Petroleum and the needs of man
FOOD
by Fred Annesley

The terrible famine that killed 10 million people in Bengal in 1769 and 1770 were seen by Thomas Malthus as a warning that humanity was outrunning its food base and facing disaster. Malthus’ famous warning, issued in 1798, was premature, for though famines continued as they do even today in densely populated areas, mankind’s food base has widened. The opening up of new lands in the Western Hemisphere and the introduction of better agricultural techniques have not only enabled mankind to survive but have increased humanity’s numbers from the 800 million of Malthus’ day to the current world population of three and a half billion.

Today there are warnings that man is outrunning his food supply again and this time there are no new lands to discover. The world population is expected to double to seven billion by the end of the century, unless some very sudden steps are taken to reduce the rate of population increase.

About half the people in the world aren’t eating properly and population is increasing slightly faster than food production in developing countries. The Food and Agricultural Organization of the United Nations estimates that about 60 per cent of the people in the developing areas of the world, where two-thirds of the world’s people live, are malnourished; their diets are inadequate.

UNICEF estimates that the death rate between the ages of one and four in developing countries is 35 per thousand; in developed countries it is one per thousand. The difference is attributed mainly to malnutrition. The main lack is protein.

Proteins are composed of amino acids needed by the human body and they are found in some extent in almost all foods. But not all proteins provide a sufficient balance of these acids. There are eight amino acids that are necessary for normal growth, but most common vegetable proteins don’t contain them in proper balance. Leafy vegetables are low in two essential amino acids and consequently it is almost impossible to eat enough of any single leafy vegetable to supply the minimal amino acid need. For example, an adult would have to eat four pounds of spinach in a day; that’s six and a half of those 10 oz. plastic bags of spinach sold in supermarkets.

Animal proteins, such as meat, fish, milk and egg, provide all the necessary amino acids but the supply of animal proteins, fish and poultry can’t be increased quickly enough to meet world protein needs in the immediate future and the cost of these foods is beyond the reach of many people, especially in the developing countries.

A compound annual growth rate of four per cent in food production must be achieved by the developing nations if they are to meet their food requirements between now and 1985, the United States President’s Science Advisory Council warned earlier this year, but it reported that most of these were increasing their food production by only 2.7 per cent annually.

British economist Colin G. Clark believes the earth’s arable land could adequately feed 10 billion people—if it were fully cultivated. But all-out cultivation of land, making use of irrigation and fertilizer, cannot be achieved overnight.

New sources of high quality protein are needed to meet a hungry world’s demands and such sources are being found. One of the most promising of these is a rich protein that can be derived from petroleum.

‘This new meat will save lives,’ says Dr. W. J. Sweeny of the United States, vice-chairman of the World Petroleum Congress, ‘will be one of the most important scientific and technological projects of the next 10 to 20 years.

Such food is being developed in laboratories and pilot plants in several countries. The product is a fine, white powder, bland-tasting and odorous—and loaded with protein.

The term ‘single cell protein’ (SCP for short) has been coined at Massachusetts Institute of Technology recently to describe this type of product. One research project on SCP is being conducted jointly by Switzerland’s Nestle Alimentana, S.A., one of the world’s largest food companies, best known in Canada for its coffee, and Jersey Enterprises, an Imperial Oil affiliate. Laboratory work is carried out by another affiliate, Essa Research and Engineering Co., in Linden, N.J.

SCP could be called the fastest food raising program in the world. Feeding cattle to get animal protein in the form of beef means supplying the animal with vegetable protein and losing between 40 and 80 per cent of that protein in the process. It also takes about two years. Feeding microorganisms with hydrocarbons from petroleum results in a pound of nutrient for every pound of food—which in Essa-Nestle’s case is about 70 per cent protein. And the process takes only a few hours.

Just as ranchers continually strive for the perfect breed of cattle, the scientists search for the strain of microorganism that
The selectivity of microorganisms to hydrocarbons was being studied in Esso Research laboratories before the protein project was ever launched. Bacteria were being studied for their ability to bring about certain chemical transformations in petroleum.

The enzymes of bacteria can alter the composition of certain fractions of petroleum. These enzymes can, technically, be separated from the bacteria and used for their catalytic effect on the petroleum chemicals, but researchers find it simpler, and more effective, to use the bacteria. It was during this research that the scientists noticed that the petroleum material was being consumed by the microorganisms under certain conditions; and the bacteria were rich in protein.

There followed a search, involving the screening of more than 1,000 species of bacteria and yeast, for a microorganism that would utilize hydrocarbons to produce the best protein. Only a limited number of microorganisms can utilize hydrocarbons, and among those that can the amino acid content varies.

So far the most successful microorganisms have been found in the soil near petroleum storage tanks. There, in the oil-soaked ground, researchers found microorganisms that had adapted naturally to hydrocarbons.

In the laboratory the fermentation goes on in a glass drum of white-clouded water at ordinary room temperatures. Air constantly bubbles through the water, and a technician checks gauges that record the temperature and flow of nutrients on several other pipes running into the drum.

In the water are the bacteria, growing and multiplying and producing protein faster than it’s ever been produced before. One theoretical calculation is that a single-celled microbe weighing one-millionth of one-millionth of a gram could, if given sufficient space and nutrients, generate a mass roughly 4,000 times the weight of the earth in 48 hours.

The bacteria used in the project grow on a combination of carbon, hydrogen, oxygen, nitrogen and up to a dozen inorganic compounds such as salts of sodium, phosphorous, calcium and magnesium. All of these are fed to the bacteria in the fermentation chamber at carefully controlled rates.

Traces of the necessary inorganic salts are put in the water and the hydrogen and carbon are supplied in the form of the highly refined hydrocarbon. Ammonia is used as a source of nitrogen for the microorganisms and the oxygen comes from the air.

The researchers found, too, that the residence time of the bacteria in the chamber had to be just right to allow for full use of the hydrocarbon.

After fermentation the cells can be separated by centrifuge and sterilized. Finally they are dried into the finished product: a fine white powder that is 70 per cent protein.

Not only is it nutritious, it is also very low in cholesterol. By using industrial processes it can be produced in any quantity, independent of conditions that have made food supplies fluctuate in the past. The supply of arable land or the vagaries of weather mean nothing to SCP. An SCP plant can be built anywhere in the world since supplying the hydrocarbons to a plant anywhere poses no technical problem. The plants can be operated with very little manpower and can be geared to produce the exact amount of protein required, which is something that the uncertainties of agriculture will never let you do for crops.

There are a number of other possible solutions to the world food problem.
protein shortage. SCP, says Dr. McNab, may well be one of them, but he does not think of it as the only one. 'We may need all new sources of protein,' he says.

The most obvious solution, but also the most gradual, is in increased land yields. Rich vegetable proteins such as soy beans, chick-peas and certain oilseeds present a strong hope as dietary supplements. But they need a bolstering in content of essential amino acids and are dependent on the supply of land, water and favorable weather.

Food from the sea, not long ago hailed as the hope of starving millions, isn't working out. Dr. George H. Beaton, head of the University of Toronto's Department of Nutrition, says the protein harvested from the sea's plentiful plankton, algae and seaweed, has definite taste and color problems. To remove the taste and do something about the product's green color makes it an uneconomical project at the moment, he says.

