All things considered, we like the oil business. There’s drama in its tense corporate decisions, excitement in the drilling of a wildcat well, the suspense of wondering whether you can get out before the muskeg thaws, and the adventure of undersea drilling on the stormy Grand Banks. There’s also a good deal of satisfaction to be gained in the knowledge that what you do is important to your country and essential for the well-being of your fellow men.

It’s also nice to know that people are finally beginning to realize that the industry isn’t to blame for some of the things we get blamed for. Like the price of gasoline. Everybody knows the price of gasoline is up. Since 1988, the price of a gallon of regular Esso averaged across 10 principal cities in Canada has risen from 43.6 cents to 47.9 cents. When the price of Esso goes up, Imperial gets blamed.

And yet, generally speaking, Imperial has had nothing to do with it. Quite the reverse, in fact. While the price has gone up, the amount Imperial gets for a gallon of Esso, excluding federal sales tax, has gone down. Since 1988, it has dropped by two cents a gallon, from 21 cents to 19 cents. The reason you pay more is because the federal sales tax has gone up (from 1.5 cents a gallon to 2.1 cents), the average dealer markup has increased (from 7.6 cents to 8.7 cents a gallon), and the average of provincial gasoline taxes has gone up (from 13.4 cents a gallon to 18 cents).

So you see, the price has risen because the provinces have increased their tax (all told, Imperial alone collected more than $190 million for provincial governments in gasoline taxes in 1987), because the federal sales tax is higher (Imperial collected 44.8 million last year for Ottawa), and the dealers got more. But Imperial got less. We have coped with that situation by spending a lot of money to keep the costs of our products down. It makes us unhappy when increases we can’t control push the price up and we get blamed.

But things seem to be looking up. A recent advertising campaign planned to make exactly that point in a specific area, seems to have succeeded. Ask why the price of Esso has gone up and the chances are better now in the region where the campaign was held that you’ll be told it’s because of taxes and markups, not Imperial.
paved with stone, concrete, asphalt or good intentions, it will take you wherever you want to go

THE OPEN ROAD

by Nathan Dreskin

The Trans-Canada Highway stretches 4,430 paved miles from Sydney, N.S., to Vancouver, and if you add the 550 miles it covers from St. John's to Port aux Basques in Newfoundland, and the 20 miles it stretches from Swarts Bay to Victoria on Vancouver Island, you get a 5,000-mile road that is the longest national highway in the world. If we all went out tomorrow and lined up along it, each man, woman and child in the country would have just one foot, three inches to call his own.

The Canadian road system covers half a million miles; last year it gave the seven million vehicles in this country somewhere to go to rack up the 69 billion miles they all traveled. Since World War II we have spent more than $1.5 billion on the road system.

What have we got for the money?

"One of the finest road systems anywhere," says C. W. Gilchrist, managing director of the Canadian Good Roads Association, a group of government officials, road builders, engineers and other people interested in roads. "The 510-mile Macdonald-Cartier Freeway through southern Ontario is the longest freeway under a single jurisdiction on this continent and, like some of our other roads, it compares with the best in the world."

Roads have been important to Canadians since the early 1700s when they were needed to link the centers of government with outlying farms and settlements. In New France, for example, such roads joined the colony's administrative headquarters at Quebec with Beauséjour and Be d'Orléans. By 1734, coaches were making the trip between Quebec and Montreal in four and a half days (three hours by bus today).

The history of Canadian road building is marked by periods of apathy and, at times, downright opposition. During the mid-1800s, Haines Highway runs 154 miles south from Mile 1016 on the Alaska Highway through British Columbia to the Pacific at Haines, Alaska.
funds were diverted to railway construction and roads allowed to fall into neglect. They began to stage a comeback with the sudden popularity of the bicycle in the 1890s and then, about the turn of the century, the automobile. By 1912 there were 30,000 cars in Canada. But early cars didn’t enjoy universal popularity. Angry farmers in Ontario set up tarred roads and spoked planks in the roadway to discourage drivers of the noisy, frightening, dust-raising vehicles. When they couldn’t stop them, they vandalized them—farmers would dangling mudholes with straw to trap unwary motorists, then charge $5 to hunt them out. In 1909, the premier of Prince Edward Island effectively outlawed autos, and the ban didn’t come off completely for 10 years.

But cars were here to stay, and their increasing numbers created a rising demand for paved roads that the methods of the time could not meet. Blacktop roads of the 1920s had to be laid with hot asphalt, laboriously mixed and laid by hand. They were so expensive—about $300,000 a mile—that only the cities and towns could afford to pave their streets.

Country roads went unpaved until Imperial pioneered a new paving technique that used asphalt liquified with kerosene to the point where it could be mixed cold with roadside gravel to make a serviceable blacktop. It cut the cost of paving roads to $5,000 a mile, but nobody rejoiced. “When one of our technical people tried to promote these low-cost asphalt pavements he met strong objections from a group of local road builders,” reports Dr. Norman McLeod, Imperial Oil’s asphalt consultant. “They felt it would ruin their business, and they even petitioned the head office to have the man withdrawn. But soon these same people were making much more money building many miles of low-cost asphalt pavement per year, compared to their previous mile or two of the expensive kind.”

There have been difficulties and setbacks, but the need for roads has always managed to prevail. One of our first highways, about 1700, ran the 12 miles from Cap Rouge to Quebec. As a chemin du roy, it was 24 feet wide, with three-foot ditches. Farmers brought their produce in ox carts along it to market and transact business in the colony’s capital. Parts of that original route today is Quebec City’s famed Grande Allee.

Soon after choosing what is now Toronto as the capital of Upper Canada, Gov. Simcoe visualized a main street on a scale new to this country. It would run 33 miles in a straight line between Lake Ontario and Lake Simcoe. By 1796, the Queen’s Rangers had blasted such a route, and thus began Yonge Street. The 627-mile Terenceiva Trail or ‘French Path’ from Fredericton, N.B., to Quebec was the first interprovincial highway. In 1792 it drew what is probably the first reported complaint about speeding in these parts. After a trip over it, Gov. Simcoe’s wife noted in her diary: “The carrioles were driven furiously, as the Canadians usually do.”

Nineteenth century Canadian roads discouraged all but the hardest travelers who feared, above all, the notorious corduroy stretches, named for their resemblance to the ribs in corduroy cloth. Corduroy roads were made of logs from nine inches to two feet in diameter laid across marshy, muddy ground. They threw passengers, sometimes with fatal results, destroyed wagons and lamed horses.

“Those terrible corduroy roads,” reported a visitor, Anna Jameson in 1837, following a trip to Chatham, Ont. “Black, bottomless sloughs of despond. I set my teeth and commenced myself to heaven but I was well-nigh dislocated.”

In 1835 plank roads, an original Canadian contribution to road building came into use. The planks were spiked to stringers and often covered with sand or gravel. It seemed the perfect solution to the road problem of the time. ‘You glide along much the same as a child’s go-cart on a carpet,’ Sir Richard Bonnycastle of the Royal Engineers reported enthusiastically. Some 400 miles of plank roads were built in Ontario and Quebec, and they were copied widely by the Americans. Unfortunately, not proved their undoing and although plank roads continued to be built for special reasons, they lost their popularity within 20 years.

One of the most famous Canadian pioneer roads was the Cariboo Road that ran 385 miles up the mountain-flanked Fraser River in British Columbia. It was built in the 1860s to link the goldfields to Vancouver so that the territory could be administered by the colonial government under Gov. James Douglas. The road boasted Canada’s only camel caravan, imported to carry supplies to the mining camps. But the 22 hapless beasts couldn’t take the rough terrain and had to be retired to the interior in favor of mules and ox trains. Stagecoaches carried express and passengers over the 18-foot-wide road, in places carved out of sheer rock through the canyons. The Cariboo Road, considered one of the wonders of its age, survives today in a blacktopped, 60 m.p.h. highway.

