4, 4x6 or 6x6 pressure-treated stock, redwood or cedar. The pressure-treated stock should be approved for ground contact and graded for .40 retention. The redwood and cedar come in a variety of grades and prices, so when shopping explain to the salesperson what you have in mind for the wood. Another choice in timber edging is the standard railroad tie. True railroad ties are long-lasting and can be economical, especially if a railroad in your area is doing extensive track work. For this patio we used 4x6 pressure-treated timbers with an actual dimension of $3\frac{1}{2}$ x $5\frac{1}{2}$ in.

No matter what type you choose, when designing your patio, plan to use as many full-length timbers as possible. Full-length sides hold the bricks better, look more uniform and, if straight, require less alignment. But if you want a large patio, simply butt the timbers together and just try to avoid very short lengths.

Selecting the brick

With the edging chosen and the patio size and shape roughed out, select your brick. We recommend brick that was manufactured as a *paver*, that is, a hard-fired brick with a severe weather (SW) rating. This is especially important in cold climates where freeze-and-thaw cycles will cause soft brick to crack and spall. Bricks are available in various geometric and interlocking shapes, but the most common are the standard and modular types.

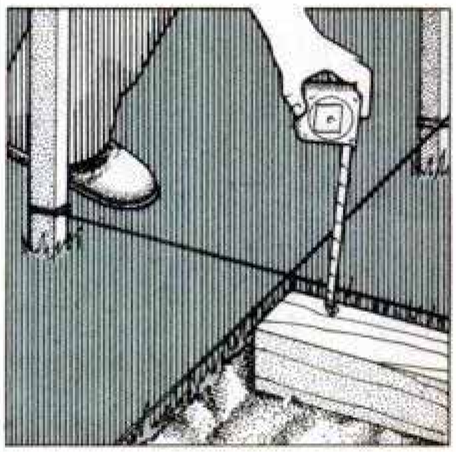
A standard paver is $2\frac{1}{4}$ x 4 x 8 in., with $4\frac{1}{2}$ bricks equalling 1 sq. ft. Modular brick measures $2\frac{1}{4}$ x $3\frac{5}{8}$ x $7\frac{5}{8}$ in. and it takes $4\frac{7}{8}$ bricks to cover a square foot. Because of the uneven square footage of modular bricks, they can be a bit more difficult to lay in a uniform pattern. But if you've chosen a design that is not geometric, you won't have any problems. We opted for standard brick with a rough face for good footing. But no matter what you choose, order enough brick to cover your square footage, plus about 5 percent more to replace any bricks you break.

4 Remove soil from patio area with shovel and pick for stubborn spots. Measure to strings frequently to check progress.

Site preparation

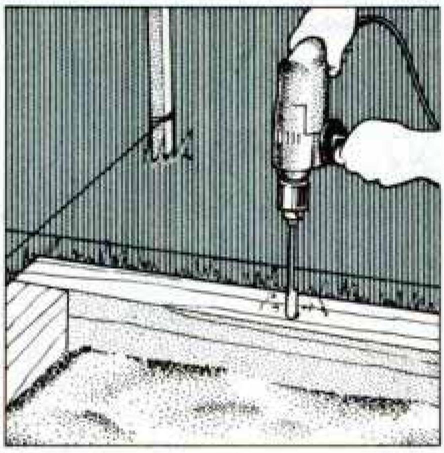
Preparing the site requires a shovel and pick (for stubborn areas) a few wooden stakes, nylon mason's string, a line level and a tape measure. Once your general area is staked out, choose one side as a starting point, usually the side nearest the house. Keep in mind that you want the patio to slope slightly away from the house so water will not drain toward the foundation wall.

The finished surface of your patio will only be as uniform as the excavation underneath it. Soil must be removed so the resulting surface is as flat (not level) as possible and so it slopes uniformly away from the house. Begin by driving a stake 1 ft. beyond each end of your reference side. These stakes should be equidistant from the house wall and should align with the outer

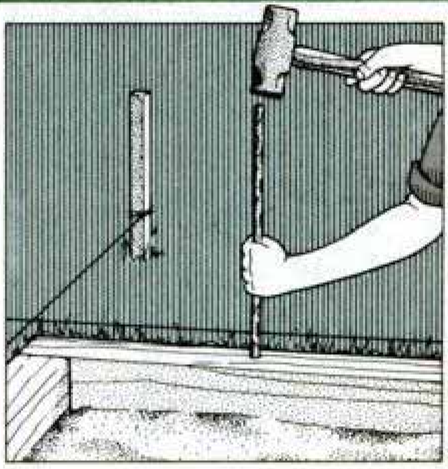


5 Lay timber within perimeter of excavation. Then measure to string to determine depth of trench required under beam.

6 Adjust beams—relative to the string—by adding or removing sand from underneath. Make sure beams do not rock.



7 Once beams are laid, bore ⅝-in.-dia. hole through beams at 2-ft. intervals. Use spade bit in drill or auger in bit brace.



8 To stabilize beams, install lengths of reinforcing bar in each hole using a sledge hammer. Drive rebar flush to surface.

edge of the patio, including the edging timbers. Level a mason's string about 4 in. above the ground using a line level and mark both stakes where the string intersects. Next, measure down to the soil. If you want the patio to be roughly flush with the surrounding ground, then this point will represent the surface of the brick. However, if the ground already slopes slightly away from the house—which is a fairly standard building practice to help divert water away from the foundation—then you may want to keep the bricks at the high end slightly above grade. Two inches would be a good starting point.

Once the measurement from the string to the finished brick surface is established, add to this figure 2¼ in. for the brick and 2 in. for the sand underneath. This determines the depth of your excavation below the string.

Next, drive stakes and set up lines for the two adjacent sides. Level both lines in place and check where they meet the first line for square using a framing square. Both lines should slope away the same amount from the reference line, about 1 in. for every 10 ft. of patio. Measure down the same amount on the outboard stakes for both these lines, to establish the proper slope. Then lower the strings to these marks. Add the layout string for the last side of the patio and check where it intersects the sides for square. This completes the layout, and because all the strings are on the outside of the finished patio, you can excavate without removing them.

Excavation

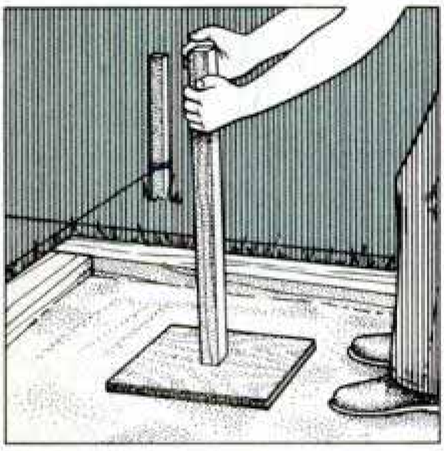
Begin digging at the perimeter of the patio. Check measurements to the line frequently to maintain proper depth. Then move toward the middle area. Always try to slide the shovel into the surface at a low angle instead of digging straight down. This will create a smoother, more compact surface for the sand and bricks above. For additional reference points in the middle of a large excavation, install a few temporary strings—that span the area—at the same height as your layout strings.

Once the excavation for the brick is complete, you'll have to remove more soil from the perimeter for the edging timbers. Because we used 4x6s with their wide side aligned vertically, this meant digging an extra trench that was approximately 4 in. wide and 1½ in. deeper than the rest of the excavation. Cover the bottom of these trenches with a thin layer of sand for adjusting the timbers. Slide the timbers into place and again measure to the string frequently to check for alignment.

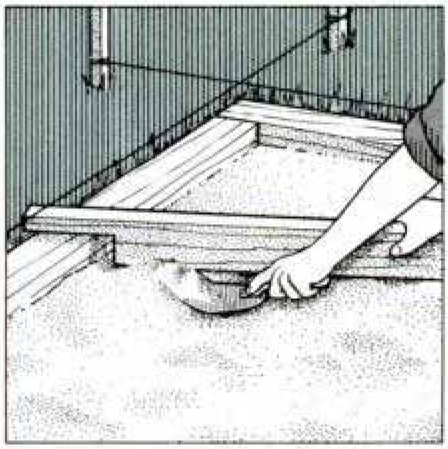
When the timbers are installed, they should be stabilized with either wooden stakes or steel reinforcing bar (rebar). If your ground is soft, use 2x2 pressure-treated stakes at least 24 in. long. Drive these every 3 ft. around the perimeter of the timbers to a depth 1½ in. below the top of the timbers. Nail the stakes to the timbers with 16d galvanized nails. If your ground is rocky, it's a better idea to stabilize the timbers with rebar. To install, simply bore a ⅝-in.-dia. hole through the timbers at 3-ft. intervals. Then drive a 3- or 4-ft. length of rebar into each hole. You can buy the rebar at most building supply outlets. It's easily cut to length with a hacksaw or bolt cutters.

Laying the base

With the edging now in place, smooth out the interior as much as possible using a garden rake. Then cover the ground with 4-mil.-thick black polyethylene plastic, overlapping the rows about 6 in. This plastic greatly reduces the likelihood of grass and other plants taking root between the bricks.