Fish are an excellent source of protein and they don't take up any precious land space. Fish for food are being reared now in Japan on several large fish and shrimp farms.

Another possibility is a fish protein concentrate made from ground, defatted whole fish. The resulting powder is about 80 per cent protein and, when marketed in large quantities, would probably be competitive with other sources of high quality proteins. In the United States the Food and Drug Administration has raised objections in the past to this fish protein because the whole fish is used. Recently, however, the FDA approved a specific process for making the protein powder from a variety of Atlantic hake. Fish now provide only three per cent of the world's protein. Just how much more could be taken from the oceans without upsetting nature's balance is not known and several food experts feel it is high time we did know if we are to husband the oceans.

Because a certain amount of secrecy is maintained between nations and between competing companies, there is no sure way of telling just how soon any of these new developments will provide the protein that the world's people need.

Price is a very important factor. SCP from hydrocarbons will probably never be as inexpensive as the lower quality proteins from cereals and oil seeds, but with large scale production Dr. McNab expects it to be competitive with high grade animal protein.

Acceptability is another big stumbling block. Nutritionists are finding that people in developing countries, hungry though they may be, will spurn food they think is second rate.

A way around this may be to introduce food based on SCP to sophisticated audiences in developed countries first, suggests Dr. Arthur E. Humphrey, Director of the School of Chemical Engineering at the University of Pennsylvania. Once the food has earned some prestige, it will be more readily accepted, he believes.

Dr. McNab of Esso Research points out that it should be possible to incorporate SCP into a wide variety of foods, such as cookies, bread, soups, pastas and cereals and already this has been done experimentally by several oil companies.

Foods from such new sources will be commonplace in 35 years, says the University of Pennsylvania's Dr. Humphreys, for the reason instant breakfasts are popular. 'If it tastes good, is easily packaged and easily stored, people will accept it.' [5]

World maps show that areas of population don't always coincide with food-producing regions. But plants utilizing hydrocarbon-fed microorganisms could be built anywhere, supplied with easily-shipped oil
CLOTHING

Whatever you want
a fabric to do
a petroleum derivative
will do it

by VICKI INNES

There's a hip ad in last December's Canadian Textile Journal showing Jason face to face with the dragon guarding the Golden Fleece of Greek mythology.

"If only Jason had known about Berkshire Color's Acid Dyes," it reads, "he could have dyed a fleece and saved himself a whole boatload of trouble."

The ad writer didn't say it, but Jason could have saved himself even more trouble if he'd been able to stay home and order a fake fleece of synthetic fiber.

Modern Jasons can do this and more if they want to save themselves the trouble of going out to create a legend. They can slay their private dragons with the help of innumerable other "fakes": unshrinkable white shirts and uncrushable trousers and coveralls that fire-starting monsters can't set afire. And they can adorn their women with flosses that, according to another ad, aren't fake anything, but real synthetic fiber.

All this magic is accomplished with oil. Jason probably knew about oil but the thought of using it to make a fiber would never have occurred to him. In his day, and for centuries after, men depended on animal or vegetable fibers for their clothing. There was a choice of linen, wool, cotton or silk, all of them in use as far back as 3000 B.C. The first man-made fiber—rayon—didn't come into production until 1891, and at that it was only a semi-synthetic. It depended for its basic material—cellulose—on mulberry leaves. Mulberry leaves? Yes. Rayon was developed as a substitute for silk, which the silkworm exudes after a diet of mulberry leaves. Today, rayon is commonly made from wood pulp.

The search for an artificial fiber had been going on ever since the 17th century. Rayon was a great success, but chemists continued their search for a completely synthetic fiber.

The breakthrough came in 1939. Researchers at E.I. du Pont de Nemours and Co., Inc. in the U.S.A. had been studying the process by which single molecules united with others to form giant molecules such as are found naturally in

Space suit with glass-fiber outer covering has inner layer of special nylon that protects against the 250°F heat of the sun outside space capsules
claimed to be 48 per cent more effective than other armors being used.

Nylon's usefulness has been expanded still more with Du Pont's new high-temperature-resistant nylon which will char but will not support combustion. U.S. Navy tests of this fiber, called Nomex, showed that suits of Nomex would give pilots far better protection against flaming aviation fuel, where temperatures surpass 2,000 degrees F., than either conventional nylon or fire-retardent cotton. Probably the most interesting use of Nomex was as the outer layer and several inner layers of the space suits worn by the Gemini astronauts. The suits had to withstand temperatures ranging from 250 degrees F. in the sun to -250 degrees in the shade. (The astronauts who died in the Apollo fire last January of asphyxiation were wearing Nomex suits and received only minor burns. For future flights, nonflammable Beta fiberglass cloth has been substituted for the outer layer of Nomex, and Nomex is still used as a liner under the Beta material.) Other uses are in clothing for forest fire fighters and racing car drivers. Paper of Nomex is used to insulate magneto wire and transformer coils as well as to make the formed insulation parts in electric motors and generators.

Du Pont has also been busy improving existing uses of nylon. It has produced a resilient new stockaying by extruding two different types of nylon polymer together as a sheath and core. Because the two nylonos have different shrinkage, the yarn sets on treatment into permanent kinks. Another new nylon developed by Du Pont has a triblock crom- section, which gives fabrics a dry feeling, a silky sheen and a textured look.

Nylon's best synthetic fiber competitor, in terms of world output, is polyester—a fiber as strong, but less elastic. World production of polyester will reach an estimated 937,000 tons during 1967. This compares with 1,488,000 tons of nylon and 651,000 tons of acrylic, the third big synthetic fiber, which also comes from petroleum.

Polysters such as Dacron, Fortrel, Terylene and Kodel fibers are also expected to be the fastest growing of the three synthetics. Since its discovery by English researches in 1941, polyester fiber has appeared in everything from sewing thread to conveyor belts. Polyester fiber can now be found in every article in a man's wardrobe, from his crocheted hat to his shoes. In footwear, this fiber forms the foundation of the new leather-like shoe uppers material first introduced by Du Pont in 1964. The material resembles leather more closely than any previous substitute and can be used for coats, jackets and furniture upholstery.

The United States army medical service has found yet another use for this versatile fiber: field hospitals made of polyester fabric coated with synthetic rubber. The combination gives units which are strong and light, weather-resistant and airtight. The hospitals look like Qonnet huts when they are erected—a job that takes only half an hour. They're supported by inflated arches, like the rings on a child's wading pool. Twenty feet long and 52 feet wide when inflated, they can be packed, along with the other equipment needed, into a space about four feet by seven feet by 12 feet.

Like polyester and nylon, the acrylic fibers (such as Orlon, Acrilan and Credlan) are found in a wide variety of articles. When polyacrylonitrile was first developed—soon after nylon—a great industrial future was predicted for it because of its excellent resistance to acids (nylon and polyesters dissolve in some acids). And, sure enough, it has found a place in industry, in belts, uniform, filtration fabrics and paint rollers. But polyacrylonitrile made its first major appearance in women's sweaters, where the fiber's warm and luxurious feel and lightweight fluffiness were ideal. These qualities, plus durability and crease resistance, have fitted acrylic fibers for many other apparel uses, including ski suits and dresses. Acrylics and modacrylics like Dvvet and Vell fiber also make pile fabrics for fur-like coats. And they go into carpets and curtains, too.