But the Cariboo Road was an exception. The last half of the 19th century was the heyday of railroad building—from 1830 to 1900 the length of Canada’s railroads increased from 66 to 17,657 miles—and it wasn’t until the appearance of automobiles in this century that roads got a fresh, new impetus. The Canadian Good Roads Association was formed in 1914. Its slogan at the time: “Let’s get out of the mud?”

In 1936, the CGRA was still bemoaning the state of the nation’s roads. In its annual report it described the situation in these words: “An 80 m.p.h. car with a 20 m.p.h. driver using a 35 m.p.h. road.”

Improvements, however, did come, if slowly. In 1939 Ontario opened the first divided highway on the continent with partially-controlled access: the 91-mile Queen Elizabeth Way that now stretches between Toronto and Fort Erie. It led the way in Canada in introducing such safety measures as overpasses and eliminating sharp curves and steep hills.

World War II slowed the rate of new road building for six years but it also resulted in an unsurpassed first-the Alcan Military Highway, now known as the Alaska Highway. The Canadian and U.S. governments decided to build this supply road from Dawson Creek, B.C., to Fairbanks, Alaska, out of fear of a Japanese invasion of the continent via the Aleutian Islands. The posters used for recruiting laborers for the project were sternly realistic: “This is no picnic,” warned the big black type. “Temperatures will range from 90 above to 70 below zero. Men will have to fight swamps, rivers, ice and cold. Mosquitoes, flies and gnats will not only be annoying but cause bodily harm. If you are not prepared to work under these conditions DO NOT APPLY.”

Some 6,000 did. With 10,000 soldiers they performed a miracle of road construction. Covering eight miles a day, working around the clock, they built a 24-foot-wide graveled roadway 1,523 miles long over five mountain ranges, 129 rivers and thousands of streams. They finished in eight months what, under normal conditions, would have taken five years. The invasion never came, but the Alaska Highway proved that roads could penetrate the ‘impenetrable’ north; it became the forerunner of the current federal-provincial ‘roads to resources’ program, a network of pioneering roads in the Yukon and Northwest Territories to exploit the potential in mining, industry, fishing and tourism.
Good roads do more than open a country for development; they are an active social and economic force. In education, for instance, they have made it possible to eliminate one-room country schools and replace them with large, well-staffed, well-equipped central schools to which students can be brough daily by bus, and taken home again at night. In commerce, roads have made possible the development of enormous shopping plazas that draw customers from cities and towns that were once considered to be impossibly distant for a shopping trip; Toronto’s Yorkdale Shopping Centre, for instance, is close to the junction of Ontario’s two major highways—400 and 401—and regularly attracts shoppers from Peterborough, 80 miles east, from Barrie, 85 miles north, and London, 115 miles west.

Roads are too much for granted today that it’s hard to realize the first cross-Canada road trip took place only 22 years ago when Robert Macfarlane and Kenneth MacDougall drove from the Atlantic at Louisbourg, Cape Breton, to the Pacific at Victoria. It took them nine days to cover the 4,743 miles and they had four flat tires along the way. Part of the trip was by car ferry across the Canoe Strait in Nova Scotia. Nine years later, in 1955, Cape Breton was joined to the mainland by Prince Edward Island’s Confederation Bridge linking Nova Scotia with New Brunswick.

In the past decade it has been their year-round road. Ten years ago, heavy traffic had to be restricted during the spring thaw for periods from six to 10 weeks. Now this ban has been virtually eliminated on the nation’s arterial road network to the immense benefit of commercial transportation and the industrial complex at large.

Last winter, Sudbury put down a test patch of deep-strength asphalt pavement 200 feet long. Its resistance to frost heaving has, as The Sudbury Star put it, "exhausted even the experts." Tests with stationary pies embedded in the road showed that this frost raises the pavement only a quarter to three quarters of an inch—almost negligible compared with the two to two-and-a-half inches it raises a conventional pavement.

As Imperial’s Dr. McLeod stresses, the new type of paving will replace the conventional only when it can be shown to be of equal or lower cost. The factor of cost has always been crucial in road construction, especially in Canada with its formidable distances and relatively small population to pay the bill. Everybody wants good roads but few like to pay for them. Who should pay, and how much is a pernicious theory.

The early settlers were required by law to build roads and maintain them. They had to work on the roads a fixed number of days a year, or pay a road tax. The arrangement was bitterly resented especially since the system favored the wealthy. A disgruntled Halifax shoemaker is supposed to have written to the government when he threatened to be held to the road commissioner (a threat that wasn’t carried out).

Early in the 1800s, pioneering capitalists financed the building of toll roads, and such turnpikes were widely used from Halifax to Upper Canada throughout the century. King George III’s famous painting, "Biting the Toll" portrays a popular sort of the time-speeding through the tollgate without paying. Operators of the turnpikes were supposed to maintain them in good condition but they rarely did so. Feeling ran high about this neglect and the toll roads used sometimes vent their anger by cutting down the tollgate or even burning the tollhouse.

Governments eventually took over and paid for roads out of their general funds. The province, beginning in 1903, began issuing motor vehicle license plates as early as 1903—the fee was made of leather—but it was not until after World War I that licenses became an important source of revenue and were collected to help offset road costs. Then Alberta led the way, in 1922, with a provincial gasoline tax—it was two cents a gallon; today it’s 15 cents—the average in Canada is 18.3 cents. Governors at large have often stipulated that the roads are not open because there is no license fee. Last year the federal government bore 10 percent of the cost of roads and streets, the provincial governments bore 60 percent, and the municipal governments 30 percent.

The total spent last year was $855 million, and the lion’s share of that amount was met by motor fuel taxes and license fees. The private car is the basis of our road system, and the private car holding such predominance for the next 25 years. He predicts no basic change in our road system within that period other than more emphasis on safety.

If financing is a problem, even more so is the alarming increase in road accidents. The use of automobiles has brought with it a new disease of epidemiologic proportions, that of traffic death and injury," says Dr. Eric Campbell, medical director of the Traffic Injury Research Foundation of Canada. In 1966, there were 5,261 Canadians killed and 160,942 injured in traffic accidents; approximately 14,000 hospital beds are needed daily to care for the injured.

The Canadian Highway Safety Council claims that not enough attention is being paid to those features of highway design that can reduce the accident rate. It calls the controlled access highway "the most significant advancement ever made in accident prevention," and urges that the safety lessons of such highways be applied to the conventional roads which still bear the greatest traffic volume.

It points out, for example, that the Macdonald-Cartier Freeway is four times as safe as other Ontario roads. In 1966, the province’s accident rate per million miles driven was 6.9 on all streets and roads was 5.9. On the freeway it was 1.4. And the overall death rate per million miles driven was 6.7; for the freeway it was 2.2, despite speeds greater than those of conventional roads.

Based on this experience, the CHSC urges road authorities to reduce the number of stop lights, which it sees as the cause of many rear-end collisions. It claims that it’s not speed that causes accidents but differences in speed in a traffic flow. "The law-abiding little old lady poses the major danger," says the CHSC. As one remedy, it suggests raising speed limits to a practical level—that is, the traffic speed is the same on any road. And it recommends the installation of well-lit, illuminated signs for the point where the driver must decide which direction to take.

Ottawa recently installed a resilient steel safety barrier on its cross-town Queenway to prevent cross-median crashes, a move highly recommended by CHSC on all such expressways. Such barriers had dramatic results wherever they have been installed—they cut fatalities by 90 percent on the Cross Country Parkway in Westminster County just north of New York City, and by 60 percent on the Pennsylvania Turnpike.

The Highway Safety Council also would like to see roadside obstructions reduced, pointing to the toll taken in life and limb in run-over road accidents. Among such obstacles the CHSC lists trees, poorly designed ditches, signposts and poles that resist impact in the face of slowing off, bridge abutments and piers too close to the roadway, and guardrails that start at headlight height like a spear aimed at the car if they sloped up from ground level like a ramp, both car and driver would fare better.

What does the future hold for our roads? At present the private auto provides about 85 percent of intercity travel. Experts like Dr. G. A. Campbell, CHSC’s director of research, see in the private car holding such predominance for the next 25 years. He predicts no basic change in our road system within that period other than more emphasis on safety.