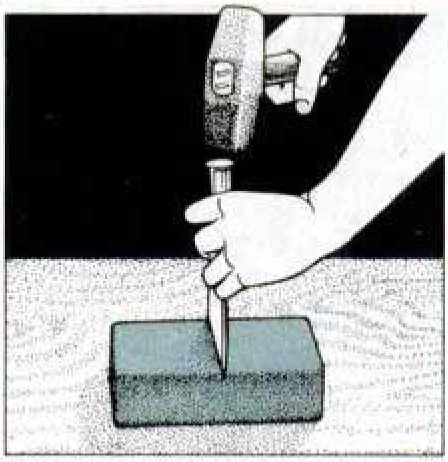


9 Install sand, rake smooth then spray with water. Compact sand with tamper made of ¾-in. plywood and 2x2 handle.

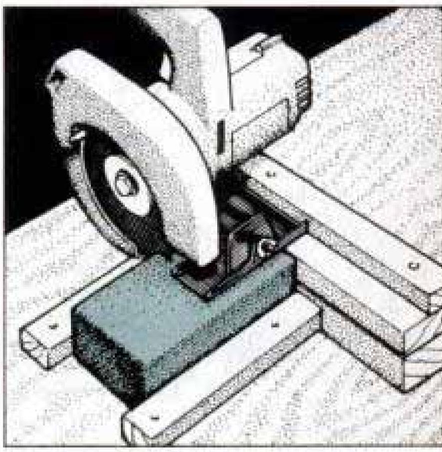


10 Rest screed on beams and move back and forth to smooth sand. *Remove* high areas with trowel, *add* sand to low areas.

11 Begin laying brick in one corner. Work from plywood panel, and use rubber mallet to adjust brick alignment.



12 Cut brick to size using brick chisel and maul. Score cut line on all four sides of brick, then strike with maul to break.



13 For cleanest cuts, use masonry blade in saw. Build jig from 2x4, 1x4 and 1x2 stock nailed to surface of plywood panel.

Cover the plastic with sand. Builder's fill-sand often is used for patios like this. It's inexpensive and works fine. But we decided to use No. 10 limestone screenings instead. We felt the latter forms a superior base because the particles tend to "lock-up" better once they are compacted. But if these screenings cost more in your area, stick with the fill sand. Your building supply outlet will know how much you need based on the size of your patio.

Distribute the sand with a rake to the approximate depth, then use a pitch fork to pierce the plastic every 12 in. or so to allow for water drainage. Rake the sand as smooth as possible, then soak the whole area with water. Use a wide, soft spray on your hose nozzle to prevent washing the sand away.

As the sand is drying, make a screed board from a straight 2x4 or 2x6 that spans the width of your patio. The sand must be smoothed and tamped to a uniform depth of 2¼ in. to match the thickness of the brick, so cut a notch on both ends of the screed board about 6-in. long and 2¼ in. deep.

Build a tamper like the one shown in drawing No. 9, then tamp the sand in the whole patio. Make sure it forms a firm base, but don't worry at this point about slight mounds or depressions. Next, set the screed on top of the timbers and use a back-and-forth sawing action to move it across the sand. Stop and tamp the base ahead of the screed as it builds up. If the sand compresses so much that it no longer reaches the bottom of the screed, add more sand, tamp again and screed again. The result should be a smooth, firm surface. Keep in mind that screeding areas wider than 10 or 12 ft. will require the aid of two helpers, one on each side of the screed, while you work the tamper and trowel.

Setting the brick

Stack all your bricks around the perimeter of the patio, then lay a sheet of ¾-in. plywood on the sand near one corner of the timbers. The plywood will distribute your weight over a larger area and therefore will not distort the smooth sand base.

Begin laying the bricks at one corner. Start your pattern and move out from the corner, repeating the design as you go. For the tightest fit, set each in place by abutting the adjacent bricks near the top, and then pushing the new brick down onto the sand. If you place it on the sand, then push it over, sand will pile up between the bricks and your pattern will be loose.

Do not stand or kneel on the bricks at this point because your weight will distort the pattern. Besides, working off the plywood will give a good vantage point for checking the bricks for poor alignment. If your pattern is geometric, check for alignment every few rows by holding a string or straight board across the entire patio. Have a trowel and some extra sand handy for elevating the bricks that are thinner. For those that are thicker, a few sharp blows with a rubber faced mallet should bring them flush.

14 Once bricks are installed, spread sand over them and sweep to drive sand between cracks. Then, spray with water.

Cutting brick to size

If your pattern requires cutting some bricks, you have several options. You can use the straight claw end of a mason's hammer to score the cut line. Then simply strike the waste with the face of the hammer and it should break on the line. But unless you are familiar with this method, it can be a little imprecise. A better approach for the beginner is to use a brick chisel or wide cold chisel to score the brick first. If, however, you need a perfectly smooth cut, the best way is with a masonry blade in a circular saw. A simple jig for holding the brick and aligning the saw is shown in drawing No. 13.

Cut into both sides first to a depth of about ¾ in. Make each of these cuts in three successively deeper passes. Once both side cuts are made, simply break the brick with a hammer and chisel. No matter how you choose to cut the brick, be sure to wear safety goggles to shield your eyes from flying chips.

Once all the bricks are laid, spread some sand over the patio and sweep it in several different directions to force sand between the bricks. Spray the entire surface with water, let it dry and sweep off any excess sand. PM

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343-360-401	119.00	139.00	[illegible]	209.00	174.00	194.00	224.00	264.00
390	119.00	139.00	[illegible]	209.00	—	—	—	—
BUICK								
231 V6	79.00	93.00	123.00	163.00	139.00	154.00	184.00	224.00
300-340-350	119.00	139.00	[illegible]	209.00	164.00	214.00	244.00	284.00
400-425-430-455	125.00	149.00	179.00	219.00	164.00	214.00	244.00	284.00
CADILLAC								
390-429-472-500	169.00	213.00	243.00	—	—	—	—	—
CHEVROLET								
145-164 Corvair	[illegible]	84.00	114.00	—	—	—	—	—
194-230-250-292	[illegible]	84.00	114.00	154.00	119.00	134.00	164.00	204.00
216-235	[illegible]	84.00	114.00	154.00	119.00	134.00	164.00	204.00
265-283-327	[illegible]	[illegible]	124.00	154.00	139.00	[illegible]	[illegible]	219.00
305-307-350	[illegible]	[illegible]	124.00	154.00	139.00	[illegible]	[illegible]	219.00
396-400	[illegible]	119.00	154.00	184.00	219.00	233.00	263.00	293.00
402-427-454	119.00	139.00	[illegible]	[illegible]	204.00	279.00	309.00	339.00
FORD								
144-170-200-250	[illegible]	84.00	114.00	154.00	119.00	134.00	164.00	204.00
260-289-302-351W	[illegible]	[illegible]	124.00	154.00	139.00	[illegible]	[illegible]	219.00
351C-351M-400	[illegible]	114.00	139.00	[illegible]	[illegible]	[illegible]	219.00	249.00
332-352-390	[illegible]	119.00	149.00	[illegible]	139.00	[illegible]	[illegible]	229.00
272-292-312	104.00	124.00	154.00	194.00	—	—	—	—
429	104.00	124.00	154.00	194.00	279.00	299.00	329.00	369.00
429-460	119.00	139.00	[illegible]	[illegible]	179.00	[illegible]	239.00	279.00
MOPAR								
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273-318-340-360	[illegible]	[illegible]	124.00	154.00	140.00	163.00	193.00	229.00
361-383-413	119.00	139.00	[illegible]	[illegible]	[illegible]	209.00	239.00	279.00
440	144.00	164.00	194.00	234.00	[illegible]	209.00	239.00	279.00
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394-400-425-455	[illegible]	179.00	[illegible]	249.00	[illegible]	219.00	249.00	289.00
PONTIAC								
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CADILLAC		
390-429-472-500	$423.00	—
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194-230-250-292	$294.00	$344.00
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305-307-350	$299.00	$359.00
396-400-402-427	$334.00	$443.00
454	$344.00	$489.00
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144-170-200-250	$299.00	$339.00
221-260-289 302-351W	$299.00	$354.00
351C-351M-400	$319.00	$389.00
332-352-390	$329.00	$349.00
272-292-312	$334.00	—
429	$334.00	$509.00
428-460	$349.00	$409.00
MOPAR		
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273-318-340-360	$299.00	$368.00
361-383-413	$349.00	$419.00
440	$374.00	$419.00
OLDSMOBILE		
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394-400-425-455	$389.00	$428.00
PONTIAC		
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- OIL PUMP
- CAM BEARINGS
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390	$509.00	—
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305-307-350	$459.00	$519.00
396-400-402-427	$494.00	$603.00
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FORD		
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221-260-289 302-351W	$459.00	$514.00
351C-351M-400	$479.00	$549.00
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FORD		
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351W	$789.00	$849.00
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FORD		
289-302	$1098.00	$1198.00
351W	$1098.00	$1198.00
351M-351C-400	$1199.00	$1270.00
390	$1199.00	$1270.00
429-460	$1279.00	$1399.00
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NEW STOCK REPLACEMENT CAMSHAFT— LIFTERS SPRINGS KIT

Available for most V8 & 6 cyl. Domestic engines
Ford—Chevrolet—Mopar
$119.95

TRW FORGED FLAT TOP PISTON & RING SPECIAL

Available Std-030 (040-060 Call)

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283-327-350	$149.00
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Ford	
289-302	$149.00
351C	$169.00
390	$159.00
Mopar	
318-340	$163.00
383	$209.00
440	$209.00

ON SALE
HI-PERFORMANCE DOUBLE ROLLER CHAIN SETS

SB Chevy **$18.95**
BB Chevy $29.95
SB Mopar $29.95
BB Mopar $29.95

HIGH VOLUME OIL PUMPS

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20% More volume than stock pump.
Chevrolet Mopar Ford Pontiac

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The Fabulous PAW Blown Motor Logo in 3 Colors on both Front & Back of a Quality Hanes Beefy 'T' Shirt. Available SM, M, L & XL. State Your Size **ONLY $6.50**

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NOTE: NO REFUND ON SHIPPING CHARGES. PRODUCTS MUST BE IN NEW AND UNUSED CONDITION IN ORIGINAL PACKAGE. INSTALLED ITEMS CANNOT BE REFUNDED. CALL 818-998-3641 FOR RETURN AUTHORIZATION.