One of the newest test-tube creations is polypolyethylene, which is marketed as Vectra, among other trade names. Commercial production started just nine years ago but by last year, polypolyethylene seemed to be on its way into the class of high-performance fibers along with nylon, polyester and acrylic. Although polypolyethylene has a relatively low melting point and has been difficult to dye, it is amazingly strong for its weight. It is the lightest known textile fiber; ropes made from it are as strong as steel. Polypolyethylene, a similar fiber, is the only other synthetic lighter than water. Polypolyethylene's lightness, strength and resistance to abrasion and sea water have made it a potential competitor of fiberglass as a resin-coated covering for wooden boat hulls. Polypolyethylene is lighter than nylon and has more "yield"—it takes less fiber to make the same amount of fabric. It has greater abrasion resistance than acrylic on an acrylic carpet lasts only about a third as long as a polypoly-
Polyethylene is being used in a fabric which undergoes an Alice-in-Wonderland change when heat is applied. Called Space Fabric, the material consists of polyethylene and either polyvinylidene chloride (better known as Saran), polypropylene or nylon fibers woven into a flat fabric. Put into an oven, the heat-sensitive polyethylene shrinks, puckering the fabric into a three-dimensional waffle shape. One style becomes almost an inch high. It is five inches in length; worn over such names as Lyra, Nuna and Spanidelle, spanedel’s stretch—up to five times its original length—makes figure-molding bathing suits and girdles comfortable.

These synthetic fibers can be made from petroleum derivatives or their products: ethylene is the starting point for polyethylene, polyvinyl chloride and saran fibers; paraxylene and ethylene for polyester; benzene and toluene for nylon; methane for fluorocarbon, acrylonitrile for polyvinyl alcohol; toluene for spandex; and propylene for acrylic and polypropylene. However, most of the synths can start from more than one point; nylon, for example, can be made from propylene or benzene, toluene, benzylidine and acrylonitrile. And the raw materials themselves can be obtained not only from oil and natural gas but coal and even, in the case of nylon, from coal tar, corn broths and oat hulls. However, petroleum is the most important raw material used for fibers in North America. Imperial Oil Limited has committed some $135 million to the building of petrochemical manufacturing plants that produce, among other things, benzene, toluene, propylene and polyvinyl chloride; the company has a $5 million plant in Sarnia for acrylonitrile, which goes into acrylic fibers.

The characteristics of any synthetic fiber depend not only on what’s in it but how it’s made. Many techniques have been developed to change the ways fibers perform, including such obvious ones as changing the cross-section from round to some other shape, and blending different polyesters and acrylics; say—before extrusion to get a fiber with the qualities of both. Fibers can also be ‘‘spunbonded’’—the name coined to describe a web of uncut fibers arranged at random and bound together. Material made this way is used to make disposable dresses and as interlinings to keep the shape in dresses and collars, as shoe linings and as a backing for carpets and rugs. In another new process, polypropylene yarns is obtained inexpensively by twisting flat PP film or tape as it is produced. And in electrostatic flocking, short fibers are charged electrostatically and then oriented perpendicularly to an adhesive backing so that they stand straight up, like plush.

Even the finished fabric can be modified. One recent development is ‘‘durable press’’ which succeeds the earlier ‘‘wash and wear’’ treatment. The durable process, the fabric—typically a blend of cotton and polyester—is chemically treated, sewn and then heat set to lock the desired shape into the garment. Cotton reacts with the chemical treatment; polyester gives the fabric its strength.

All work this to develop new fibers and new techniques has made a great difference to the end product. And this has made for a lively time in the market place.

The battle in tire cord fabric is one example. At first tires were reinforced with cotton. Then rayon was adapted for this use and, in 1947, nylon cord added further competition. Since then, cotton has dropped out of the race but another fiber, polyester, has entered the fray. It has been called ‘‘the newest that any fiber has come to be ideal for tires.’’ Some Atlas tires, which are marketed by Imperial Oil, may be converted to polyester cord next year. Competition may be fiercer in future-tire cords can be made of glass, polypropylene or high temperature-resistant nylon fibers or cable finer steel wire so.

The lure of sudden success keeps the competition keen, not only among tire cords, but other applications as well. The story of Oizte Corp, an alloying company in 1961, shows what can happen. This American carpet maker reset its sales figures zooming by being the first on the market with indoor-outdoor carpet made of 100% Vectra polypropylene. Sales—6 million in 1964 when the carpet was introduced—will be an estimated $150 million this year.

This success story is based on a tough, polypropylene carpet which resists water, sunlight, mildew, rotting, freezing and stains, even, as an admixture cosby put it, the incriminations of pets and children. The carpet can be used on walls as well as on floors indoors and out, and it can be cleaned with a garden hose.

The enthusiasm for synthetics in carpeting and other fields helped push Canadian production of wholly synthetic fibers to almost 100 million lbs. last year, nearly three times the 37 million lbs. produced in 1969. Another 28 million lbs. were imported last year and seven million lbs. were exported.

As of last summer, there were 21 plants producing synthetic fibers in Canada; among them, they turn out acrylic, nylon, polypropylene, polyester and saran and spandex fibers. There aren’t any statistics on the output of specific fibers but, according to one estimate, most of the production was saran: 55 million lbs. in 1965, compared to 30 million lbs. of polypropylene.

What of the future? Current research indicates the possibilities. Peter Sherwood, a U.S. consulting chemical engineer, has written about these four other developments. Polymers can be modified to produce a new series of fibers said to be more like wool than any other synthetic fiber. A Japanese firm has grafted polyvinyl chloride and polyvinyl alcohol and, using a new spinning technique, has impregnated the inserted raw material with fibers that makes woven fabrics said to be more weather-resistant than polypropylene. And the U.S. army has found that nylon fibers mixed in cement prevent the growth of algae in concrete.

In fact, research possibilities are endless. Sherwood says that ‘‘literally thousands of polymers have been studied for fiber potential.’’ It has been written in a book published last year that he observed a ‘‘perceptible slowdown in the activity devoted to development of new general-purpose nylons, polyesters, and acrylics other than modifications of the basic types. ’’ The reason, he suggested, is that the raw materials either cost too much or that their costs would not justify the amount of developmental and educational work needed to ‘‘tum a new fiber into a successful commercial product. ’’ As G. J. Sherr, Jr., Nuna’s chief executive, put it in Esso Chemical Co., Inc. put it: ‘‘We’ve discovered the automobile; now we’re working on model changes.’’ The ‘‘model changes’’occupying fiber researchers are things like improved dyeability and comfort, and modification for certain uses.

All this work promises a bright tomorrow for consumers. Researchers talk of ski jackets that become thicker and warmer when exposed to snow and cold, sheets that change color with the sun’s rays; and of a fiber product that will take salt or waste from water. But that may be nothing. Du Pont is building a plant said to be for the production of a ‘‘mystery fabric’’ that will be a year more beautiful and more durable than anything now known.