---

The paving gang at Stoney Creek, Ont., in 1912. A gang of 22 men and a team, working 16 hours, could lay 300 feet of paving a day.

CIVILIZATION

CONVENTIONAL PAVEMENT

DEEP STRENGTH PAVEMENT

FULL DEPTH PAVEMENT

---

Deep strength and full-depth pavements that resist frost action better are beginning to replace conventional gravel-and-topping pavements.
Make your own nuclear magnetic resonance spectrometer or seawater desalinator; Van de Graaff generator, or anything else that interests you. Almost any teen-ager with a science fair background will show you how.

When Marjorie Doyle was 17 she completed a series of experiments at the Research Institute of the Hospital for Sick Children in Toronto that contradicted the report of an Israeli cancer researcher. What's more, she did the experiments while she was a grade 12 student living in Welland, 90 miles from Toronto, and had to get up on weekends in time to catch a train that left at 5:45 a.m. The experiments took eight months to complete, and won her a grand prize at the Canada-Wide Science Fair held at the University of British Columbia last May.

Marjorie is one of thousands of science-minded young Canadians who take part in local school science fairs, regional science fairs, and the annual Canada-Wide Science Fair which brings together the best projects of the 33 regional fairs every year. Her project—an experiment to compare the rate of liver regeneration between well-fed rats and starved rats that had parts of their livers removed—was one of the two judged best of the 68 finalists, and won her a trip to England for the International Youth Science Fortnight. The other big winner, Peter Jennings, also 17, of Niagara Falls (the winners are always a boy and a girl), got his award for a nuclear magnetic resonance spectrometer he built from $30 worth of used electronic parts. He studied protons with it and investigated the chemical structure of some hydrocarbons. A physics professor from Simon Fraser University told Jennings that his post-graduate students had been trying to do something similar, without success.

For Jennings, the trip to London is the highlight of the five years he has been entering regional science fairs. His first exhibit was a rocket containing a radio transmitter, tested in Niagara Falls, N.Y., because it is illegal to fire homemade rockets in Canada except under certain conditions. The rocket rose about 1,000 feet and sent back information on temperature and spin rate. In 1966, Jennings designed a model of a spacecraft meant to land on Mars. It was equipped with a way of determining whether life exists there: simply a string to be dragged across the ground. The string then goes into a culture medium where any bacteria it has picked up will grow. Light traveling through the medium and striking a photo cell measures the growth.

Jennings successfully tested the model on the roof of his home. 'It detected life,' he says.

That project won him a trip to the 1966 International Science Fair in Dallas, Tex., where one of the judges, who was involved with the U.S. space program, told Jennings that National Aeronautics and Space Administration scientists had come up with the same idea to detect microbes on Mars and planned to test it in 1972. The NASA project cost $50 million, Jennings said, while his cost was $50. It consisted of two cake pans, one above the other, on four legs, to hold his electronic equipment. Jennings also built two model satellites which won him trips to the Canada-Wide Science Fairs of 1965 and 1967.

Jennings has also found the time to make a 'teaching machine' to help his brother David study for exams. A teletype machine attached to a tape recorder containing test questions types out the questions. After David has typed the answers the machine gives the correct answers. Peter also uses the teletype in his ham radio operations.

In fact, all of this electronic equipment relates to Peter Jennings' abiding interest in ham radio. The spectrometer that won him the trip at Vancouver was built partly of bits and pieces from the radio, and has since been dismantled and re-integrated into the radio. Among the people Jennings has talked to over his set is Yuri Gagarin—he had a short conversation in English with the Russian space explorer a week before Gagarin was killed.

Jennings will go to London, too, to meet 400 young men and women from 40 countries who gather there for two weeks of seminars and visits to scientific points of interest. (Canada's representation in London is limited for economic reasons. 'We'd send more students there if we had the money,' explained F. C. Le Scotter, executive director of The Canadian Science Fairs Council.)

Though only two Canadian youngsters win trips to England, the others who qualify to exhibit in the Canada-Wide Science Fair up to four from each regional fair receive silver medals to commemorate their achievements. In addition to the prizes-four firsts,
A computer that plays tick tac toe and never loses was the project of Leslie Park hurd, 16, of St. Pius X High School in Montreal. He took five months to make the machine—which includes a light-board on which the moves are plotted—using computer Christmas tree lights, in cans, kitchen utensils and switches he made himself. 'The main unit is the memory chip,' Leslie explained in his note. "It is divided into the sensory section that identifies the problem and the coordinating section which dictates the solution." The memory drum is a five-gallon oil can.

Many of the projects are stupendously technical to persons of limited scientific background. For instance, Joyce Young, of Port Arthur, Ont., describing her 1967 experiment in avian tetracycline-study of defecations in the embryos of birds—wrote: 'I injected NaF into the yolks directly below the neural plate and found that it caused the yolk to contract with glycogenosis.' In other words, she injected sodium fluoride and discovered that it interfered with the embryo's utilization of sugar, and therefore affected its development.

One boy invented a baffling new numerical system and another the number eight. The boy, Vincent Capo-Greco, submitted his project to the Montreal Science Fair in 1963, and they still remember him well.

Vincent's exhibit was simply himself, notebook in hand, talking a blue streak,' recalled Dr. Wolfker, a 16-year-old high school scientist who founded the Montreal Science Fair and served as president of the Youth Science Fair for five years. "It was unlike any number system most people ever heard of. It had nothing to do with the binary or decimal systems, or of Egyptian or Chinese counting systems. The judges, including some eminent mathematicians, spent a great deal of time arguing with him and arguing among themselves. Some thought he was a genius; others said it was absolute baloney. In the end, Vincent received a second prize."

Victoria Van Asperen of Brockville, Ont., entered the 1967 national fair with a scale model of the fourth dimension. She said it showed how the extra dimension could confer invisibility, duplicity as mirror image, move unopposed by solids, provide spatial short cuts, allow internal surgery without cutting the patient open."

Another Ontario student, 16-year-old John Janis, of Perth, won first prize at this year's Canada-wide fair for his work on skin grafts. He wanted to overcome the body's natural rejection of a skin graft that comes from another person. He took skin from a rat, allowed the skin to grow in solution and then stopped its growth by freezing the skin. The skin was later reconstituted and then surgically implanted identical rat. The graft was not rejected. Janis believes the system could be used to establish a bank of skin tissues for human grafts. Tests have shown that one of the first aspects of the population belongs to a definite tissue type, he notes. Therefore, he believes that 100 genetically different frozen banks would be sufficient to supply any individual tissues or spare parts when needed.

Another idea with great potential was submitted by Thomas Spatafore, an 18-year-old grade 12 student from Thornhill, Ont. His aim was to apply genetics to produce the ideal tree for a particular purpose. Through selective breeding, Spatafore produced a hardy red pine with a superior growth and survival rate. He proposed planting these trees on the prairies to serve as shelter belts. His wide, bushy shape would break the wind. Spatafore, who wants to be a forester, also observed that white pine survives better on the prairies and snows that it could be planted over an area stretching 100 yards north of the present tree line, adding millions of dollars to Canada's forests. For the originality of his thought and the effort that went into his presentation, Spatafore won first prize in the biology category.

Other exhibits in the 1968 Canadian science fair ranged from muscular coordination to aerodynamics. Seventeen-year-old Carolene Hirsch, of Brandon, Man., plans a career teaching the deaf, studied the effect of exercise on circulation, stamina, depressants and training on eye and hand coordination. Another teenager, 15-year-old Robert Rowe, of Victoria, B.C., compared the effects of gravitational forces on humans and insects. He used a homemade centrifuge to create G-forces and his experiment. Gerard Couture, 17, of Longueuil, Que., did research over a three-year period in physics, nuclear physics, chemistry, biochemistry and cryogenics to complete his exhibit—the main propulsion system of a nuclear submarine. A Regina boy, James Kennedy, 17, produced a "new type of weather satellite system which I conceived and developed," and explained its advantages over the present system. And Stephen DeFrenne, of Sutton, Que., demonstrated air disturbance by a car. He fed heated sodium carbonate into the wind tunnel and used stop-action photographs and the chloroform deposits on various parts of the car to demonstrate its resistance. He gave the "fast back" top rating.