Genuine Clevite Bearing *Special*

Rod Bearings
Available STD - 010 - 020 - 030
Main Bearings
Available STD - 010 - 020 - 030
SB Chevy only
Both for the Low Price of **$36.95**
Most Others **$39.95**

Available for most domestic 6 Cyl & V8 engines.
For Cam Bearings ADD $10.00

NEW TRW FUEL PUMPS

Your Low Price From **$12.95** SB Chevy & Ford
Available for all Makes & Models. Phone for Your Low Price

CHROME MOLLY PUSH RODS

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Available for most popular Domestic Engines. Set of 16

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Solid/Hydraulic
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Available for most popular Domestic Engines

HI-TORQUE STARTERS

50% more Torque than O.E.M.
Available for most domestic V8s
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NO EXCHANGE REQUIRED
Prices do not include Solenoid
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SB Chevy 39.95 set 16
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All includes Arms, Balls, Nuts

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Kit includes:
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Available for most V8 and 6 Cyl. Engines
Buy all three and save! Your Low Price
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YOUR LOW PRICE **$99.95**
S.B. CHEVY ONLY
KIT INCLUDES:
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- CL77 MAIN BEARINGS
- ENGINE GASKET SET
- OIL PUMP
- TIMING CHAIN SET

NOTE: BATH TUB INTAKE GASKET NOT INCLUDED WHERE APPLICABLE

OPTIONS AVAILABLE: Molly Rings ADD $15.00/ H.V. Oil Pump ADD $6.00/Double Roller Chain Set ADD $3.00. NOTE: Bearings Available Std. 010, 020, 030/Rings Available 030, 040, 060

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S.B. Ford 289-302-351W	$49.95
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Adjustable Kit w/Arm, Ball, Nut	
390-427-428	$82.00
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PONTIAC	
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MOPAR	
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We have Rocker Arms for all engines. Phone for your low price.

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BB Chevy
SB Ford
BB Ford
Cleveland
SB Mopar
BB Mopar
Pontiac
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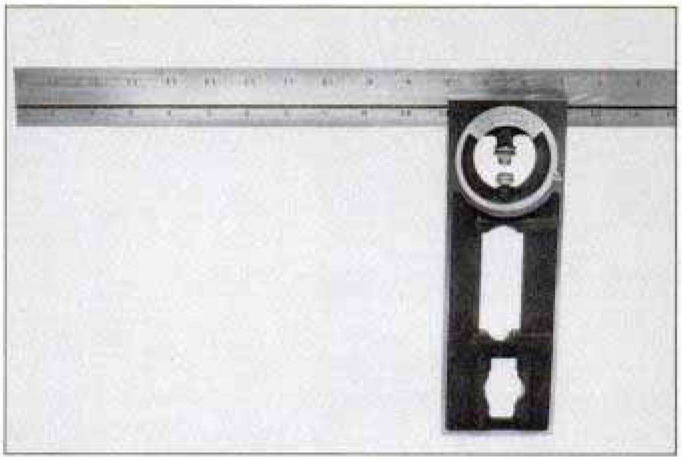
Address ______________________
City ____________ State ________ Zip ________
Make ________ Model ________ Year ________ Engine Size ________

NOTE: P.A.W. is not responsible for typographical errors in pricing or applications, including all contents of this advertising.

IF YOU DON'T SEE IT, PHONE FOR YOUR LOW PRICE.

California residents: Items in this ad are: Not legal for sale or use on pollution controlled motor vehicles in California; Legal in California only for racing vehicles which may not be used on highways

Tool Tests



Versatile shop tool is seven tools in one. Features include adjustable, double-graduated turret, 1½ x 18-in.-long steel rule and four levels.

Precision builder's tool

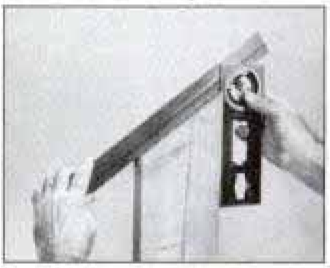
If you enjoy top-quality tools, then check out this versatile builder's tool. It's made by Starrett, one of the country's top precision tool manufacturers, and it's actually seven tools in one—a rule, square, level, protractor, bevel, plumb and pitch-to-foot indicator.

The tool comes with a 1½-in.-wide x 18-in.-long tempered-steel rule that has inch graduations in 8ths, 16ths, 32nds and 64ths. The rule is mounted to a revolving turret that allows you to adjust the angle of the rule. One side of the turret has double graduations from 0 to 90°. The reverse side is graduated in ½-in. pitch increments. Also, the 9-in.-long stock is fitted with four level vials to determine level and plumb. The rule folds flat for easy storage.

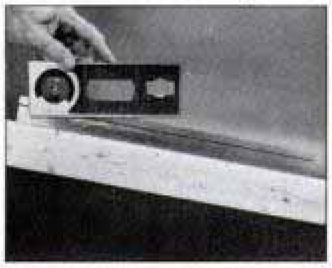
It's available for about $150 at hardware stores or with a 24-in.-long rule for about $160. Contact Starrett Tools, Athol, MA 01331.

—Rosario Capotosto

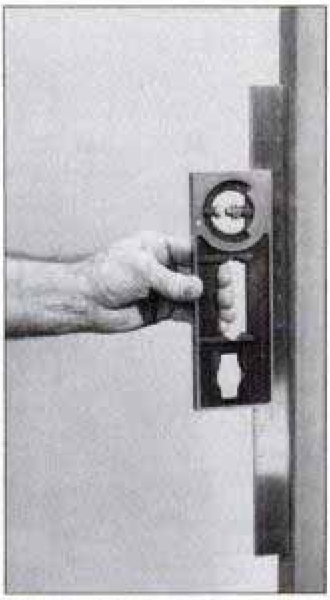
One side of the adjustable turret has double graduations from 0 to 90°. Adjust rule to desired angle, tighten knurled knob.



Adjustable turret makes it easy to determine, transfer and mark angles—a real timesaver when cutting hip and valley rafters.



Turret's reverse side has ½-in. pitch graduation. Adjust stock until it reads level. Then, read pitch directly off the turret.



The 18-in.-long rule folds for easy storage and for use as a straightedge. Here, the level is used to determine plumb.

Clamp-on table

Cast-aluminum worktable can support a load of 500 pounds.

If you have a column in your basement or garage, convert it into a valuable work area with a Versa-Table clamp-on work surface.

The cast-aluminum table mounts to any column with a diameter of 2½ to 4¼ in. Use the holes in the tabletop to mount a bench grinder, vise, portable drill press or other compact, benchtop tool.

The table's height can be adjusted easily from floor to ceiling and the table rotates 360° around the column. The 6-pound table measures 3 x 6 in. wide x 9¼ in. and, when properly installed, will support a 500-pound load.

The Versa-Table is available for $32.50 postpaid from Woodcraft Supply Corp., 41 Atlantic Ave., Box 4000, Woburn, MA 01888.

—Rosario Capotosto

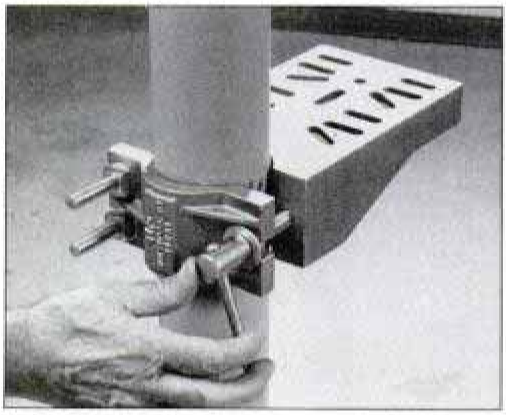
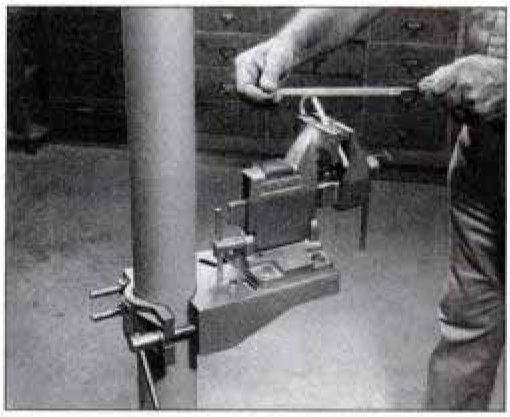


Table fits a 2½- to 4¼-in.-dia. column. Tighten clamp handle to secure table at desired height.