Twenty years from now fabric will be even easier to care for and more comfortable than their present easy-care comfort. Michael L. Haider, chairman of the board of Standard Oil Co. (N.J.), last year forecast that in 20 years ‘‘we will be wearing clothes, made either from new petrochemical fibers or treated natural fibers, which will last longer, cost relatively less, be more attractive, and be more comfortable.’’ Robert L. Stultz, of Celanese Fibers Marketing Co., N.Y., forecasts fabrics that will all require little or no care and be virtually self-cleansing by that time.

It’s a far cry from the world portrayed by a British film of the early 30s, The Man in the White Suit. It is a laboratory helper who’d invented a fabric that would never wear forever and never get dirty. But, instead of praising him, the mill owners and workers attacked him, frightened that the discovery would end their profits and their jobs. They didn’t kill his invention, just as they caught him, the suit began to disintegrate.

Maybe the producers judged the mood of the public accurately, but the pad has never been the same since. Now. Anybody who invests a new miracle fiber today can count on fame and fortune tomorrow.
Next to food, the thing you need most is a roof over your head. Changes are it’s petroleum-derived. In this country, for every roof that has wood shingles, there are five covered with asphalt, and even the one that is shingled with wood has an underlay of asphalts-impregnated building paper to keep out the damp. We’re not quite ready to make a meal of oil derivatives yet (see page 1) but we’ve been living in the products of the petroleum industry for generations.

The number of uses for petroleum-derived products in the building of houses today is enormous; from vapor barriers that go under the foundations to shingles on the roof. Even in the most conventional houses, petroleum-derived plastics turn up in doors, windows, walls, ceilings, floors, roofs, wiring, plumbing and heating. The building industry is probably the biggest single customer of the petrochemical industry; one estimate places the amount of petrochemicals that go into building materials at between 20 and 30 per cent of all petrochemicals produced.

It has already been demonstrated that masonry units may be produced by molding and heat-curing a precise mixture of sand and clay and a petroleum-derived binder. Blocks of traditional shape made in this way are less expensive to produce than concrete blocks. Known by their inventors as BMX masonry units, these blocks and their brick counterparts may be laid up by conventional mortar and trowel methods. Or they may be laid up with a rolled-on adhesive that speeds construction so that savings as great as 25 cents per square foot of wall surface may be achieved. Now in the late stages of development, BMX blocks are stronger and have better freeze-thaw properties than concrete blocks, are non-porous, and so smooth that only one coat of plaster is needed to provide a finished interior. The BMX blocks were developed by Imperial’s affiliate, Esso Research and Engineering Co., which built two research model houses of them in 1964, one in Linden, N.J., and the other in Bogota, Colombia. They are being tested in Canada this winter, in service stations in Hamilton and a warehouse in Montreal.

Imperial’s subsidiary Building Products of Canada Limited has been testing vinyl siding for some years, and their biggest problem today isn’t in the products, but in the builders, who insist on nailing the siding so tightly that when the vinyl expands with the summer’s heat, the expansion shows in bulges between the nailing spots. Building Products has given up trying to convince builders that vinyl siding should be nailed a little loosely so that it can expand without bulging, and are trying to develop a nailing slot that will make tight nailing impossible.

While such problems may be frustrating, solving them is a worthwhile activity, for the value to the building industry of petroleum-derived plastic building materials is great. The first advantage they have over conventional materials is lightness. A four-story office building in New Jersey was built recently with walls of glass-reinforced plastic and aluminium. They weigh only 11½ tons, as compared to 612 tons for conventional brick-and-plaster walls. What’s more, they’re half as good again as double-glazed windows for conserving heat.
they admit soft light into the offices, and the walls glow dramatically at night if you leave the lights on inside.

The light weight of plastics allows extra stories to be added to old buildings whose structures would not be able to support the additions if they were of brick and mortar. Plastics are resistant to many substances that will corrode other building materials; they don't support rot or mildew, and they don't suffer attacks from insects. They can be colored all the way through. In some of them the color is permanent, although this is an area where a lot of work remains to be done. Even in those plastics where the color fades, it does so gradually and evenly, without discoloring in blotches. If you want to paint it, vinyl makes an ideal surface to paint on, and the paint won't blister afterwards.

It is these qualities that have encouraged the building of experimental plastic houses ranging from the Monsanto House of Tomorrow of 1957 that is now in Disneyland, to a three-bedroom bungalow in Ghent, Belgium, that sold for $10,000 in 1961. The Monsanto house was slickly futuristic in style—four bays cantilevered from a central supporting core—and while it has been called economically unreal, it did show what plastics could achieve in a dramatic way. The Belgian bungalow looks like any other bungalow in fact, it looks a little old-fashioned even for 1961 and has a life span estimated at 50 years. The house is supported by pillars and beams made of hollow vinyl extrusions that are positioned in slots in a prepared foundation, then filled with concrete. When the concrete hardens, the pillars and beams form a single concrete framework on which a team of builders fasten a roof of extruded vinyl panels. The walls form a sandwich of vinyl and glass-reinforced polyester over a rigid foam core that acts as fireproofing and insulation—made in continuous lengths in an eight-foot width that matches the height of the framework. At the site, the workmen simply cut a length to fit the site of the room they want to enclose and presto they have a seamless wall that snaps into recesses in the framework. Windows and doors are made simply by cutting holes in the walls where you want them; the walls are rigid enough to make frames for the windows and doors unnecessary—the builders just screw them directly to the walls, using hinges, doorknobs and locks of plastic.

Even some of the fixtures inside the house use plastic: the kitchen sinks are polyurethane, which is as smooth as porcelain-laid enamel, cheaper than stainless steel, and quieter than either; and the kitchen drawers are made of polyurethane; in fact, the drawers came first and the kitchen afterward—it was designed to utilize the mass-produced drawers most efficiently. Other all (or nearly all) plastic houses have been built in other places. One was built in England, about 20 miles from London three years ago, using plastic in about 30 different ways ranging from the conventional (installation on wiring) to the unique (translucent doors of hollow polyvinyl chloride extrusions locked together in a wooden frame). In the British house the roof is composed of panels of urea-formaldehyde treated strawboard joined with tape made of polyvinyl chloride-reinforced polyester, a convention in Traverse City, Mich., with a dented roof made of foamed polyester, a market near Paris with a translucent plastic roof, and whole villages of polyurethane-paper laminated temporary houses for migrant farm workers in California, developed by a Canadian firm and tough enough to last five to seven years, with care. In all of these examples, the important thing is that the petroleum-derived material from which the structure is made does its job of providing shelter unobtrusively, economically, and well.

There are obvious examples too, like the American pavilion at Expo, with its 2076 acrylic pyramids in a 50-foot bubble that glittered with reflected sunlight by day and glowed spectacularly at night. One of the aims of the material was to draw attention to the building in that case. In a house, the purpose would be precisely the opposite: to disappear entirely. People may enjoy reading about experimental house designs in magazines, but precious few want to live in them. This is one reason that plastics used in construction are sometimes made to look like conventional materials and may pass unrecognized for what they are. Yet they are there, and their effect on house building has been marvellous.

