To reach the J. R. Simplot Plant in Aberdeen, Idaho, you drive through downtown Aberdeen, population 2,000, and keep heading north, past the half dozen shops on Main Street. Then turn right at the Tiger Hut, an old hamburger stand named after a local high school team, cross the railroad tracks where freight cars are loaded with sugar beets, drive another quarter of a mile, and you’re there. It smells like someone’s cooking potatoes. The Simplot plant is low and square, clean and neat. The employee parking lot is filled with pickup trucks, and there’s a big American flag flying out front. Aberdeen sits in the heart of Bingham County, which grows more potatoes than any other county in Idaho. The Simplot plant runs twenty-four hours a day, three hundred and ten days a year, turning potatoes into french fries. It’s a small facility, by industry standards, built in the late 1950s. It processes about a million pounds of potatoes a day.

Inside the building, a maze of red conveyer belts crisscrosses in and out of machines that wash, sort, peel, slice, blanch, blow-dry, fry, and flash-freeze potatoes. Workers in white coats and hard hats keep everything running smoothly, monitoring the controls, checking the fries for imperfections. Streams of sliced potatoes pour from machines. The place has a cheerful, humble, Eisenhower-era feeling, as though someone’s dream of technological progress, of better living through frozen food, has been fulfilled. Looming over the whole enterprise is the spirit of one man: John Richard Simplot, America’s great potato baron, whose seemingly inexhaustible energy and willingness to take risks built an empire based on french fries. By far the most important figure in one of the nation’s most conservative states, Simplot displays the contradictory traits that have guided the economic development of the American West, the odd mixture of rugged individualism and a dependence upon public land and resources. In a
portrait that hangs above the reception desk at the Aberdeen plant, J. R. Simplot has the sly grin of a gambler who’s scored big.

Simplot was born in 1909. His family left Dubuque, Iowa, the following year and eventually settled in Idaho. The Snake River Reclamation Project was offering cheap water for irrigation, funded by the U.S. government, that would convert the desert of southern Idaho into lush farmland. Simplot’s father became a homesteader, obtaining land for free and clearing it with a steel rail dragged between two teams of horses. Simplot grew up working hard on the farm. He rebelled against his domineering father, dropped out of school at the age of fifteen, and left home. He found work at a potato warehouse in the small town of Declo, Idaho. He sorted potatoes with a “shaker sorter,” a hand-held device, nine to ten hours a day for 30 cents an hour. At the boarding house where he rented a room, Simplot met a group of schoolteachers who were being paid not in cash but in interest-bearing scrip. Simplot bought the scrip from the teachers for 50 cents on the dollar — and then sold the scrip to a local bank for 90 cents on the dollar. With his earnings, Simplot bought a rifle, an old truck, and 600 hogs for $1 a head. He built a cooker in the desert, stocked it with sagerbrush, shot wild horses, skinned them, sold their hides for $2 each, cooked their meat, and fed the horse meat to his hogs through the winter. That spring, J. R. Simplot sold the hogs for $12.50 a head and, at the age of sixteen, became a potato farmer.

The Idaho potato industry was just getting started in the 1920s. The state’s altitude, warm days, cool nights, light volcanic soil, and abundance of irrigation water made it an ideal setting for growing Russet Burbank potatoes. Simplot leased 160 acres, then bought farm equipment and a team of horses. He learned how to grow potatoes from his landlord, Lindsay Maggart, who raised yields by planting fresh seed every year. In 1928, Simplot and Maggart purchased an electric potato sorter; it seemed a remarkable invention. Simplot began sorting potatoes for his friends and neighbors, but Maggart did not want to share the new device with anyone else. The two men fought over the potato sorter and then agreed to settle who owned it with the flip of a coin. J. R. Simplot won the coin toss, got the sorter, sold all his farm equipment, and started his own business in a potato cellar in Declo. He traveled the Idaho countryside, plugging the rudimentary machine into the nearest available light socket and sorting potatoes for farmers. Soon he was buying and selling potatoes, opening warehouses, forming relationships with commodities brokers nationwide. When J. R. Simplot needed timber for a new warehouse, he and his men would just head down to Yellowstone and chop down some trees. Within a decade, Simplot was the largest shipper of potatoes in the West, operating thirty-three warehouses in Oregon and Idaho.

Simplot also shipped onions. In 1941, he started to wonder why the Burbank Corporation, an outfit in California, was ordering so many of his onions. Simplot went to California and followed one of the company’s trucks to a prune orchard in Vacaville, where the Burbank Corporation was using prune dryers to make dehydrated onions. Simplot immediately bought a six-tunnel prune dryer and set up his own dehydration plant in Caldwell, Idaho. The plant opened on October 8, 1941. Two months later, the United States entered World War II, and Simplot began selling dehydrated onions to the U.S. Army. It was a profitable arrangement. The dehydrated onion powder, he later recalled, was like “gold dust.”

The J. R. Simplot Dehydrating Company soon perfected a new method for drying potatoes and became one of the principal suppliers of food to the American military during World War II. In 1942, the company had a hundred workers at the Caldwell plant; by 1944, it had about twelve hundred. The Caldwell facility became the largest dehydrating plant in the world. J. R. Simplot used the profits earned as a military contractor to buy potato farms and cattle ranches, to build fertilizer plants and lumber mills, to stake mining claims and open a huge phosphate mine on the Fort Hall Indian Reservation. By the end of World War II, Simplot was growing his own potatoes, fertilizing them with his own phosphate, processing them at his factories, shipping them in boxes from his lumber yards, and feeding the leftover potato scraps to his cattle. He was thirty-six years old.