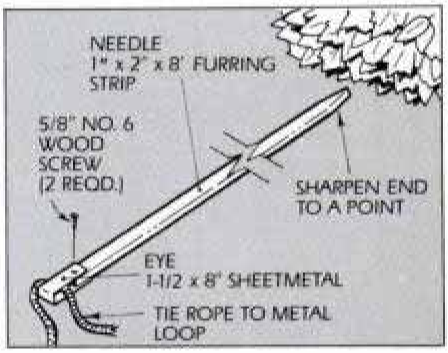


The holes in the tabletop make it easy to secure a vise or compact power tool. Table rotates 360°.

HINTS FROM READERS

Moving brush and branches

Large piles of branches or brush can be roped into bundles for easy towing with a garden tractor. To get the rope under the pile, use a needle-like tool made of an 8-ft.-long section of furring strip. Fasten a 1½ x 8-in. strip of sheetmetal



to one end of the wood to form an eye, and shape the other end to a point. To use the "needle," tie one end of the rope to the eye and push it under the pile of brush. Remove the needle, loop one rope end and pass the free end through the loop. Attach the free end of the rope to a garden tractor for towing.

—*George Danko*

Paint can care

Avoid a hard film at the top of a partially filled can of paint or varnish by floating a piece of plastic wrap on top of the liquid. The plastic wrap prevents the air in the can from reaching the paint and forming the skin. It also keeps out dirt and hardened pieces of paint or varnish that occasionally fall down from the rim of the can. When using paint or varnish where a thick film has already formed on top, you should tip the can over and open the bottom with a can opener. Then stir the liquid as you normally would, but be careful not to break the skin.

—*Millard Demy and Greg Williams*

Renew drapery cords

If the traverse rod cords of your draperies are becoming frayed and hard to pull, just apply floor wax with an old toothbrush to add to their life. The wax impregnates the drapery cords and makes them smoother.

—*George A. Mayerchak*

Make your car 'invisible' to radar for $17.95

Police radar can't find your car anywhere.

It's gone.

That's because it's been protected with AUTOGARD™, a new clear silicone-based spray you put on your car yourself.

It's made with the same innovative technology that makes U.S. fighter jets invisible to enemy radar.

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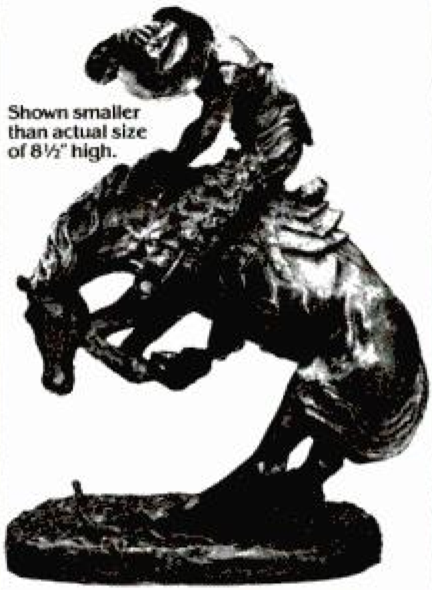
NE

"The Rattlesnake"

by Frederic Remington



Shown smaller than actual size of 8½" high.

Available in a single limited edition issue of 9500 serially numbered sculptures.

One of Remington's best known works —"The Rattlesnake"—depicts the moment a horse and rider startle a snake. The few original bronzes, made in 1905, have recently sold for over $135,000. Now this ⅓ size reproduction is available for only $195.00 per sculpture.

The fine reproduction was produced under the supervision of Ms. Christine Roussel—a creator of fine reproductions for the Metropolitan Museum of Art and The Nelson Rockefeller Collection.

Each Rattlesnake replica will be created in cold-cast bronze—a blend of powdered bronze and resins. Once the casting is completed, it will be finished with a rich patina, similar to the original. Each sculpture will be serially numbered and hallmarked. The edition will be limited to 9500 pieces.

To reserve "The Rattlesnake" simply return the application below.

"The Rattlesnake" RS0265

NE New England Collectors Society
237 Saw Mill Road, P.O. Box 509
West Haven, CT 06516

Please accept my reservation for "The Rattlesnake" crafted in cold-cast bronze at $195.00* plus $3.00 for shipping and handling.

☐ I need send no money now. When my sculpture is ready for shipment, I will be billed for my deposit of $49.50* and, after shipment, for the balance in three monthly installments of $49.50* each.

☐ I would like my four equal payments of $49.50* charged to my:
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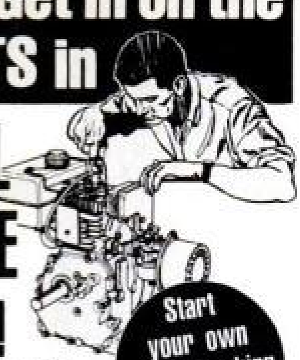

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No doubt about it... as a small engine pro, you can cash in on the huge demand for qualified men in one of America's fastest growing industries. You'll be able to command top hourly rates of from $25.00 to $30.00 per hour — and that's just for labor. A simple tune-up earns as much as $49.95 for less than an hours work, and parts, engines and accessories will add even more to the profits.

Plenty of business waiting for qualified men.

65,000,000 Small Engines Are In Use Today!

That's the official count from the Engine Service Assn., and one-million new engines are being built each month. With fully accredited Foley-Belsaw training, you can soon have the skills and knowledge to make top money servicing these engines. People will seek you out and pay you well to service their lawnmowers, tillers, edgers, power rakes, garden tractors, chain saws, minibikes, snowmobiles, generators, go-carts, paint sprayers, snowblowers... the list is almost endless.

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You don't need to be a 'born mechanic' or have any prior experience. You can master this profitable trade right at home in your sparetime. Lessons are fully illustrated...so clear you can't go wrong, and with our famous 'learn-by-doing' method you get practical 'hands-on' experience. We also show you how to get business, what to charge, where to get supplies wholesale...all the inside tricks of the trade you need to assure success right from the start.

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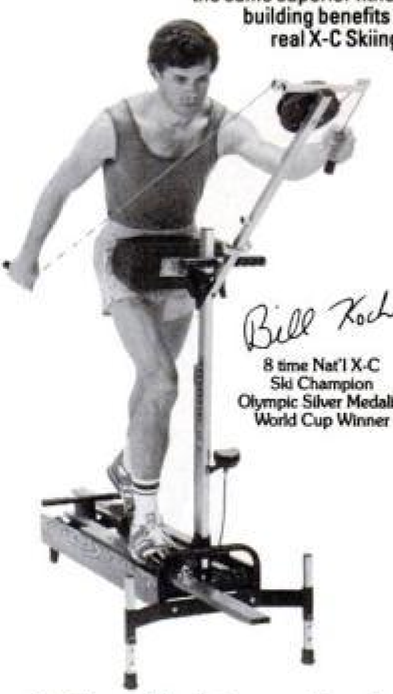

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Scientific Tests Rank NordicTrack #1

In tests of exercise effectiveness at Oregon Health Sciences University, NordicTrack was found significantly superior to the exercise bike, the rowing machine and other exercisers.

Rank of Effectiveness

1. NordicTrack X-C Ski Exerciser
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NordicTrack's higher oxygen usage score shows that more muscle mass is involved in the exercise and more calories are being burned. This means you build your own fitness faster and with less effort on the NordicTrack.

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  NordicTrack's skiing motion more uniformly exercises the body's major muscles for a more effective workout.
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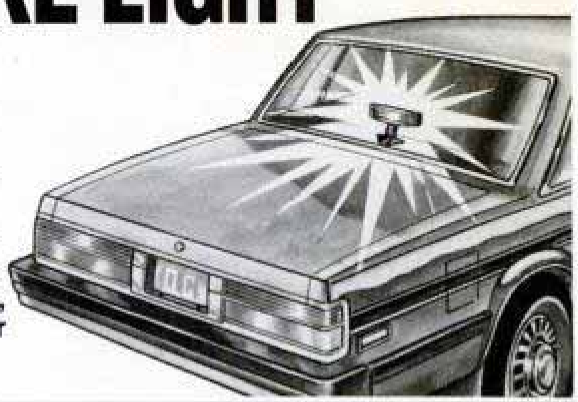

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Astonishing Fact: Use of the eye-level third brake light can reduce vehicle damage and repairs by almost 60%.

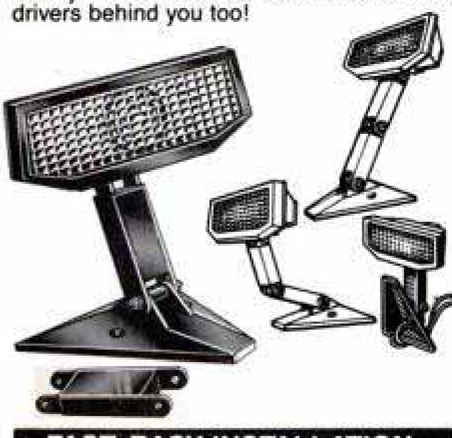
The overwhelming benefits of the eye-level third brake light demanded strong government action. So in the public interest . . .