Take leaky basements, for example. At one time, a leaky basement meant an expensive repair job that could involve digging down to the base of the foundation all around the house and sealing the walls with asphalt, then digging a drainage ditch around the perimeter and filling it with tiles to carry away any water that might collect. Now, a two-stage epoxy waterproofing stopper will stop seepage through the walls or floor. You can put it on the inside of the basement walls and forget it. On many new houses today, polyurethane sheet properly applied to the outside of the foundation and base- ment walls means that they just don't leak, ever.

Plastic foams promise startling advantages as insulation. The most exciting at present is urethane foam, a product made from toluene. Until recently it found its greatest use in thin-wall applications like refrigerators and freezers, but it has begun to turn up as building insulation. Urethane foam has an insulating efficiency two or three times as great as glass wool and nearly twice as great as polystyrene, which means builders can use less of it to get the same insulation value. By using urethane foam insulation only one inch thick, a Halifax apartment building saved 1,300 square feet, the equivalent of a whole apartment. Another apartment building in Arlington, Va., sprayed foam urethane directly on the inside of his cinder block walls and plastered over it, eliminating both rock lath and furring. He said the foam cut his insulation costs by a third and saved him $3,000 a year in heating and air conditioning expenses.

Petroleum chemicals have enormous significance for the building industry. A year ago last October, Better Homes and Gardens reported new plastic adhesives to suggest that 'adhesives based on plastics may one day hold your house together.' They already hold quite a bit of it together—plywood, counter tops, floor tiles and even roofs. But rubber phenoxy glues will fasten panelling to wood studs, mahogany, or plaster, and fix the subfloor so tightly to the joints that a Sears appliance service man refuses to work on them.
temperatures, resistances at temperatures as high as 300 degrees F., will stick to rubber, metal, or wood, and will remain pliable for a very long time. One company is reported to be working on a paint using polynyl fluoride that will last perhaps 30 years. There is even a paint that retards the spread of fire by fortifying up when it's heated to produce an insulating mat of tough, spongy cells. It's expensive, but it finds an application in places like schools, hospitals, and apartment buildings.

Their astonishing qualities have given petrochemical products a strong foothold in the conservative building trade where innovations are accepted slowly. Each new building material offered to the industry must earn acceptance by owners, builders and building code regulations. All must be assured that new materials will give the performance their promoters claim for them. Before being accepted as an alternative or improvement on other materials being used, even the most superior of new materials must endure a trial period of testing and demonstration. Already many petrochemical-based materials have won their place in the sun; plastic in pilot tarpas for roofs and flashings; in vinyl facing on siding; in vapor barriers and insulation for foundation slabs; in vinyl sheathing (the glue that binds the plywood together); in vinyl covestripes, downspouts and shutters; in window frames, muffins, sits and hardware; in fillers for cement and plaster. Even a material that goes around doors, the drip caps that go over them to keep the rain off, the sweep that goes under them; even in the doors themselves; in interior trim, wall facings, and acoustical ceiling; in electrical hardware; in the lining of plastic pipe and drawer slides; in bathroom sinks and vanities; in counter tops, kitchen drawers, sub-flooring and floor tiles.

Plastic pipe can be added to the list. The provincial plumbing authorities in Quebec, Ontario, New Brunswick and Saskatchewan have accepted CSA-approved plastic pipe and fittings, and the other provinces are expected to follow suit. Polyethylene water main materials, used by the City of Montreal and Chateauguay in Quebec, and polynyl chloride maines have been installed in Fort Frances, Coginwood and Enfield in Ontario. In Europe, plastic pipe is old stuff; in Holland alone, it is estimated that 50,000 miles of plastic pipe connects homes to water mains. Plastic pipe is so easy to work with that it could cut labor costs on a house by anywhere from $50 to $70, and it comes in any length—a Swedish plastic pipe manufacturer once extolled its virtues in vapor barriers and insulation for foundation slabs; in vinyl sheathing (the glue that binds the plywood together); in vinyl covestripes, downspouts and shutters; in window frames, muffins, sits and hardware; in fillers for cement and plaster. Even a material that goes around doors, the drip caps that go over them to keep the rain off, the sweep that goes under them; even in the doors themselves; in interior trim, wall facings, and acoustical ceiling; in electrical hardware; in the lining of plastic pipe and drawer slides; in bathroom sinks and vanities; in counter tops, kitchen drawers, sub-flooring and floor tiles.

Plastic may very well take over from glass, particularly where vandalism is a problem. A school in California that was forced five days a week to switch to plastic in 1961 and saved $15,000 in one breakage-free year. A steel plant in Pennsylvania used to repair 2,500 broken windows a year. It went to plastic in 1961 and reduced the breakage to 250, and reaped a saving of $12,000 a year. Plastic windowglasses break, but when they do, they don't shatter into razor-edged fragments—they break into big, light, dull-edged pieces that wouldn't cost anybody.

Putting the shoe on the other foot, a British architect named D. C. Kirby told the Conference on Plastics in Building Structures in London two years ago that "if glass were discarded today it would be the worst thing in building because of its low impact resistance in sheet form."

You might wonder if a material that's as clear as glass and won't cut anybody if it breaks, that can take any color, that can be produced in an infinite array of the materials, has a variety of shapes, that is rustless, light in weight, warm to the touch, and will stick to wood, metal, concrete and glass in its liquid form, could have any faults at all. Well, it has: it's expensive (although it's getting cheaper); it lacks structural strength (although some combinations show promise in panel form); it's easily scratched; some kinds deteriorate in ultra-violet light; most of its heat is conducted; it's self-exinguishing (for the most part); they collect static dust; and they're not stable at temperature extremes.

But there is no such thing as the perfect building material, anyway. Wood burns; metal rusts; insulation is noisy; glass is heavy; steel rusts; glass shatters. Pit the advantages of petrochemical-plastics against other building materials and they may come out on top. In fact, they have outlasted the most aggressive of the materials based on natural materials; shapes, for instance, that is rustless, light in weight, warm to the touch, and will stick to wood, metal, concrete and glass in its liquid form, could have any faults at all. Well, it has: it's expensive (although it's getting cheaper); it lacks structural strength (although some combinations show promise in panel form); it's easily scratched; some kinds deteriorate in ultra-violet light; most of its heat is conducted; it's self-extinguishing (for the most part); they collect static dust; and they're not stable at temperature extremes.

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THE EARTH

Petroleum can make the desert bloom
the clouds give down their rain
the weeds to wither
and the good crops yield abundance

by ROBERT COLLINS

Maybe the real measure of achievement in our society is
whether or not it inspires writers to lofty flights of fiction.
Consider, for instance, the matter of Rupert and Rosamund.

Rupert took Rosamund's hand and pulled her up a steep bank that
led to a short cut and then released her again. She looked about her with
interest, surprised to see a number of tree-tops burst and dead, silhouet-
ted against the sand.

'Is that what the sand can do?' Rupert told her grimly.
It hardly seemed possible. Rosamund touched one of the dead trees
with gentle fingers, and at the fijy that had overcome it.

'But it will be a forest again,' she said defiantly.
Rupert stood with his hands on his hips, looking far out across the
sand.

'Ve hope so,' he said.