Other students, investigating the desalination of the sea, ways of growing plants without soil, the curious rings precipitated from gels and known as Liesegang rings, and a model of a Van de Graaff generator, smashed atoms that used a salt shaker and a loaf pan to illustrate the principle involved. Dr. Wolfker said many of the students were "purely inspired by the spirit of Montreal biologist and current president of the Youth Science Foundation, estimates that the cost of the fair to him, 15,000 students from across Canada-wide fairs are being written by professional people. But the purpose of the fairs is to create an awareness among young people to give a live interest in science. For many, this interest leads to a career in science. For instance, there's Kenneth Block, who played a digital computer in the 1962 finals. The application of the computer to seismology, he noted, is an example of computer and electronic engineering and his present work on hydrographic surveys for the federal Department of Mines and Technical Surveys.

Julio Stada, who won a scholarship for a project on electrolysis he exhibited at the 1964 Montreal Science Fair when he was 17, studied it to use at McGill. He graduated this year, but he has already co-authored two scientific papers in theoretical chemistry for publication.

One of his professors said Stada was the "modern crash barrier for an idiot's brain," students," said McCull's Dr. Bolker. 'Older graduate students used to go to him all the time to get the tip of the blade.' But he was interested in science. "I think that the science fairs had something to do with developing his talent. "The science fairs set the stage, the partici- pate will become scientists," said Dr. Bolker. "But even if they become poets or jazz musicians or beavers, they will have a good working knowledge of the physical world we live in."

Dr. Wolfker agreed with Dr. Bolker's opinion when he referred to Marjorie Doyle's work on the livers of rats. The remarkable thing about the experiment was that no cures were found, but that the fact was the work was carried out by a young girl, he pointed out. Dr. Coulillard was also enthusiastic about an exhibitor at the 1968 Wide Science Fair by Victor Rabel of Franklin, Ont., who experimented with mice. Dr. Coulillard "made a study of helmets used by medics and firemen. He pointed out the dangers and came to the conclusion that all the concepts developed by designers of modern crash helmets for air crashes had already been determined by 15th century designers of armor."

"It's the classic science project—getting a good idea and following it through." Teenagers like Victor Rabel and Marjorie Doyle have become the "science impression mark." How will future adults have that today or irresponsible? All too often, it's the irresponsible people who think about science. Says Dr. Bolker: 'When a teen picks up someone's car and tears down the road in it at 90 miles an hour, the newspapers report it as big thing of the day. This aspect of teenagers is brought forcibly to our attention. We must not neglect the good things of them or reject them in the press.'

Science fairs themselves have been given very good coverage in newspapers. Two years ago, a press clipping service gathered 5000 clippings on local science fairs in Canada. The Canadian science fairs during March, April and May. These science fairs originated in the United States and the first national science fair took place in Philadelphia in 1950. The fairs are beginning to catch on in Europe and other countries, but they have been held regularly in Canada since the first one in Quebec in 1958. Two years later, the Canadian Science Fairs Council was set up to organize the growing number of fairs on a national basis. The first national fair was held in Ottawa in 1962. By 1966, as many as 5,000 exhibits were being entered in regional and other fairs across Canada.

The Montreal Science Fair is the biggest of the 33 regional fairs held in Canada every year and the largest places an emphasis on the Inuvik in the North West Territories, and everywhere else in Canada except New Brunswick, mostly Newfound-land. Each regional fair sends up to four contestants—two boys and two girls—to compete in the national annual Canada-wide Science Fair. (Finalists this year came from the six provinces from June 2nd to 4th.) The most recent science fair wide exhibition has been held in Ottawa, Toronto, Montreal, Winnipeg, Windsor and Quebec.

Two years ago, the council decided to branch out into other scientific activities and changed its name to the Youth Science Foundation. Among the other activities are a magazine called Science Affairs, which goes to high school science teachers and students, and support of the Royal Canadian Institute.

But the country's science students aren't the only ones to benefit from the organiza- tions to close the gap between themselves and the professional scientists. Dr. Hans H. Van der Grinten of Montreal is one of Canada's most famous scientific researcher, receives hundreds of letters every year from students, parents and teachers. "I have reached the point where I can't handle all the letters," Dr. Selye said. "But the letters tell me that the independence certainly doesn't make me unhappy. "The organizers of the science fairs are doing a very good job and they should be applauded for it."
Salmon Run

Every year at this time the sockeye salmon change from silver to bright red and fight their way from the Pacific Ocean 300 miles upstream to Adams River to spawn and die.

The most romantic tragedy of nature is enacted every year about mid-October in the Adams and Little rivers, deep in the interior of British Columbia, west of Salmon Arm.

The drama is the mysterious return of the sockeye salmon from the far northern reaches of the Pacific Ocean to the sparkling little mountain stream where they were born four years before.

It is a spectacle of joy and sadness, of brilliant autumn beauty and the sorrow of death.

The Adams becomes a frothing maelstrom of flashing, jumping, twisting red sockeye as thousands of fish arrive to spawn and die.

It's a phenomenon that has never been fully explained by scientists.

Driven by some overwhelming compulsion, the fish assemble near the Gulf of Alaska after four years of feeding. Now fully mature, they head unerringly for the mouth of the Fraser River where they wait for several weeks before starting their treacherous journey upriver. How they find their way to the river's mouth is unknown. Some experts believe they navigate by a highly developed sense of smell. Others think they work out their directions from the stars. In any case, the migration coincides with the development of suitable temperatures, around 58 degrees Fahrenheit, in their home stream.

But the 10,000 commercial salmon fishermen on the coast don't care how they get there as long as they arrive and in great numbers. It is during this mass migration that the fishermen reap their annual bonanza.

In 1966, a peak year, they divided up $38,600,000 after expenses. Canners processed a catch with a wholesale value of $66,500,000 and this year's is expected to run very close to that.

The fish that elude the fishermen's gill nets then begin their swim upstream.

After an eight-hour battle against river currents, a group of fish rest in an eddy
They stop feeding as they enter fresh-water and from then on live on stored body fats.

And then a spectacular change occurs. Normally a blue-tinged silver, the salmon start turning a brilliant scarlet, with pea-green snouts. The female retains her graceful, sleek body lines, but the male develops a humped back and a protruding upper jaw armed with sharp teeth which he uses to fight off other males.

They must first negotiate the deep canyons and buckling, churning falls in the muddy Fraser. Then they turn into its largest tributary, the blue-green Thompson and from this into the South Thompson. This leads them into Little Shuswap Lake, Little River, Big Shuswap Lake and, finally, into Adams River, 300 miles from the mouth of the Fraser.

They travel an average of 20 miles a day, resting in quiet pools at night. It takes them about 15 days to make the hazardous journey.

When they reach the stream where they were born, they select a mate and fight for a spot to dig their nests, or redd, as they’re called after the old Scottish fashion.

The trip has taken its toll. Many of the fish look near exhaustion. Some show pinkish patches on their scarred bodies where wounds have become infected. Some of their fins are frayed and ragged from scrambling over rocks and shimmery through gravelly shallows. From fat, energy-filled ocean fish, they’ve turned to little more than skin and bones.

But they fight on to the climax of their life.

When the female finds a spot to her liking, she begins hollowing out a bed in the gravel. By lying on her side and flapping her tail vigorously, she kicks up the gravel and the current carries the smaller particles downstream. Eventually she builds a hollow six to 12 inches deep.

She prefers a place in a riffle, where the fast-running water will provide an ample supply of oxygen for the eggs. One female may hollow out several redds before she has finished spawning.

While the female prepares the nest, her mate hovers by protectively, sometimes giving her an amorous nudge. If another
The fish choose a site to spawn where the bottom is gravel and the water is fast.

Oddly enough, the sockeye hatch downstream from the lake, in Little River, and swim farther downstream into Little Shuswap Lake. But they eventually swim back up to Big Shuswap and join the Adams River bunch.