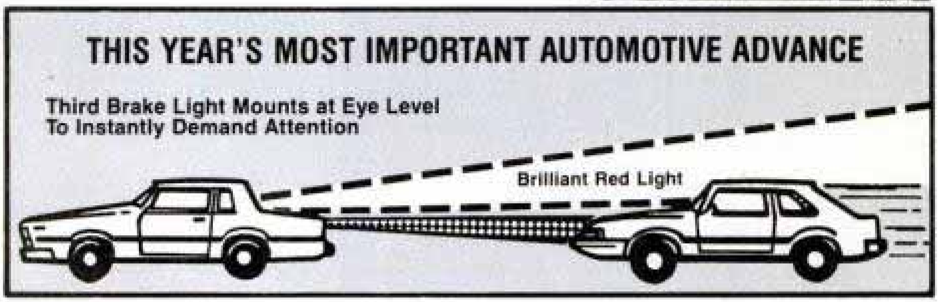
Federal Safety Regulations Now Require Eye-Level-Mount Brake Lights On All 1986 Model Cars.

You owe it to yourself, to those who ride with you, and to those who drive behind you, to equip your car with this light as soon as possible.

Here's How It Works

Your third brake light is mounted at eye level, so it is highly visible to the driver behind you . . . and to the second and third drivers behind you too!





Drivers following you enjoy improved depth perception . . . night and day . . . and tailgaters are warned to keep a safe interval.

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This light is coordinated with your brake lights, and positioned in the center of your car, so that drivers behind you cannot confuse it with turn-signal or tail lights . . . even for a moment.

Installation of this light may even qualify you for a discount on your auto insurance.

Easy Do-It-Yourself Installation

Your light mounts easily INSIDE your rear window—just like new cars—where it is protected from harsh weather, car washes, theft and vandalism. No need for any nasty drilling into your car body. NO wire cutting, stripping or taping either. Special splices are included to let you connect light wires to your brake-light wires . . . instantly- . . . with any pliers!

Fits ALL Cars, Trucks, and Vans

The universal mounting bracket, pivoting joints, and extra mounting extension make it easy to position your light perfectly. You will enjoy easy installation in any sedan, hatchback, station wagon, pick-up truck, van, or any other American or imported vehicle with a 12-volt electrical system. Your light has a big 6¾" wide x 1⅜" high red lens, and wiring, splices and easy-to-follow illustrated instructions are included.

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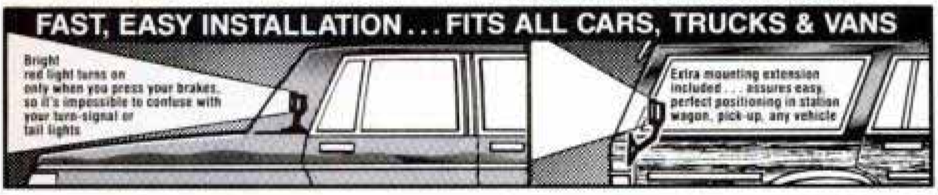

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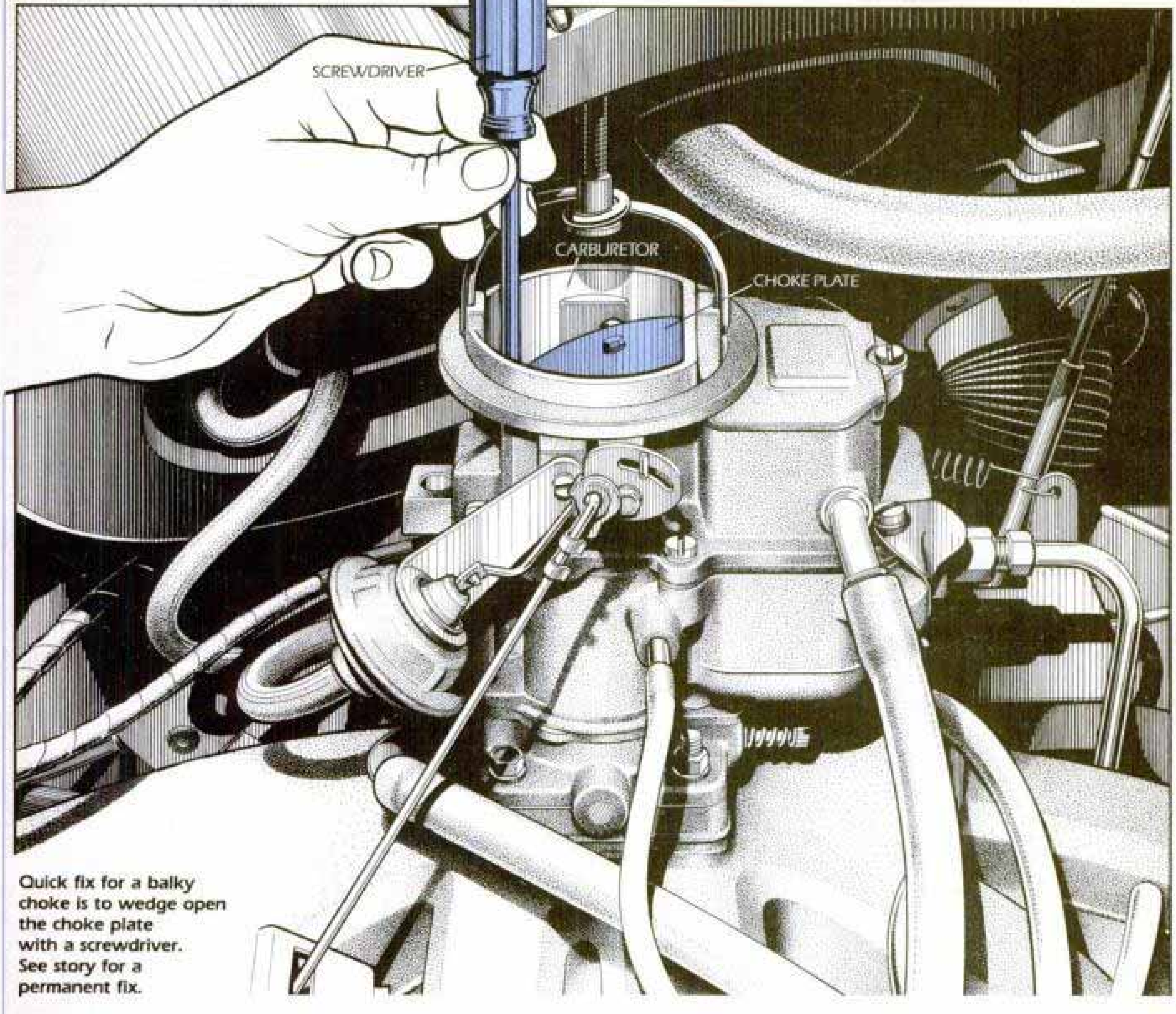


Quick fix for a balky choke is to wedge open the choke plate with a screwdriver. See story for a permanent fix.

SOLVING HOT-START PROBLEMS

BY PAUL STENQUIST

It's a hot day in the middle of August. You park your car for 30 minutes or so while you do a bit of shopping. When you return you discover that the car, which started easily on the coldest mornings last winter, won't start now.

Hot-starting problems are a common source of driver distress. Because they sometimes go away when the engine has cooled completely, they can be very difficult to diagnose.

Hot-start problems can be divided into two categories: those that cause the engine to crank so slowly that it won't fire and those that make the engine hard to start but don't affect cranking speed.

Hot start, slow crank

Here, when you turn the key to the START position, the engine sounds like it's turning one revolution at a time with a pause between each. The engine may suddenly begin to crank faster, or it may just continue cranking laboriously until the battery is dead.

If it occurs only once, it may be due to nothing more than a discharged battery or inoperative charging system. If it occurs often when the battery is fully charged, it may be the result of high cranking circuit resistance, internal engine problems, cooling system problems, excessive spark advance, or several of these conditions in combination.

High cranking resistance

When corrosion or loose connections in the starting circuit raise circuit resistance, your battery might have a tough time cranking the engine. And, because resistance increases further when underhood temperature is high, the problem may be noticeable only on hot summer days.

Before even attempting to diagnose the problem, clean the battery posts and terminals as well as the connection points on the starter motor, starter relay and/or solenoid. Reinstall the terminals and make sure all connections are tight. Start the engine and warm it to maximum operating temperature by driving it slowly for at least half an hour. Then check starter positive and negative circuit resistance by measuring voltage drop.

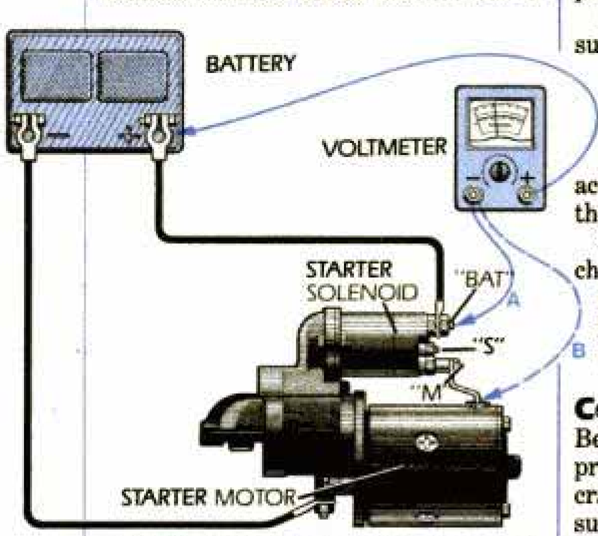
To check positive circuit voltage drop, connect the positive cable of a voltmeter that reads in tenths of a volt to the positive battery post and the negative cable to the terminal on the starter (see Fig. 1). On starters with external solenoids (including most GM cars), connect the negative lead to the large copper connector that joins the solenoid to the starter. Crank the engine with the meter attached. It should read less than .5 volt if circuit resistance is within limits.