Rupert (stiff-lipped, indomitable) and Rosamund (plucky,
defiant) seem almost totally unbelievable in this British
women's magazine serial of three years ago. But as they wade
on through the sand and purple prose, they leave fiction and
encounter hard fact. They come upon a sand dune stabiliza-
tion project: the slicking-down of the desert with petroleum
spray for a period long enough to allow new trees to take root.
Essai is doing exactly this in Tunisia, Libya and other parts of
the world. It's a truly important little drama, as is the whole
story of oil, sand, sun and water. Our lives may depend on it.

One of the painful oddities of this earth is the uneven dis-
tribution of sunlight, water and good land. 'Earth' is really a
miniscus. Seventy per cent of our planet is ocean, river or
lake. Fifteen per cent is desert, spreading slowly but continu-
ously, destroying everything in its path, like a disease. Much of
the remaining land surface is rock, ice, soil with enough rain
but not enough sunlight for the growing season, or soil not
technically desert but too arid to raise decent crops.

Ideal farmland is rare and precious—and too many farmers
mismanage it, through ignorance or indifference. Somehow,
if we are to feed hungry people, we have to correct the im-
balance of nature.

None of this would seem to be the oil industry's business—but it is. From petroleum come substances that make the roost of
scanty sunlight, hasten seed germination and reduce moisture
evaporation; canals and reservoir linings of asphalt or plastic
to prevent seepage of precious water supplies; fertilizers to en-
rich the soil; sprays to halt the march ing sand.

For centuries men have fought the drifting desert with crude
weapons: windbreaks, fences and mats of twig, dead
grass and brush. It has been a slow and losing battle. In many
parts of the world the sand is still advancing, engulfing vine-
yards, forests, farms, even villages.

Yet some deserts will grow crops if they can be tamed long
enough to let plants gain a foothold. Even in areas of light
rainfall the sand can hold enough moisture a few feet below
the surface to sustain growth. But seedlings haven't a chance
under ordinary circumstances. 'Chihilis', the famous desert
sand storms, expose their roots, strip away the leaves and kill.

This was the problem Tad Les, a young Polish chemist with
Easo Research Ltd., in England, was pondering in 1960. He knew Libya from his World War II service with the Polish brigade. He'd seen sandstorms and he'd also noticed another phenomenon: rain would temporarily quiet the sand. Why couldn't a man produce a longer-lasting fluid to stick sand particles together and give plants a fighting chance? The oil industry knew, too, that Middle East drillers sometimes sprayed oil around their rigs to get temporary relief from sandstorms. Could this technique be adapted to agriculture?

Laboratory researchers built miniature sand dunes, sprayed them with various oils and tested them in wind tunnels. Untreated sand drifted in winds of 17 miles per hour; oil-sprayed sand resisted gales of 70.

In 1961 Tad Lees and the Libyan Forestry Department moved the experiments into the desert at Khallit el Masaoudi, 25 miles east of Tripoli. They needed the best conditions that this parched region could offer: 12 inches of rain concentrated into a single growing season which, in this part of Libya, lasts from November to February. Down went quick-growing eucalyptus and acacia seedlings, 18 inches tall, through the dusty surface sand to the dampness below. In moved big tanker trucks, fitted with fine, soft sand tires and long hoses. Men switched on the spray nozzles and 'painted' acres of desert black with an asphalt chemical mixture. It left a spongy surface, about 14-inch thick, porous enough to admit rain and sticky enough to hold the sand.

The covering lasted about a year—a period long enough for the trees to root firmly and take on the stabilization job themselves. By then the eucalyptus seedlings averaged six feet tall—a substantial windbreak. The shorter acacias were returning valuable nitrogen to the soil.

Today in those first experimental acres, the eucalyptus stand 25 to 60 feet tall. Yellow-blossomed acacias cluster in dense thickets. Beneath is a carpet of sturdy grass.

In about 15 years these desert plots will be commercial forests with fuel, charcoal, rough lumber and wood pulp. They'll give Libya new industry and they'll give people pleasant new places to live. Meanwhile, dust stabilization experiments go on in the deserts of other countries such as India, Argentina and Pakistan.

Less dramatic than the suddenly-blooming desert, but potentially just as important to world agriculture, is the job petroleum mulch is doing for soils short on rainfall or sunshine. Oddly enough, petroleum mulch came about by accident about three years before the dust stabilization experiments. In 1958 Easo Research and Engineering Company scientists in the United States were testing asphalt coverings for the watershed areas in Arizona, Texas, Colorado and North Dakota. They hoped these coverings would catch and hold more rainfall for subsequent storage.
Canadian municipalities. Such catchments gather and hold 60 per cent of the rain, compared to three per cent in untreated areas.

The water collected in this way is fit for cattle without any purification. With a little additional treatment it would be suitable for humans. The crumbling asphalt that plagued the 1958 researchers, and inadvertently led to melts, is no more.

Linetings have lasted five years and would probably last indefinitely with minor yearly repairs. Catchments could rejuvenate those parts of the world where pure water is too far away, or too far down in the ground, to haul or pump economically.

Here again, asphalt isn’t petroleum’s only answer. In England a strawberry farmer lined a 250,000-gallon earth reservoir with thin butyl sheeting, increasing his water supply and providing irrigation to increase his plant yields. Similar sheeting has been successfully used in garden pools and swimming pools.

If you can line water catchments and reservoirs with petroleum products, why not line irrigation channels? In some parts of the world, these channels lose enough water through seepage to warrant and ruin adjacent land.

Most of West Pakistan, for example, is steppe or desert, irrigated by the Indus River. This, the world’s largest irrigation system, covers 25 million acres and faces a seepage problem of catastrophic proportions—each year another million acres are lost to farmers. In Pakistan and India, terning with people and always on the verge of famine, such waste can be the difference between life and death. Petroleum researchers are testing materials to contain the precious water and protect the adjacent land. Because the water is flowing, the problem calls for a sturdier product than the linings of catchments.

Remarkable as all these scientific tricks are, they pale a little beside the dream of Eseo Research and Engineering Co. chemist Dr. James Black. He wants to use oil to make it rain.

The principle is simple enough. You coat arid land, usually a coastal region, with asphalt. This, as the model experiment shows, absorbs solar heat. Like a city street or parking lot, it gets to 30 degrees hotter than surrounding earth.

This creates an updraft; the hot air rises. Moist winds are drawn in off the water, and carried upward. Condensation occurs. Clouds form and dump rain downwind from the asphalt-coated patch. Dr. Black, the rainmaker.

The idea, now about to undergo major tests, proves out well in small tests and in computerized calculations. There is also much man-made and natural-science evidence to reinforce the theory. Masses of rain clouds characteristically form off theeward slopes of Pacific and Caribbean islands. Large forest fires and wartime incendiary bombings have produced rainstorms by the effect of their updrafts. Big cities which are really ‘islands’ of heat, and very big industrial plants, are often associated with heavier local rainfall. Mountains, by forcing warm air to rise over their peaks into cooler altitudes, produce rainclouds.

According to calculations, a large asphalt-coated tract—say, 20 to 50 square miles—could provide 20 to 30 inches of rain over an area two or three times the size of the ‘black island’. (Most cows need at least 20 inches of rainfall.) The cost of such rainmaking would run around $75 an acre, with annual maintenance costs of $10 per acre. Large irrigation projects in Egypt and Australia cost $300 to $600 an acre. Asphalt rainmaking would be more than competitive.