They all remain in the lake for a year. The following spring, sometimes even before the ice is gone, they suddenly leave the placid waters. As three-inch smolts, they cascade downstream to the sea, reversing the route taken by their parents.

Three years later, when they've grown to maturity, they'll again feel the mysterious urge and migrate from the vastness of the North Pacific to the mouth of the Fraser to complete their life cycle where it started—the Adams and Little rivers.

The Adams River spawning grounds, comprising 300 acres, are known locally as The Richest 300 Acres In The World. In October 1966—a peak year—it was estimated about 1,322,000 fish were in the spawning grounds.

Fraser River sockeye are almost exclusively four-year fish; a period of four years elapses from the time the egg is laid until the adult returns. Sockeye in the Skeena, Nass River inlet and other systems on the northern and central B.C. coast, range from four to six years at maturity. Other species—pink, coho, chum and chinook (or spring) salmon—have different life cycles.

In addition to providing a livelihood for thousands of B.C. residents, the sockeye are becoming a big tourist attraction. More than 40,000 visitors viewed the Adams River spawning grounds in 1966, with as many as 12,000 crowding the banks in a single day.

The fisheries departments have turned the area into an educational field trip. Paths have been cut through the woods bordering the stream, and rustic bridges have been built to enable visitors to walk up and down the river, literally within arm's reach of the spawning fish in many spots. But all the visitor can do is look; there is a fine for disturbing the fish in any way.

A big conservation display called the Salts to the Sockeye is set up in a tent where there are movies and talks on the fish. Pamphlets are distributed at border-crossing points to U.S. tourists who go up to witness the spectacle. Motels, hotels and campgrounds prepare for the annual influx of 'sockeye visitors'... some of whom have come from as far away as Australia and England.

Even Nature demise in her finest to celebrate the arrival of the sockeye. The woods glow with gold, scarlet and orange leaves that waft silently down to form a rustling carpet on the ground or bob like gems on the jade-green water where the life and death drama is repeated every year.
If you want to see something truly relaxing, look into a pipe line. It’s such a well-mannered, peaceful place. Take, for example, any section of Interprovincial; the 2,000-mile line that hauls crude oil from Alberta to Ontario. Down there, four to seven feet underground, it’s temperate, about 30 degrees in winter, 65 in summer. It’s quiet; a faint tremor from far-off pumps or the whirl of an oily tide churning along at four miles an hour. The pumping pressure, 750 pounds per square inch, is almost the same as 1,200 feet under the sea. And under normal conditions the pipe line is just as unobtrusive as the deep sea too; steel, fast, traffic jam, sit-down strike or love-in up above, the line just goes on blimp-bluring its 600,000-barrel a day in an orderly manner.

Which is exactly the way pipeliners want it. And which is why a million miles of line already lie under this continent and why they already move 20 per cent of all North American land cargo. Pipe lines are marvelously efficient and cheaper than any other form of land transport, a no-nonsense kind of cargo-mover that stays out of everyone’s way and seems to let the cargo do the work. But behind the apparent simplicity of these underground tubes is a complex mixture of engineers, formulators, accountants, friendly persuasion, bitter frustration, bureaucratic regulation and perhaps even politics.

For example, let us assume that your wealthy uncle, deceased, has left you a field of that swell Alberta oil. You would like to move it a hundred miles and sell it. Fortunately, your late aunt has willed you $6 million. This is approximately what you’ll need to build 100 miles of 6, 12-inch line. Pipe lines are cheap to operate but they’re not cheap to build. The Interprovincial Pipe Line cost more than $224 million when it was built between 1920 and 1925. To carry oil from Edmonton to Sarnia, but it has been worth every penny. It can carry a gallon of oil at that way—more than 1,700 miles—for less than a cent a mile. It costs more to send a letter. Shipping crude oil by railroad tank car costs five times as much as it does by pipe line. The only way to move crude oil cheaper than by pipe line is by large ocean-going tanker. Venezuelan crude can travel 2,600 miles to Montreal for less than it costs to pipe Alberta crude from Edmonton to Sarnia.

But to get back to that 100-mile domestic line you’re interested in, you’ll need an Act of Parliament and a permit from the National Energy Board if your line is going to cross provincial boundaries, plus various other permits and easements from municipalities, highways departments, railways and landowners along your proposed route of way. Although landowners get a cash settlement and can almost always use the surface land after the line is laid, getting the right of way (a strip anywhere from 20 to 100 feet wide) can be frustrating and tedious. The Interprovincial line from Edmonton to Sarnia went through land owned by more than 5,000 different people, but that’s no record; a line between Texas and New Jersey made deals with 17,000 landowners. Sometimes sneaky owners won’t yield the right of way and the line must detour.

Once you have a route you must clear it. And that, according to one pipe line hand-book, calls for 110 men for an 80-foot right of way and may require all or some of the following machines: one bulldozer with winch, two wheeled-type and four chain-type power saws, four angledozers, a grader, a tow tractor and two trucks. What they do is cut a swath through brush, fill in small depressions and shape sharp peaks off hillslopes. Next trucks or caterpillar tractors haul in 40 to 80-foot sections of steel pipe which they string along the route. A trenching machine chews out the ‘ditch’ where necessary a huge bending machine shapes the pipe to fit the major contours of the land; the steel ‘skins’ of a typical big ing pipe is only 1/12 of an inch thick, but the pipe is immensely strong. All of this is relatively simple if you’re working on nice, uncomplicated terrain, such as a stretch of open prairie. But where the line traverses navigable waters it faces one of the most peculiar hazards of any form of transportation—the anchors of ships. To avoid the possibility of its being swamped by an anchor dragged by a ship in a storm, the line must be buried deep in the harbor mud or riverbed, and covered with rock. To make the pipe heavy enough to sink and stay sunk, it must first be swathed in a blanket of concrete. To cross a narrow, swift stream you’ll probably build a bridge for the line. At highways or railways the line must take to an underground tunnel and perhaps be encased in an outer formula to help withstand the pressure and vibration of heavy traffic. In mountain areas you might have to string the line from a helicopter equipped with a television camera in its tail so the pilot can see both ends of the pipe. In desert sand pipelines are laid alongside with 16-feet-wheel and seven-foot tires.

One of the most difficult places to lay pipe line is the Canadian north. For years it was laid only in summer by men and equipment working from rip-rap-floating roadbeds or logs and branches laid over the treacherous...
The meagre continuously swallowed up the roads while mosquitoes and black flies tried to swallow up the men. Vehicles moved slowly, and camps often had to be set far away from the swampy areas, that crews had to put 12-hour days to produce four hours of effective work. Half a mile a day was considered fast work under those conditions.

But not any more. Equipment now available is powerful enough to ditch through frozen muskeg. A typical result: in the winter of 1966, crews handled against sub-zero temperatures in thermal underwear, insulated parkas and heavily lined boots, laid 240 miles of line out of the Rainbow Lake field in 37 working days.

Winter eliminates the worst aspects of muskeg, but it creates problems of its own. For example, every pipe line must have a minimum of three consecutive welds or "pastes" at every joint. On the Rainbow job it was so cold the pipe ends had to be preheated with propane burner rings to 250 degrees Fahrenheit before welding. Then, after the first pass, specially designed canvas insulating pads were buttoned around the joints to control freezing, before the final welds and after all three passes were completed.

In that job, as in every other, finished welds were checked by X-ray for flaws or pinholes invisible to the eye. Pipeliners go to enormous lengths to be sure the pipe is leak-proof before it goes into the ground. After the X-ray check, the line gets a double-coating against soil and moisture corrosion. First, a primer and enamelled asphalt, coal tar or a petroleum wax is painted on; over this goes a wrapping of asphalt, asbestos felt, waxed polytype or plasticylene.

After that you must look for 'holidays'. In the breast of every pipeliner beats the heart of a poet. They have called them 'unadverted spots in the coating that might invite corrosion' but they say 'holidays' and they use a holiday detector, a kind of electrically-operated coil that encircles the pipe and rings a bell or sounds a buzzer when it finds a thin spot.