If you get a reading in excess of .5 volt on a car with an external solenoid, attach the negative probe of the voltmeter to the BAT terminal on the solenoid where the battery cable is attached. If there is less than .5 volt to this point with the engine cranking, but more than .5 volt at the bridge between the starter and solenoid, the resistance problem is within the solenoid.

High solenoid resistance is very common on some GM cars. The problem is due to a buildup of corrosion on the brass disc that transmits voltage to the starter when the solenoid engages. New Delco solenoids have an improved design contact plate, so rather than purchase a rebuilt solenoid, buy a new one from your GM dealer.

If positive circuit resistance was excessive at both points, the problem is in the positive battery cable or its connections. Replace the cable and recheck all terminals for corrosion.

Check negative circuit resistance by connecting the voltmeter's negative lead to the negative battery post and the meter's positive lead to the starter housing. Make sure you make contact with the bare metal of the housing. When the engine cranks the ground circuit, voltage should drop less than 0.2 volt. If not, check all connections again and replace the ground cable if necessary. If the ground circuit cable is attached to the frame, make sure that the cable joining the frame and engine is in good condition. By connecting your voltmeter's positive lead to various points in the ground circuit you can usually pinpoint the problem area.



1 To check resistance on starters with external solenoids, connect meter as shown.

Excessive spark advance

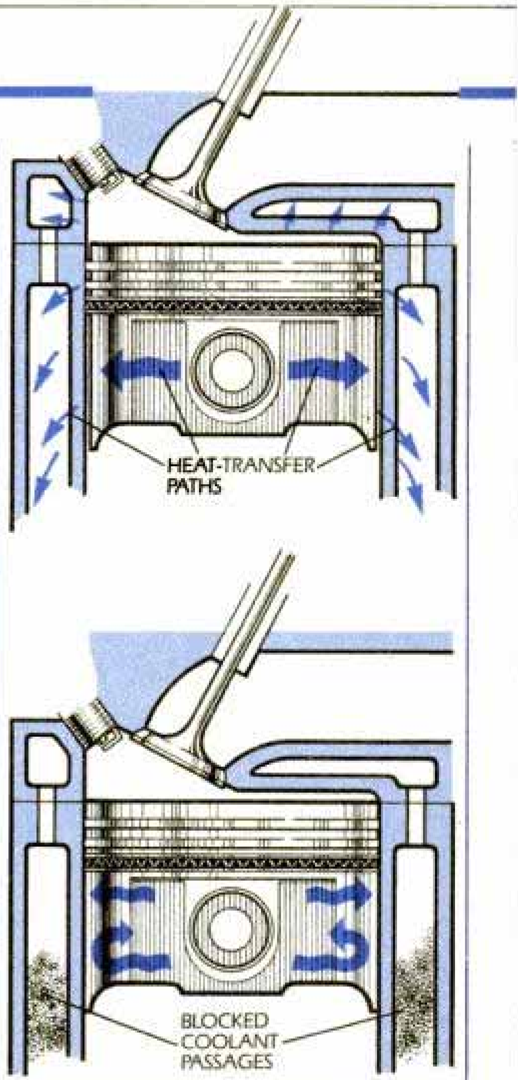
Slow crank/hot problems are frequently caused by a combination of high resistance and excessive advance, so it's a good idea to check spark timing even if you think you've solved your problem with a solenoid or cable replacement.

First, attach a tachometer and make sure idle speed is at specification. Then, check timing following the directions on your vehicle information label or in your shop manual. If the manufacturer provides a range of acceptable timing, adjust to a figure at the lower end of the range.

On cars with mechanical advance, check the centrifugal weights inside the distributor to make sure that corrosion isn't causing them to stick when the engine is hot.

Cooling system problems

Believe it or not, serious cooling system problems can cause hot start/slow crank problems. If coolant passages surrounding engine cylinders are blocked with sludge and corrosion, heat from the pistons won't be transferred to the coolant (see Fig. 2). This causes the pistons to expand to the point where friction between them and the cylinder walls makes the engine difficult to turn.



2 Heat flows easily from piston to coolant in normal cooling system (top). In clogged system, piston can expand enough to drag.

This can sometimes be remedied by a power backflush combined with a cooling system cleaner. In severe cases, cylinder block replacement may be the only solution.

Ordinary overheating problems can also cause an engine to crank slowly when hot, so check the cooling system thoroughly.

Internal engine problems

Any internal engine problem that produces friction can cause the engine to crank slowly. And since most clearances tighten up when the engine is hot, it's most likely to happen then.

You can tell if your engine is hard to turn by removing the plugs and attempting to turn the front crankshaft bolt with a torque wrench. It should break away at 90 lb.-ft. or less and should turn with the application of 70 lb.-ft. or less.

Internal engine damage might occur

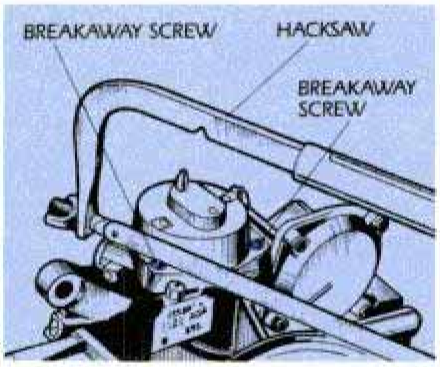
in combination with, or as a result of, blocked cooling system passages. The torque wrench test can't tell you for sure that the problem is due to one or the other. So before disassembling your engine or asking the mechanic to do so, make sure you've exhausted more conventional remedies.

Fast crank, no hot start

What about cars that crank fast when the engine is hot but still won't start? This problem is usually the result of a choke system failure, a fuel flooding problem, a serious vacuum leak, fuel starvation or an intermittent electrical failure. If your car is in need of a tuneup, do that before looking for more unusual causes.

Choke problems

The scene is repeated over and over again in supermarket parking lots during the heat of summer. After a futile attempt at starting his car, the driver jumps out, throws up the hood, unscrews the air cleaner and jams a screwdriver between the choke plate and carb body (see opening illustration). After starting the car, he reverses the procedure, slips behind the wheel and drives away.



3 Remove carb from engine if necessary to cut slots in choke housing screws.

The culprit could be an incorrect choke adjustment, but you must also consider the carburetor flooding problems discussed below. Although the screwdriver holds the choke flap open, that may only be necessary due to engine flooding.

Choke adjustment and cleanup, though, are the first two things you should consider. Make sure the engine is cold. Use a small solvent brush and a can of carb cleaner, or an aerosol can of carb cleaner, to remove all the varnish and accumulated dirt from the linkage arms and choke assembly.

Because there are a number of different choke mechanisms on recent carburetors, we can't provide exact directions or specs for checking each. So to do this job properly, you'll need a service manual. Most choke systems require at least three adjustments: vacuum break, choke flap closing and fast idle. Some call for as many as five or six different adjustments.

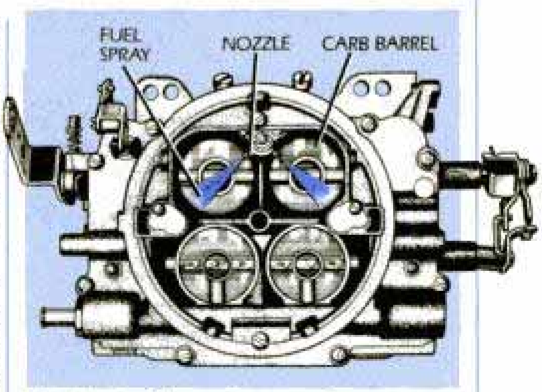
On most systems, a temperature-sensitive bimetal coil, mounted either on the carb body or within a stove on the intake manifold, opens and closes the flap. On some, the coil is heated electrically, on others, exhaust heat is used. Adjustment is frequently accomplished by turning the housing that surrounds the bimetal coil until a pointer aligns with a specified point on a scale that is attached to the carb body. On others, the housing is mounted in a fixed position and adjustment is made by bending a linkage rod or lever. Sometimes the correct choke flap position must be gauged with a rule, or with a drill bit or rod gauge.

On most cars, the choke housing is mounted with rivets or slotless screws to discourage tampering. To remove rivets, drill them out. To remove slotless screws, make a slot in each with a hacksaw blade (see Fig. 3).

Choke flap sticking can become a problem on very old carburetors or poor rebuilds if the choke flap bushings have worn to the point where the flap won't stay in one position and can't be adjusted properly.

Bowl vent boilover

When you park your car, heat from the engine is transferred to the fuel remaining in the carb float bowl. The temperature increase is accompanied by rising pressure. This pressure has to be relieved or fuel will be forced into the intake manifold. Once the manifold becomes soaked with fuel, the engine floods and can only be started by holding throttle and choke flap wide open. If you're greeted with a powerful gasoline odor when you open the hood, the engine is most likely flooded.