To put it another way, says Dr. Black, rain may be able to make rain ‘for less than the present cost of desalting sea water or piping fresh water from rivers.’ This then, could be the greatest petroleum miracle of them all: oil from the earth working with the sun to water back down to earth, to feed and quench the thirst of a hungry world.
It's energy that makes the world go round and petroleum is Canada's principal energy source

by FERGUS CROCKN

The preceding pages of this magazine have described the many glamorous features of the future of fuels. As we use in the production of food, clothing, shelter, fertilizer and climate control are exciting and revolutionary. But attractive and exotic as these uses may be, they will use only a small part of world petroleum production; it has been estimated that only one per cent of the world's oil would be sufficient to synthesize enough protein to meet the world's annual protein needs. The figures for fertilizers, petrochemicals and building products are not much larger. In Canada, only 8 per cent of petroleum products go into non-energy uses. The greatest use we make of oil and gas today is as a fuel. We burn more than 92 per cent of it to provide energy; Imperial alone makes and markets two grades of automobile gasoline, two grades of tractor fuels, marine gasoline, three grades of aviation gasoline and three grades of jet fuel, five diesel fuels and 14 different fuel oils; in addition, Imperial produced 27.8 million net cubic feet of gas per day in 1966. As far as anyone can see clearly into the future, oil will continue to find its greatest use as a fuel.

How great? On a world-wide basis, oil and gas will supply a significantly larger percentage of energy needs than they do now as other countries enter a period of intensive oil use. Canada passed through such a period in the last two decades to become the country with the greatest per capita oil use in the world. By 1985, oil and gas will be supplying a greater proportion of our energy needs than they do even now—about 78 per cent of the total, as compared to today's 73 per cent—although on a percentage basis gas will supply more than it does today, and oil less.

This doesn't mean that oil consumption will be declining. In the short a time as a decade and a half oil demand in Canada will rise from the present 1,200,000 barrels a day to about 2 million. The demand for natural gas will triple. To make such predictions, oil company researchers look at such indicators as the present demand for energy, the population trends (we'll have more than 25,000,000 people by 1980, maybe 40,000,000 in 2000), and the rate of energy use. For example, over the past 30 years Canadians have been using energy at a rate that has been increasing by over 100 billion British Ther- mal Units a year. (A BTU is the amount of energy it takes to raise the temperature of a pound of water by one degree Fahrenheit). One hundred billion BTUs is more than all the power inherent in all the water flowing over Niagara Falls in a year. This means that, over the past 30 years, the increase in energy use in Canada required the power of another Niagara every seven months. But for the next 20 years, Canada will demand more energy at the rate of a new Niagara Falls every 2.7 months, or a total increase equal to 87 Niagaras by 1987.

Some of the energy Canada will be using then will come from water power (about 8 per cent by 1985), some from nuclear energy (perhaps 5 per cent), and a dwindling supply (around 9 per cent) from coal and wood. But the greatest amount—about 78 per cent—will come from oil and gas.

Making plans to meet the demands—both Canadian and world-wide—that will be placed on petroleum is a complicated task and one that simply cannot be done with great precision. Among the variables that affect the oil business are availability of supply, competition from other energy sources, government action, technological improvements, social climate and world conditions. If, for instance, such densely-populated countries as India, Burma, China and Indonesia should reach a point where per capita use of oil comes anywhere near that of Europe and North America, any predictions made now would be knocked for a loop.

To people in the energy business, uncertainty is just another fact of life. 'Predictions are subject to rapid erosion,' is the way William Pink, of Imperial's coordination and economics department, puts it.

You can't be sure of anything in the forecasting business, it seems, which caused a U.S. study group to comment: 'The extreme degree of substitutability makes it almost pointless to consider projections for specific fuels in the period to 2000.' As just one example of such substitutability, they point out that gasoline can be produced from coal as well as oil. It is diffi-
calt, the study group said, to make confident predictions. Forecasters faced with the imponderables of future needs can get some help from computers, but once you get beyond about 15 years, even the computer is outdistanced. It has to be replaced by human imagination, or even a crystal ball.

Leaving the crystal ball aside, with its visions of space travel, people-pipelines, and doomed cities with controlled climates, the immediate future is startling enough. One of the most exciting new uses of fuel from oil will be for the supersonic transport airplane, commonly called the SST.

There are two SSTs on the horizon. The first, the Concorde, is being developed by French and British aircraft companies to use existing fuels. The Concorde is expected to start test-flying next year and be ready for the public about 1971. The other—the American Boeing 2707—is about five years behind the Concorde in development.

The Concorde promises to expand the demand for the kerosene type of turbo fuel, the fuel most commercial subsonic jets use now. At present about 34 per cent of a barrel of oil used in Canada is gasoline (on the average), 34 per cent middle distillates, which include furnace oils, diesel oil, kerosene and stove oil, and 31 per cent heavy fuel. The balance, 11 per cent, includes the gasoline and kerosene types of turbo fuels for jet engines. These proportions will change—gasoline, for example, will rise to about 38 per cent by 1985, the so-called middle distillates will fall from about 34 to 27 per cent as the proportion of oil for home heating goes down, heavy fuel will rise slightly to 22 per cent. The balance will increase from 11 to 13 per cent; turbo fuels will increase their share of this category—their use will rise, between 1967 and 1985, from an estimated 11 million to 35 million barrels.

The Concorde, which will fly at Mach 2 or about 1,400 m.p.h., will use a kerosene-type fuel which may include an anti-oxidant to withstand the temperatures ranging from 200°F to 400°F which are generated at supersonic speeds. The fuel will also be used to help cool the cabin where, in spite of the 70°-below-zero cold at 70,000 feet, the passengers would cook without some such agent. The fuel will be used as a heat sink into which heat from the cabin will be bled, and it will have to be designed to absorb such heat without decomposing.

The Boeing’s fuel requirements are tougher to satisfy than those of the Concorde, according to fuel specialists in Imperial’s research department at Sarnia. The Boeing will fly faster than the Concorde—at Mach 3 or about 1,900 m.p.h.—and use a more sophisticated fuel. All the major oil companies are working now on SST fuels. “They’re wrestling with prices, principally,” says Clare Collins, aviation fuel expert at Imperial. It may sound like penny-pinching, but fuel represents about 40 per cent of an SST’s operating costs.

Imperial Oil’s research department, in cooperation with its affiliates, is testing different supersonic fuels, principally for their thermal stability, but also for contaminants and their ability to withstand freezing. In other departments of Imperial Oil the SSTs and jumbo jets have caused tentative plans to be made which will affect the company’s refining and marketing activities for decades to come.

The fuel for the Boeing SST has not yet been specified, but will likely be based on kerosene. There is some speculation that second or third generation SSTs may use liquified methane, which is the principal ingredient of natural gas and less expensive than kerosene. Hydrogen as fuel for later SSTs is another possibility.

The demand for kerosene will be raised even further if predictions for the tracked hovercraft come true. Like the hovercraft, the hovercar is powered by a gas turbine. Traveling at speeds of 300 m.p.h. on raised concrete tracks, it would be faster than today’s jet aircraft in getting passengers from downtown in one city to downtown in another, and faster than anything else in sight except vertical takeoff aircraft, which also loom on a distant horizon.