Even with all these precautions no pipe line is safe. Down in the depths lurk electrical currents that can destroy a pipe line by eating away the steel, molecule by molecule. To combat this electrochemical corrosion pipeliners sacrifice expendable lumps of zinc or magnesium to the electrical currents--they wire the sacrificial anodes to the pipe, and let the currents eat them instead of the pipe. It works weak and cowardly, perhaps, but it works.

Giving a pipe line a decent burial is an art. You don't just drop it in and go on earth on top. To protect the coating, the line is swaddled in wide, nonabrasive, lowering-in-bottom-ends cloth and eased down from side-riding tractors. The bottom and sides of the ditch, and the first layer of covering earth, must be free of rocks, sharp roots or hard clods that might pierce the protective coating. Then the pipe and layer must be tamped down and, where the line runs up or downhill, "brakers" or butterflies of rock or earth-filled bags are spaced at intervals to prevent soil erosion. Finally the line is filled with water and tested to 15 times its maximum proposed working pressure to make sure, there are no weak spots.

If you can find all those spots, you are ready to move crude oil. But don't just pour it in one end and expect it to flow out the other. It is under tremendous pressure at anything else through a pipe line, and the power comes from diesel or electrically driven pumps, spot-belts along the line at intervals ranging from 30 to 100 miles. By increasing pumping pressure you can increase the amount of throughput, as pipelines call the amount ofstuff that can pass a line through a pipe, but every line has its pressure limit. For any increase above that limit you must 'loop': lay a parallel section or sections of new line alongside the original, in those segments of the route where extra throughput is needed. That's what's happening now in the Interprovincial-Lakehead system, where a $108 million expansion program began last summer is expected to be completed by year's end. Part of the program is a $75 million line from Superior, Wis., to the Chicago area. Refrigerants in the Buffalo-Toledo areas want more oil than Interprovincial can deliver to them. The company had a choice of looping the line from Superior, Wis., to Sarnia, or building a new line to Chicago and making use of a couple of existing lines that run north and east from there. (Eventually, the loop will be completed from Chicago to Sarnia.) It chose the Chicago route, partly in the belief that the enormous market in that area will sooner or later require Canadian oil. The rest of the expansion program is $33 million worth of looping, extra pumping power and new tankage in western Canada and Minnesota. There will be two loops in Alberta and two in Saskatchewan.

Pumping, you'd think, should be relatively simple since it's largely a push-button operation nowadays. But there's a little matter of "fluid dynamics". How a liquid flows and there are different ways has a profound effect on pipeline operation. How it flows depends on the size and smoothness of the pipe, and the fluid's speed, viscosity and density. Put all these variables together by means of various, complicated formule, and you will get an accurate picture of fluids flowing. For instance, the Weisbach-Darcy formula explains how much pressure is necessary to drive a certain fluid through a certain size pipe at a certain velocity. This is for the obtaining a certain amount of "friction". Your well-informed pipeliner also knows the Reynolds number--calculated from tube diameter and fluid flow velocity times fluid density divided by the fluid's viscosity--which

Almost hidden by fluctuating demands that make the concrete-covered pipe light enough to be pulled, three pipe lines settle into a St. Lawrence River trench. Later, a diver will cut the drums loose

67 pounds per square inch costs makes it dramatically reduced.

Obviously some materials--heat, for instance--can't be moved as liquids or as liquids. So why not put them in capsules? For more than 10 years the Alberta Research Council has tested pipe line traffic and found that capsule of the same density as the carrier liquid flows along smoothly and require little extra pull. In 1965 experiment the council put a 414-pound steel capsule through 109 miles of the Interprovincial Pipe Line; it averaged above 10 miles an hour and showed little evidence of wear. It has been argued that some nonperishable agricultural products, canned goods or machines, might be moved by capsule. Other materials--steel, iron, aluminum or plastics--might be shipped as liquid pipes, in drums or barrels and dropped into the line.

For this sort of thing to be commercially attractive, you need to have a very large market for the material you want to pipeline and a market big enough to justify the high cost of the initial investment, the building of a line. You'd also have to consider whether the material was wearing out the pipe (surfly pipe operators have found it wise to rotate the pipe at intervals, since most of the wear is at the bottom) or wearing itself out. And finally, such transport would require a large and constant volume of fluid at the "sending" end. The ideal would be a double payload: a fluid and solid that would both be marketable, something like crude oil and baled hay or aluminum. Such a line would go on and on, moving its products efficiently in a steady stream, unhampered by weather or traffic labor troubles, oblivious to packaging or box shortage or truck breakdown, moving its cargoes in its unperishable, utterly reliable way.
TIRES

Fascinating? Hardly. But here’s all you need to know—and more—about plies, beads, treads, retractions, studs, sidewalls and whether you should fill your tires with air, water, nitrogen or barium sulphate

by Vicki Innes

The tire is ready to join politics, religion and sex as a good topic for cocktail party conversations. And why not? Even now, tires offer at least as much scope as a Grey Cup football game. Once a conversation gets past the polite ‘Yes, tires are round and black, aren’t they?’ stage, it can warm up on 50-foot-high tires that support revolving restaurants and tires filled with water. The exchange could end with a heated argument about plies, cords and biases.

If tires aren’t party-stoppers now, it’s because of theirissy image. Tire men themselves apologize. ‘With all respect to those who prepare tire advertisements,’ George F. Plummer, president of Dunlop Canada Ltd., once said, ‘tire cannot be made particularly glamorous. It isn’t pretty and it just isn’t the sort of purchase that you make and then invite your neighbors over for cocktails to inspect the new addition.’

But tires are shot on glamour, they’re long on variety. ‘Round-and-black’ comes in an astonishing range. Uniroyal’s Kitchener, Ont., factory produces 2,625 varieties of tires—a total of 700,000 tires over a three-month period. Tires can be as tiny as 8½ inches in diameter or over 10 feet tall. They can weigh as little as four pounds or as much as two tons each. They come full of air—or nitrogen or water or powder or resilient foam. Take your pick—prices ranging from $5 to $12,000.

Tires travel under all sorts of vehicles—wheelbarrows, bicycles, cars, trucks, subway trains, bulldozers, airplanes—as well as things that have no direct connection with transportation. A restaurant atop a Memphis, Tenn., office building rotates on 75 passenger car tires, traveling one mile every 24 hours. At this rate, the tires are expected to last well into the 21st century although spares are available in case of a flat. Tires are also being used under movable sections of the San Diego Stadium in California so the shape of the stadium can be changed for football or baseball. The 104 tires are 43 inches in diameter and have a smooth tread to avoid damaging the field.

Whether the tires are intended for a restaurant rotating at 0.4 m.p.h. or a DC-8 landing at 135 m.p.h., they have certain things in common. A tire has essentially four main parts: tread, carcass, bead and air. Most important is the air, which supports almost the entire weight of the vehicle. The carcass shapes the tire and encloses the air. It is made of cords of fabric coated with rubber. The bead is steel wire to anchor the carcass fabric and hold the carcass on the wheel rim. The whole thing rolls on the tread, part of the outer layer of rubber.

Exactly how a tire is put together depends on its future use. Aircraft tires, for example, are designed for skid resistance and traction, as are passenger tires. Airplane tires must operate under much more severe conditions, absorbing great shock when the plane lands, but for shorter periods of time. Each of the 10 tires on a DC-8, for example, supports an average of 24,000 pounds, compared with the 1,000-pound weight carried by a car tire. A DC-8 reaches almost 190 m.p.h. during take-off.

To operate under such extreme conditions, airplane tires have a very strong carcass but relatively little tread. The carcass supplies the landing strength, the tread the traction. The tread is thin because the more rubber—and therefore weight on the tire, the hotter it will become. With such a thin tread, airplane tires don’t have a long life. The eight main tires on a DC-8 last for 125 to 150 combined landings and take-offs—a distance of 250 to 300 miles. However, airplane tires are re treaded five to eight times on the average, a fact tire men use to illustrate the safety of recapped tires for cars.