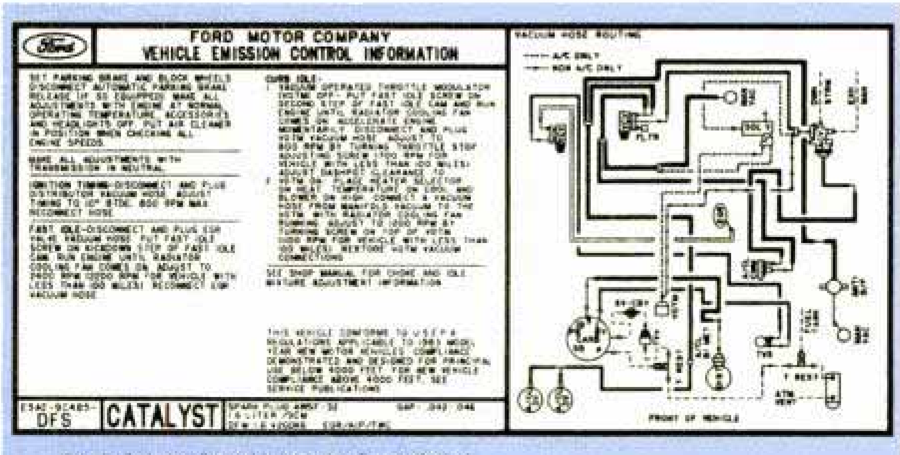
5 Fuel should spray from accelerator pump nozzles when throttle is opened manually.

On most cars, the float bowl is vented to the evaporative emissions canister. The vent must be open when the engine is shut off or high pressure within the bowl will force fuel through the carb metering circuit.

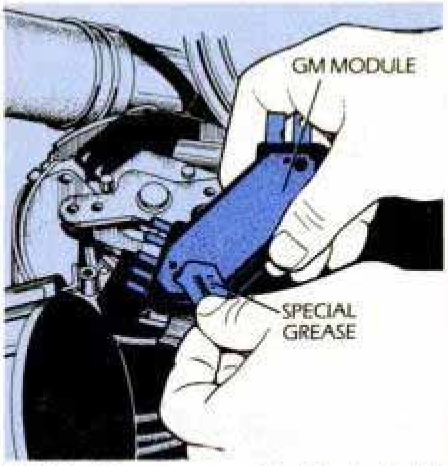
Check the bowl vent and any connecting hoses for possible blockage. If they're okay, take a look at the canister. If the bottom of the canister is open, you can usually replace its filter. If a closed canister drips fuel from the bottom, replace it and troubleshoot the evaporative emissions system (see your service manual).

Internal carb leaks

If you find that your bowl vent system is okay but your engine continues to flood when it's shut off hot, the carbure-



4 Decal in engine compartment shows vacuum hose routing and spark advance specs.



6 Dielectric grease on the back of GM ignition modules can prevent heat damage.

tor probably has an internal leak.

Before you invest in a new carb, make sure your engine is running at normal temperature. Even a good carburetor may spit fuel into the engine if it's running 30° or 40° above normal.

Vacuum leaks

If your engine is hard to start hot but does not seem to be flooded with excess gasoline, a vacuum leak could be the problem. Check all hoses for splits, kinks and other signs of damage. If they're old and brittle, replace them. Make sure all hoses are connected in the manner illustrated on the emissions information label (see Fig. 4).

In addition to making hot restarts difficult, a vacuum leak will cause a rough idle. To find a vacuum leak that is not the result of an obviously defective hose, use a needle-nose pliers to squeeze off each vacuum hose near its source while the engine is idling. When the roughness clears up, you've found the leak. If the hose itself is okay, the component it's attached to may be bad.

An EGR valve that sticks open qualifies as a vacuum leak, as it allows the engine to draw air through the exhaust passages when you're trying to start it. On most engines you can check the EGR valve by applying vacuum to it with a hand-held vacuum pump while the engine is idling. When the vacuum signal causes the valve to open, the engine will idle roughly. When you release the vacuum, the valve should close and proper idle should be restored. If the application of vacuum to your EGR valve does not cause it to open, check your service manual for EGR test procedures.

Fuel starvation

While excess fuel is a common cause of hot-start problems, they also can be the result of fuel starvation. In these cases, the engine cranks until the pump has filled the float bowl sufficiently. Then it finally starts.

You can tell if your engine is getting a supply of fuel by removing the air cleaner and looking down the carburetor barrels. (Do this while the engine is off and the starting problem is present. Take care not to burn yourself on hot engine parts.) While holding the choke flap open, crack the throttle. You should see fuel shoot out the accelerator pump nozzles (see Fig. 5). If you don't, check the fuel filter, fuel pump and carburetor float adjustment.

Electrical problems

Some electronic parts can fail temporarily when underhood temperatures are high. Unlike our previous examples, the engine will start only after having cooled off for an hour or two.

The most likely offender in these cases is the electronic ignition module. Off-brand discount-priced modules seem to be more likely to fail than name brand or original equipment types. Applying dielectric silicone grease to the underside of GM modules reduces the chance of heat damage and hot restart problems (see Fig. 6). Have a mechanic test the old module before you buy a new one; these expensive electronic parts cannot be returned.

Fuel-injected engines

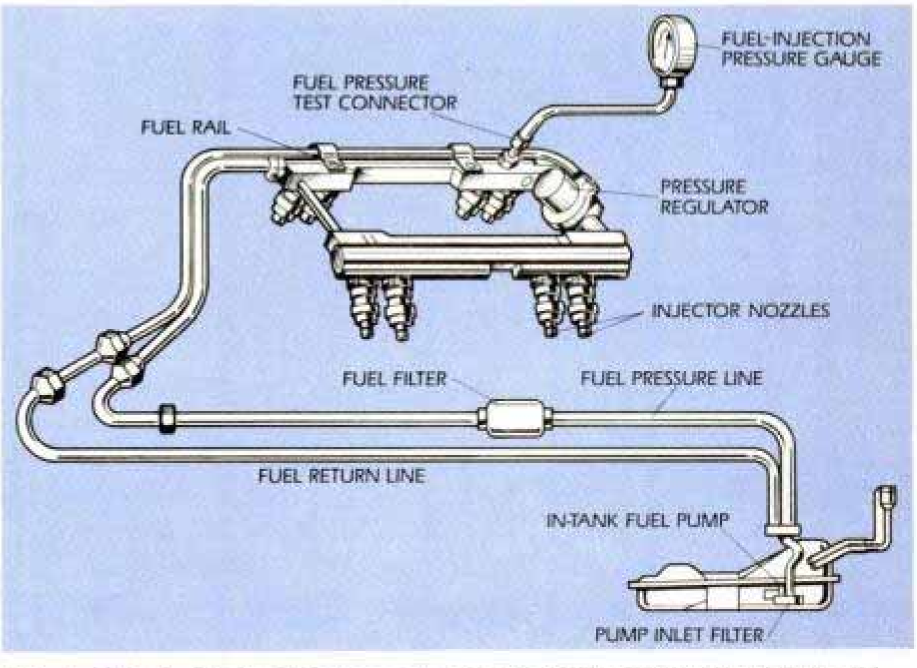
Because most injection systems remain pressurized after the engine is shut off, a fuel injector that sticks open can flood the engine and foul one or more plugs. Given enough time, the fuel evaporates and the engine starts easily. But for the first hour or so after shutoff, starting can be extra tough.

On port-injected engines (one injector per cylinder), a sticking injector can sometimes be located by checking the plugs half an hour after shutoff. If a plug is fouled or wet, it's likely that the injector for that cylinder is leaking.

A lack of wet plugs doesn't necessarily rule out dripping injectors. A visual check of the injectors is the best test. On throttle-body injection systems (central injectors within a carb-like body), the injectors are easy to observe and you can simply warm the engine, shut it off, remove the air cleaner and watch the injector(s) to see if there's a drip. On some port-injected systems you can lift the injectors and fuel rails out of the ports to watch for drips.

A check of system pressure is also useful in tracking down leaking injectors. If pressure drops continuously after the engine is shut off, a leaking injector could be the cause. But other problems—like a faulty fuel pump check valve, a leaking pump connection or a bad pressure regulator—can cause pressure loss as well.

On most systems you can measure pressure by attaching a fuel-injection pressure gauge to the Schrader valve, which looks like a tire valve. When attaching the gauge, wrap a rag around the gauge connector to catch any pressurized fuel that squirts out. PM