The hovercraft, as anyone who has been to Expo can testify, is beyond the experimental stage. A 160-ton craft will begin a regular run across the English Channel in 1968, carrying up to 500 people, or 250 people and 32 cars, at a speed of 70 knots. As a comparison, the best speed most hydrofoils can make is about 56 knots—65 m.p.h.

With the current emphasis on kerosene, the petroleum industry has a role to see every citizen. In the 1860s and 1870s, when ‘rock oil’ or petroleum was used only for lighting (or by the ‘snake-oil doctors’ to ‘cure’ everything from horse colic to human baldness), kerosene was distilled from crude oil. Then the internal combustion engine arrived on the scene, and gasoline became the big thing.

For the gasoline-engine cars of the future, octane requirements are expected to rise slightly, engine designers may develop the need for more additives for specific purposes, and there will be continued demand for improved engine oils, even though today’s oils are far more efficient than was thought possible 20 years ago.

Like most other users of energy, the home heating market is changing. Coal was once the standard fuel, replaced in the early 1950s by oil; in recent years oil has been replaced by gas in some areas because of the lower costs. The trend in the home area will be towards total environmental control, which means air cooling, humidity and dust control in addition to heating. Electricity for such uses is now created by water power and the burning of coal and oil. But coal will give way increasingly to nuclear power. Water power and nuclear energy will not be the only sources of electricity in the years ahead, particularly if a recent trend reported by the U.S.
The Canadian National Bank develops its tremendous growth in markets for electricity, the bank speculated on the effect a 10 per cent rise in power production efficiency would have, and concluded it would amount, in the U.S., to the equivalent of saving a million barrels of oil a day. The key to greater efficiency...is the recovery of a large part of the heat energy which a central system is obliged to waste," it said, and went on to describe a system that would utilize the heat.

The system, simply, is a diesel or turbine-driven generator custom-designed to provide the energy for an apartment building, say, or a school or shopping center. Although the engine would not generate electricity more cheaply than the delivered cost of electricity from a large hydro or nuclear station, the heat produced by the diesel or turbine could be recovered and used to provide hot water, space heating, cooling, and even process steam. In some applications that were examined, the bank reported savings ranging from $4,820 for a high school that had previously spent $12,420 on heat and electricity, to $117,000 for a shopping center whose electricity, heat, and maintenance bill had been running at $277,000 a year.

"It is not a stand-by power generation system to be employed only in emergencies," the bank reported. "It is a full-time light, heat and power system, site specific, under the operator's absolute control. It frees him of dependence on an outside supply of energy--in many cases at a lower cost than utility-supplied service." The bank saw the development as the greatest opportunity which has come along since the invention of the oil burner. At Imperial Oil the system is under active study. Locomotives powered by diesels will be with us for a while, although some experiments with turbine-powered locomotives are now under way. The CNR has tested a turbo-powered locomotive that uses diesel fuel. It is expected to go into

Heavy-duty highway trucks, now powered by diesel engines, are expected to be replaced by gas turbine trucks, burning either diesel fuel or kerosene trial service next year on the Toronto-Montreal run, cutting an hour off the five-hour time of the CN's crack Rapidio. The turbine was developed by the United Aircraft Corporation which is at present giving the CN locomotive and one for the U.S. department of commerce extensive instrumentation tests at Providence, Rhode Island.

Highway trucking is changing; the trend today is towards 'double-bottom rings' or two trailers pulled by a single diesel-powered tractor.

Today Canada's large transport trucks are major users of diesel fuel. But the gas turbine--in a sense a variation of the jet-plane motor--looks like the engine of the future for big transports, and the gas turbine can burn kerosene as well as other fuels.

Although it is not certain yet which fuel gas-turbine vehicles will use, it is likely to be diesel or kerosene.

The probability now is that the gas turbine will take over from the diesel in extra-heavy-duty highway trucks in the early 1970s. Automobile turbines may follow, but considerably later. For trucks, though, the gas turbine is expected to have a long life and need less overhauling than the diesel. It occupies less space for the same horsepower and poses fewer problems in air conservation.

Air pollution, and the contribution made to it by large numbers of motor vehicles concentrated in big cities, is now a dominant factor in design plans for new automotive engines, exhaust systems and fuels. Governments have already imposed certain restrictions. Last September the Ontario government announced that all 1960-model cars sold in the province would require anti-pollution devices. Los Angeles County is experimenting with emission-control equipment for cars which, together with other anti-pollution measures are expected to restore by 1970 the quality of air that prevailed in California in 1955. More sophisticated systems under development are expected to reduce exhaust emissions still further and make possible a pre-1940 air quality despite a vastly increased automobile population. In 1940 there were only 1.2 million motor vehicles in Los Angeles area; by 1970 there will be an estimated 4.7 million.

Electric cars have been proposed by some to offer a better solution than improving the internal combustion engine. There have been predictions that the first electric production models will be on our roads within five years, and that by the year 2000 all of our cars will run on batteries. Oilmen don't agree--and it's not simply a matter of blind loyalty. 'It's like the hovercraft or atomic submarines,' says Charles Rupar, fuel specialist at Imperial's research department in Sarnia. He foresees the electric car fulfilling a specialized use, but not becoming an all-purpose vehicle. 'The electric car seems bound to come, and it will find its own slot as these other forms of transportation are doing,' he says. 'There's no doubt it would be handy for some purposes.'

It is doubtful if the electric car will ever be able to match the speed, range, economy and convenience of the gasoline-powered car, and for these reasons oilmen don't see the electric car as a threat, even in the United States, where electric-car talk is loudest. Last March the chairman of the American Petroleum Institute told a government committee investigating the electric car as a way of combating pollution that 'by the time an electric car can be mass-produced and marketed . . . emissions from internal combustion engines will have long since been controlled.'

Pollution control is of concern to the oil industry on a wider basis, too, because it means that sulphur--the main source of pollution in crude oil, natural gas and coal--has to be removed before fuel is burned. There is little sulphur in gasoline, but in the heavy fuels used in industry it constitutes from 2½ to 3 per cent. Eventually this will be brought down to between ½ and 1 per cent.

Fuel cells present an interesting alternative to present-day power plants. By converting chemical energy directly into electrical energy, with a minimum of moving parts, theoretical they can use nearly all of a fuel's energy, compared to 40 per cent efficiency for a modern steam turbine and 15 to 25 per cent for an internal combustion engine.

Most experiments with fuel cells use hydrogen and oxygen as fuel, but methanol from natural gas is a possibility. However, it is generally conceded that fuel cells will not be found economical for widespread use during this century.

Every petroleum product that the petroleum industry will be as important in the next generation as it has been in this one, even though petroleum is classified as an irreplacable resource. Because of this, a healthy reserve will be necessary to permit the great production increases that face Canadian oil. For the past 10 years, exploration and improved recovery techniques have kept reserves growing faster than production in Canada; last year the reserves were sufficient to last 25 years at the 1966 rate of production. These estimates don't include the oil in the Athabasca tar sands or the black oil fields of Alberta. Nor do they take into account the potential discoveries offshore under the continental shelves, or in the remote and untouched islands of the Arctic. As the energy demands of the future increase, it is certain that the uses of petroleum will increase to meet them.