Earthmoving tires are also designed for tough conditions. Built to climb over jagged rocks, they have 10 times more puncture resistance than passenger car tires. The original tread may last 5,000 hours and the tire life can be doubled or tripled by giving it one or two re treads, an economy dictated by the cost of new tires. One tire, more than nine feet high, costs $12,000. These tires are so thick perhaps 5½ inches of tread and carcass at the crown and even thicker at the shoulder— that ‘rest periods’ are necessary to keep them from getting too hot. Some equipment being moved on the highway, for example, must stop for half an hour every 30 minutes to let the tires cool off. One of the biggest earthmoving tires in standard construction is more than 10 feet tall and weighs 4,300 pounds.

Huge tires exist for other uses too. The U.S. Army has a 100-ton amphibious vehicle equipped with tires 9½ feet tall. Each of the tires weighs nearly a ton and a half and uses enough rubber to make 150 passenger car tires. The behemoth can carry 100 troops at speeds of 18 m.p.h. over land and seven knots in the water.

Tires can be made much larger by using a special construction technique—at least in theory. The idea, developed by a U.S. firm, is to make the tires from S-shaped strips of carcass and tread, woven together like a basket and bolted to the rim of the wheel. Tubers, flaps and tread liners inside the tire would hold the air and provide puncture protection. After testing models, engineers concluded that tires at least 50 feet in diameter—taller than a four-story building—were practical. A tire this size would support a load of 155,000 pounds. A vehicle equipped with these tires could traverse mud, sand, snow or swampy terrain—and with their displacement could float across a lake. The tire could be used in oil exploration in northern Canada’s muskog to transport huge overloads carrying men, their living quarters and working equipment.

Special tires already exist for difficult terrain although on a much smaller scale. The flotation tire, used in the placer mining industry, is very flat and builds up surface wide like a camel’s foot to stay on the surface of the shifting sands. One sand tire is six feet high, with a tread width of about 30 inches.
Tire pressures are layers of fabric, laid in various patterns: left, a belted bias ply: center, a radial ply: right, a conventional bias ply pattern

Tires are designed with certain characteristics. These Atlas passenger tires have treads particularly suited for (from top) all-purpose usage: traction in snow; maximum road contact; city and country roads

All in all to increase the tire's puncture resistance and strength. Cords in the body plies can be made of rayon, nylon, polyester or steel. Nylon is noted for its strength, particularly at high speeds. Rayon provides a combination of strength and durability. Steel is stronger than rayon; it's not as strong as nylon but it is free from 'itching sickness,' the temporary flat spot formed on the bottom of nylon cord tires. The outer shoulder adds to the durability. Wire and glass are both very strong and inelastic.

And there's tire ply rating. Passenger car tires have two or four plies; station wagons have six or eight-ply rating. Ply rating refers to the number of layers of fabric in the tire. For example, the general rating for a four-ply tire is 70; this means that one-eighth of an inch of fabric in the ply is twice as strong as the same length in a four-ply tire. In other words, the two-ply carcass is as strong as the four-ply carcass. The two-ply tires run cooler—15 degrees below temperature. For safety purposes the tire manufacturer also uses in a touch-down situation to offer better resistance to ruptures, and their tread wears longer. Many tire buyers, though, are convinced that the greater the number of plies the better the tire; some car owners insist that the original two-ply tires cannot be replaced with four or six-ply tires as a condition of sale.

The treads and sidewalls of passenger tires in North America are made mainly with a synthetic called styrene-butadiene rubber (SBR) or EPDM. (Both are inexpensive and non-toxic; SBR contains no nitrogen.) Other common rubber compound materials are SBR and natural rubber. The more expensive tire lines contain another synthetic rubber in the tread-polytubadine—which is mixed with SBR to increase the tread wear. Both these synthetics are longer wearing than natural rubber. Butyl, another synthetic, is used to make inner tubes and liners in tubeless tires. These synthetics come from chemicals obtained from oil; Imperial Oil supplies butadiene, styrene and butyl rubber to the tire manufacturers. In Canada, the Treadmark used by tire manufacturers is SBR. There is no problem with nail punctures when the tire is made with SBR. There is no problem with nail punctures when the tire is made with SBR. There is no problem with nail punctures when the tire is made with SBR. There is no problem with nail punctures when the tire is made with SBR. There is no problem with nail punctures when the tire is made with SBR.

Several different combinations of material are used in making the tire. A number of solutions to the problem of flat tires are available. One tire is a tire that can actually be run flat for hundreds of miles. It's really a tire with a tire; if the outer chamber goes flat, the tire rotates a layer of the inner tube. Another approach is a tubeless tire whose sidewalls fold in when air pressure drops so that the tread contracts to form a tight, flexible band hugging the wheel. The tire was developed so that military air-planes do not have to wait for tire pressure before they can take off. The company makes a similar tire-the collapsible spare tire-for passenger cars. It is carried deflated in the trunk—taking half the space of a conventional spare.
Figuring out your mileage

If you seem to be getting more (or fewer) miles to the gallon, blame it on the weather—or the time of year, or the air in your tires, or even the baby-bottle-warmer

by Richard Dolman

What kind of gasoline mileage can you expect to get from your car?
Sixteen miles to the gallon? Twenty to 257. Around 307. As much as 39 on the highway? An average of exactly 28.8?

For John Winkler, the answer in all of them. Winkler, a research chemist at Imperial's &s car lab, bought a new Volkswagen in 1963 and kept track of its fuel economy for two years. He found that mileage varied from a low of 16.1 to a high of 39.4 according to the road, the climate, the traffic, the state of the car—even the habits of

There isn't much anyone can do about road conditions, climate or traffic—but good driving habits can add up to six, eight, even 10 miles to every gallon of gasoline you buy in summer, and up to 16 miles in winter. These figures are not just Winkler's alone, or Imperial's, but are confirmed by independent scientific tests, including studies made by automotive engineers and reported to the Society of Automotive Engineers.

The key to economical driving habits is the accelerator pedal. On the highway, the driver who strives to pass other cars at every opportunity not only consumes a lot more gasoline, but he saves surprisingly little time compared with the relaxed driver who avoids any risk and blends with traffic flow. For example, two identical test cars were driven recently on a 1,000-mile trip from Hamburg, West Germany, to Rimini, on the Italian coast. The fast driver grabbed every opportunity to hustle. He passed more than 2,000 cars (three times as many as the other car), braked 3,300 times (twice as often), burned about 10 gallons more gasoline, and finished in 20 hours and 12 minutes, only half an hour ahead of the take-it-easy driver.

Why? The average highway habits are magnified in fuel consumption for normal city traffic. The hot-rodder who beats the other cars away from the traffic light only to stoop on the brakes for the next light, would get another three miles a gallon if he drove like Aunt Matilda on her way to church. The less action on the accelerator, the better for fuel economy. This applies to automatic-shift cars too, and to those drivers who rev up the engine needlessly while putting on the brakes or wait-

figuring for traffic to get moving.

In some provinces, the law requires that manual gearshifts be shifted downward one gear below top gear when braking to a stop, since the car is under better control in a lower gear. However, de-
celerating by shifting right down through all gears, as sports car drivers like to do, wastes gasoline: the engine cycle includes a vacuum action that sucks in gasoline during this maneuver, even without foot pressure on the accelerator. It may be easier on brake linings, but it's harder on gasoline.

In addition to driving habits, fuel economy depends heavily on regular tuning and maintenance, such as keeping the tires at correct pressure (soft tires may cost one mile a gallon or more), changing engine oil (dirty, too-heavy oil costs up to two miles a gallon), ad-
justing spark timing and carburetor at least twice a year, and cleaning spark plugs or replacing them (bad adjustments and dirty plugs can cost five miles a gallon or more).

The weather can affect fuel economy to a surprising extent. For ex-
ample, at highway speed, with a steady tailwind of 20 miles an hour, you'll get about seven miles a gallon more than you would heading into the wind.