7 To check for leaking fuel-injector nozzles, attach pressure gauge to Schrader valve.

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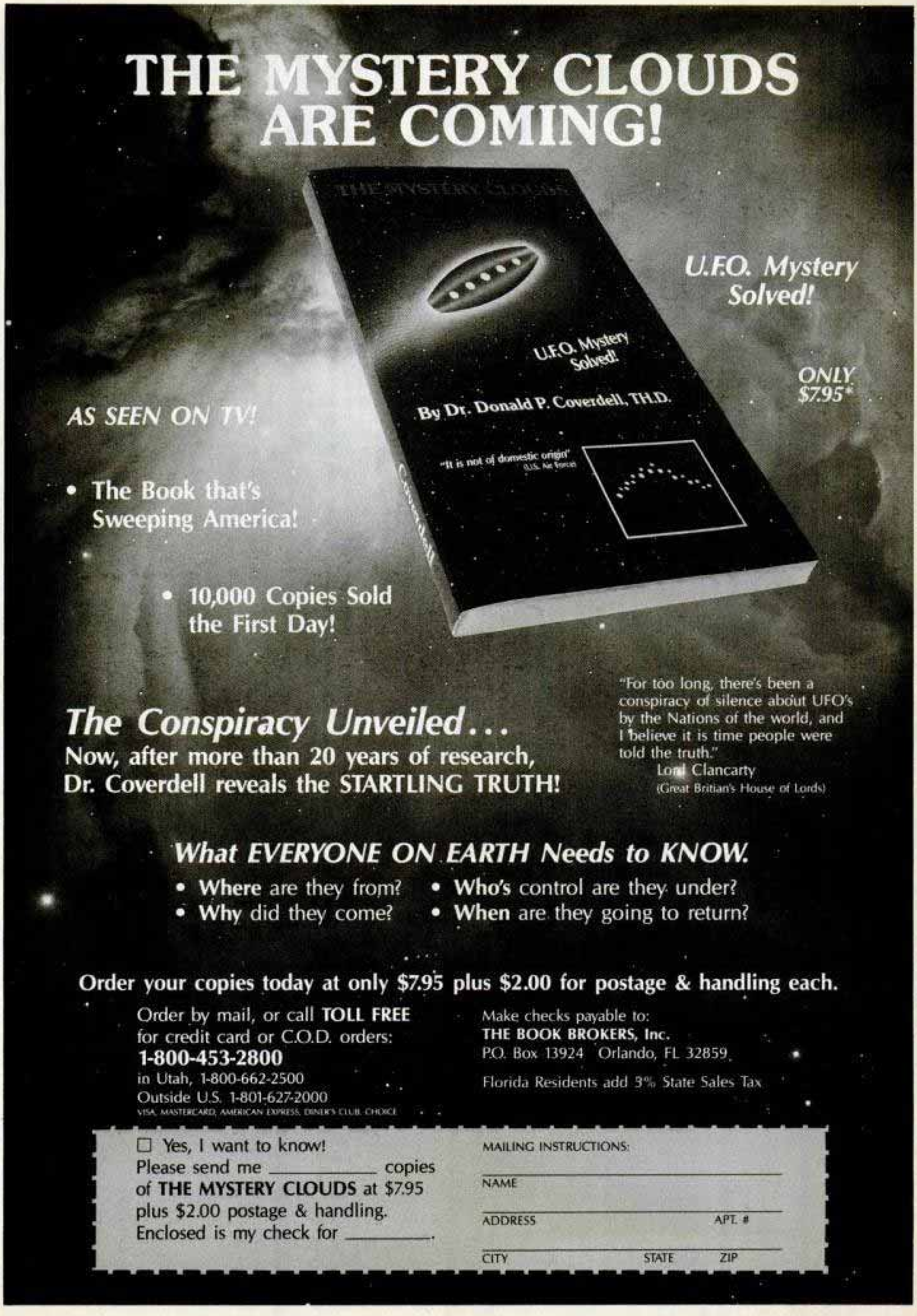

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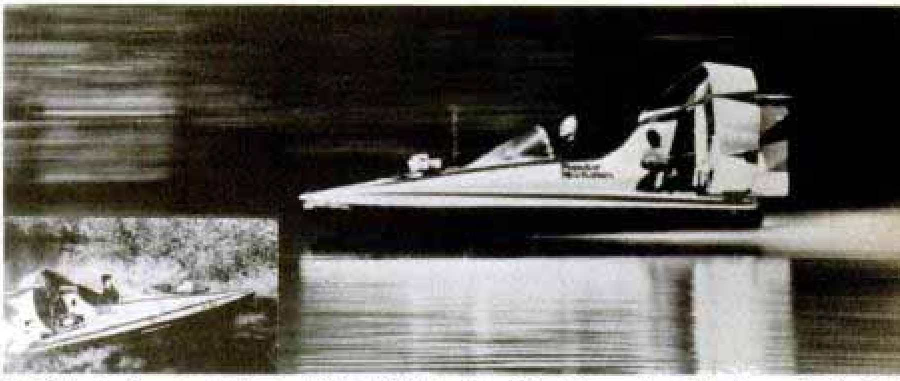

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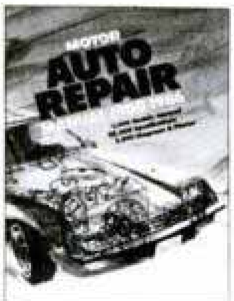

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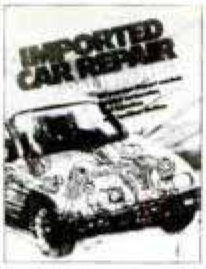

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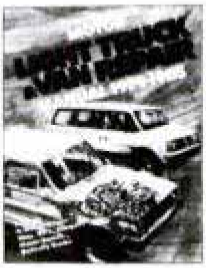

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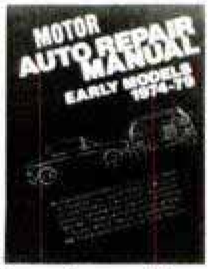

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(Continued from preceding page)

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(Continued on next page)

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(Continued from preceding page)

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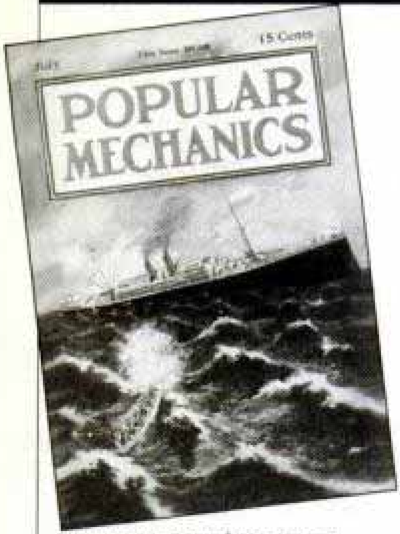
TIME MACHINE

75 YEARS AGO: July 1911



New-wave ironclads sailed.

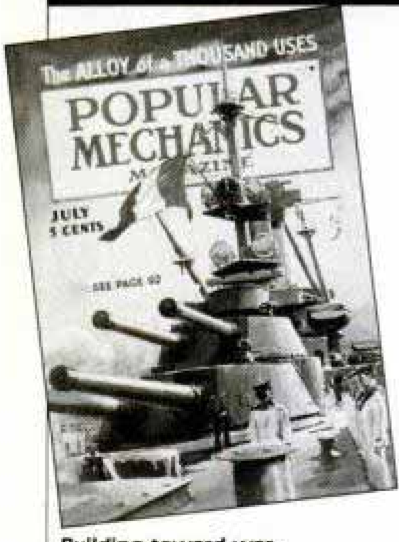
Antiroll ships

Ironclad ships had a problem in rough seas. They would roll with the waves, sometimes so violently that crew and cargo were jeopardized. Sir Phillip Watts designed antirolling tanks for the ironclads. The idea was to let the ship carry her own waves in an internal tank below decks. As she pitched to one side, water in the internal tank would pitch with her and the ship would take a while to right, breaking the rhythm of the waves. The tanks went out with the ironclad ships.

Lights, camera, action!

A New York film studio started using a revolutionary lightweight camera that was capable of shooting still pictures from a moving platform, such as a horsedrawn carriage. The photographs came out as clearly as if they were done on a steady platform.

50 YEARS AGO: July 1936



Building toward war.

Big guns at sea

America was becoming increasingly aware of the threat of a major war breaking out. Little did we realize how important the Navy would become. The emphasis was on a fleet of battleships with "guns that can hit shore battlements and even engage an enemy aircraft." Part of the battleship fleet was sunk at Pearl Harbor, but most of it remained afloat and was a key to the Allied victory in World War II. The battleships *Iowa* and *New Jersey* are back in service today.

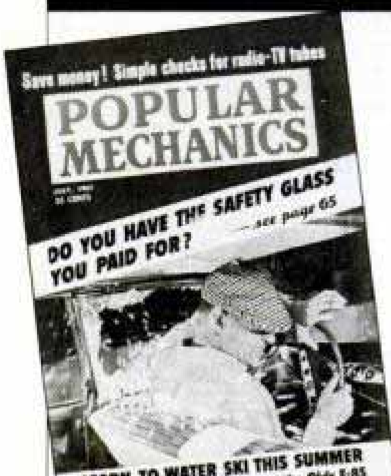
Future car?

We showed off the invention of a Wisconsin machinist, a car whose body was built sleek like an aircraft. The prediction was that aerodynamics would become important in automobile design within 10 years.

Rocket ship

Germany announced plans to build a new amphibian plane with a liquid rocket to assist in takeoffs. The twin-hulled 2-man vessel had twin overhead rotors and could take off like a helicopter. The liquid rocket, which burned for less than one minute, gave it an assist so it could do a short takeoff maneuver in record speed. The Germans wouldn't let the rest of the world know just how fast the rig went. But less than a decade later, the Germans were using rockets to menace Great Britain.

25 YEARS AGO: July 1961



Shatterproof glass breaks up.

Safety glass class

Motorists who purchased cars with "safety glass" windows were surprised to find that the glass shattered dangerously and unexpectedly in what seemed to be minor accidents. We did some digging and found that automakers were selling both laminated and tempered glass as safety glass. The laminated glass was truly shatterproof. But cheaper safety glass would break when hit hard by small objects like stones. Today's cars are all equipped with certified shatterproof glass.

Hot photo hints

Lots of new items were coming out to improve the abilities of the amateur photographer. One firm produced a minigrip with shoulder brace to take the place of a tripod in tight situations. The Addiphot photo meter came with a slide rule-type scale to read light values against outdoor weather. The Sunset-88 was a viewing projector for tabletop viewing. It came with a built-in screen and could show 36 slides in a sitting. Today's camera buff has a wider variety of products to choose from.

Future Kareem

Safety glasses for little-league baseball players were introduced. They didn't catch on immediately. But since basketball star Kareem Abdul-Jabbar started using them, the glasses have come back into style. PM

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