Traffic conditions and season are the other main environmental factors affecting mileage. Once a car engine is fully warmed up, and driven at steady highway speeds, it gets some advantage over stop-
and-go city driving mileage, since there is less fuel energy wasted in braking and idling. The gain partly depends on the ratio of car weight to horsepower. The lowest-powered car shows the least improvement, mainly because its different gear ratios demand a higher engine speed to overcome rolling friction and wind resistance. A car of the same size and weight but equipped with a more powerful engine shows a bigger improvement over its own city mileage performance. So, if you've got a compact or sporty car with a lively engine, weighting about 10 pounds per horsepower, driving it on the highway may be two or three miles a gallon more economical than driving it in city traffic. If you've got a big family sedan with a small six-cylinder en-
gine, weighing 25 or 30 pounds per horsepower, the mileage may be much the same in the city or on the highway.

Like highway driving, air temperature and humidity can boost your mileage. With a fully warmed-up engine on the highway, you'll go about one mile farther on a gallon at 60 degrees than you will when it's only 10. And if your engine knocks during acceleration, you'll go a bit farther when it's humid than when it's dry, since humidity reduces the octane requirements of the engine.

The fully warmed-up engine works better than a cold one, so if you start from cold and let the engine warm up while you're driving, you will use more gasoline. At 10 degrees, it takes up to 20 miles of city driving from a cold start to approach fully warmed-up economy. On a two-mile trip, you'll get only 40 per cent of full economy; on a four-

mile trip, 60 per cent; and on an eight-mile trip, about 70 per cent. Even in summer a car that would get a fully warmed-up economy of 16.2 miles a gallon, will get only 11.5 on a four-mile trip from a cold start, and 13.2 on an eight-mile trip.

All these figures are averages and do not reflect differences in city or gasolines. For instance, Esso gasoline in winter is blended with more of the lighter, highly volatile hydrocarbons, which are best suited for faster starting, faster warm up and short-trip fuel economy. In sum-
mer, Esso is blended with less of the lighter hydrocarbons, to help avoid vapor lock and provide good fuel economy on long highway trips.

Cold weather stifles the penalty for cold starts, but the evidence shows you can boost your mileage in any weather by using correct warm up procedure. Follow the instructions in your driver's manual. In general, after setting the choke (by depressing the gas pedal once on cars with automatic chokes), start the engine, let it idle for a minute or two, then tap the accelerator sharply to release the choke, and drive slowly and smoothly for the first two or three miles. On some older cars the automatic choke can get stuck either open or shut. If stuck open, the car is hard to get started at all. If it sticks shut dur-
ing starting, the engine gulsps fuel and coughs out dark exhaust. Tap-
ing the gas pedal sharply should loosen it in either case, but have

your service station attendant clean and lubricate the mechanism at the first opportunity. Above all, do not race the engine the moment it starts—this not only gulps gas but wears out the bearings, because of the initial delay in oil circulation. Also it dilutes the oil with unburned fuel.

Warm-up procedure is the main factor—but not the only one—affecting fuel economy in the winter. Cold weather affects fuel economy with every cold start, and the bulk of winter driving mileage comes from a succession of relatively short trips in city traffic. Additional winter mileage losses are due to power wasted on slippery roads, con-
gested stop-and-go traffic conditions, and greater use of lower gears.

There's one other big mileage factor intensified by winter. It hits the man who buys a new car in the autumn, around the time when the new models are usually introduced. A typical case, according to a General Motors report to the Society of Automotive Engineers is the man who trades in his low-priced model of a low-horsepower car on an early production model of next year's car—but this time he chooses a more deluxe model with higher horsepower. GM tests showed that his old car probably averaged 21.6 miles a gallon on summer vacation trips. After two or three months of winter driving the tests indicate his new car will average only 13.2 miles a gallon.

Such a discovery sends him back to the car dealer—and maybe his service station dealer—complaining of poor gas mileage. But the fault

doesn't lie with the dealer, or the fuel; according to GM, it's in his choice of car and in winter versus summer driving. The bigger engine-
The all-plastic car has been around for years—as a child’s toy and in conversation about the car of the future. Now, however, the future seems much closer: all-plastic cars are actually being built, even though they’re still out of the reach of the average car buyer.

One all-plastic car—claimed to be the world’s first—appeared at the Design Engineering Show in Chicago earlier this year. It’s plastic throughout the chassis except for the engine, motor mounts, drive train and undercarriage suspension system. It has plastic fenders, engine hood, roof and trunk lid. Where you find plastic in the car is not nearly so surprising as where you don’t find metal—such as in body posts or undercarriage, said an official of the company which is demonstrating the car in the United States. The car, a 120-mph sports job designed and manufactured by Germany’s Farbenfabriken Bayer A.G., has already been road-tested in Europe for two years.

A U.S. company is now racing an all-plastic car—and winning too. Marbon Chemical Division of Borg-Warner Corp., has a racing car with all-plastic chassis and body shell. The unit body is made up of three castings: a bottom shell, a central section containing wheel wells, and a top shell with seats, fenders and an instrument panel base. The plastic used for these cars—acylonitrile-butadiene-styrene (ABS)—is said to resist impact and bending stresses better than current auto steel. Other plus factors: plastic is rustproof and very strong for its weight; it allows greater styling freedom and it damps vibration so that it requires less insulation and noise reduction.

If the cars that are used to drive are not entirely plastic, they do have a lot of plastic in them. A 1969-model car has an estimated 82 pounds of plastic—compared with five pounds in 1940—and by 1970, a car might use 100 pounds. Cars contain plastics like polyethylene, polyurethane, polystyrene, ABS, nylon, polyacetal and acrylic, all of them oil-derived. Imperial Oil makes the raw materials—ethylene, propylene, butadine, benzene and acrylonitrile—for ABS, polypropylene and polyethylene, as well as polystyrene, which is plastic used for car upholstery.

Plastic is used for knobs, switches and buttons as well as items like seat belts, buckles, steering wheels, brake handles, arm rests, hub caps, glove box covers, instrument housings, vents, ducts and the flexible skin for innumerable floor and dash pats. More mechanical uses of plastic include hose clamps, small gears, battery connections, windshield wiper components and windshields washer fluid containers, fuel pumps and carburetor parts.

Even piston rings may someday be made of plastic. A U.S. chemical company has exhibited a model one-cylinder engine with an experimental piston ring of Teflon TFE fluorocarbon resin. The ring slips over the piston and forms a continuous seal; in tests, it reduced leakage of the combustion gas mixture to a negligible amount compared to engines equipped with conventional piston rings.

Among the recent applications of plastic are grilles—some plastic radiator grilles are half the weight of chrome-plated metal grilles. Some cars now have shock-absorber covers that are padded upholstered across the back of the front seat to protect back seat passengers during a sudden stop. A novel ‘squeeze’ horn is optional with some models. This is a steering wheel, covered by a layer of soft, fiber-like plastic; the horn blows when the wheel is squeezed at any point. Plastic light guides are another novel application. Basically, guides are plastic tubes filled with fine plastic strands which transmit light from one end to the other and allow light to be ‘bent’ around corners. They are being used to tell a motorist whether the front and rear external lights are functioning properly; they do it by funneling the light to where he can see it. Light guides also mean that one light bulb behind the cigarette lighter can be used to illuminate the ignition switch and theashtray.

The next big use for plastic may be gas tanks. Some truck had 20-gallon polyethylene tanks last year and a number of 1969-model cars were expected to carry plastic gas tanks. These are said to have better impact and corrosion resistance than metal tanks and they’re safer: an impact that would burst a metal tank would dent the plastic. Safety is also a feature of bumpers made of plastic. One type, made of urethane foam cast over a metal insert, springs back to its original shape when struck in a parking lot. Plastic bumpers were pro- vided on at least one model this year. Another type of bumper being sold by a Vancouver firm gets its effect from tap water. It’s a vinyl bumper with a number of compartments filled with water and sealed with plugs. The water creates a cushioning reaction which absorbs an impact. With enough pressure, the plugs pop out, releasing a stream of water into the air. The bumpers prevent or reduce both injuries and damage.

They’d also be handy for any spouse too embarrassed to admit an accident. With these bumpers, the guilty party could hide the damage to the car by simply refilling the compartments.