After the war, Simplot invested heavily in frozen food technology, betting that it would provide the meals of the future. Clarence Birdseye had patented a number of techniques for flash-freezing in the 1920s. But sales of Birdseye’s new products were hampered, among other things, by the fact that few American grocery stores, and even fewer households, owned a freezer. The sales of refrigerators, freezers, and other kitchen appliances soared after World War II. The 1950s soon became “the Golden Age of Food Processing,” in the words of historian Harvey Levenstein, a decade in which one marvelous innovation after another promised to simplify the lives of American housewives: frozen orange juice, frozen TV dinners, the Chicken-of-Tomorrow, “Potato salad from a package!,” Cheese Whiz, Jell-O salads, Jet-Puffed Marshmallows, Miracle Whip. Depression-era scarcity gave way to a cornucopia of new foods on the shelves of new suburban supermarkets. Ad campaigns made processed foods seem better than fresh ones, more space-age and up to date. According to Levenstein,
many restaurants proudly displayed their canned soups, and a chain called Tad’s 30 Varieties of Meals featured frozen dinners on its menu. Customers at Tad’s cooked the frozen meals at tableside microwave ovens.

Postwar refrigerators came with freezer compartments, and J. R. Simplot thought about the foods that housewives might want to put in them. He assembled a team of chemists, led by Ray Dunlap, to develop a product that seemed to have enormous potential: the frozen french fry. Americans were eating more fries than ever before, and the Russet Burbank, with its large size and high starch content, was the perfect potato for frying. Simplot wanted to create an inexpensive frozen fry that tasted just as good as a fresh one. Although Thomas Jefferson had brought the Parisian recipe for pommes frites to the United States in 1802, french fries did not become well known in this country until the 1920s. Americans traditionally ate their potatoes boiled, mashed, or baked. French fries were popularized in the United States by World War I veterans who’d enjoyed them in Europe and by the drive-in restaurants that subsequently arose in the 1930s and 1940s. Fries could be served without a fork or a knife, and they were easy to eat behind the wheel. But they were extremely time-consuming to prepare. Simplot’s chemists experimented with various methods for the mass production of french fries, enduring a number of setbacks, learning the hard way that fries will sink to the bottom of a potato chip fryer and then burn. One day Dunlap walked into J. R. Simplot’s office with some frozen fries that had just been reheated. Simplot tasted them, realized the manufacturing problems had been solved, and said, “That’s a helluva thing.”

J. R. Simplot started selling frozen french fries in 1953. Sales were initially disappointing. Although the frozen fries were precooked and could be baked in an oven, they tasted best when heated in hot oil, limiting their appeal to busy homemakers. Simplot needed to find institutional customers, restaurant owners who’d recognize the tremendous labor-saving benefits of his frozen fries.

“The french fry [was] ... almost sacrosanct for me,” Ray Kroc wrote in his memoir, “its preparation a ritual to be followed religiously.” The success of Richard and Mac McDonald’s hamburger stand had been based as much on the quality of their fries as on the taste of their burgers. The McDonald brothers had devised an elaborate system for making crisp french fries, one that was later improved by the restaurant chain. McDonald’s cooked thinly sliced Russet Burbanks in special fryers to keep the oil temperature above 325 degrees. As the chain expanded, it became more difficult — and yet all the more important — to maintain the consistency and quality of the fries. J. R. Simplot met with Ray Kroc in 1965. The idea of switching to frozen french fries appealed to Kroc, as a means of ensuring uniformity and cutting labor costs. McDonald’s obtained its fresh potatoes from about 175 different local suppliers, and crew members spent a great deal of time peeling and slicing potatoes. Simplot offered to build a new factory solely for the manufacture of McDonald’s french fries. Kroc agreed to try Simplot’s fries, but made no long-term commitment. The deal was sealed with a handshake.

McDonald’s began to sell J. R. Simplot’s frozen french fries the following year. Customers didn’t notice any difference in taste. And the reduced cost of using a frozen product made french fries one of the most profitable items on the menu — far more profitable than hamburgers. Simplot quickly became the main supplier of french fries to McDonald’s. At the time, McDonald’s had about 725 restaurants in the United States. Within a decade, it had more than 3,000. Simplot sold his frozen fries to other restaurant chains, accelerating the growth of the fast food industry and changing the nation’s eating habits. Americans have long consumed more potatoes than any other food except dairy products and wheat flour. In 1960, the typical American ate eighty-one pounds of fresh potatoes and about four pounds of frozen french fries. Today the typical American eats about forty-nine pounds of fresh potatoes every year — and more than thirty pounds of frozen french fries. Ninety percent of those fries are purchased at fast food restaurants. Indeed, french fries have become the most widely sold foodservice item in the United States.

J. R. Simplot, an eighth-grade dropout, is now one of the richest men in the United States. His privately held company grows and processes corn, peas, broccoli, avocados, and carrots, as well as potatoes; feeds and processes cattle; manufactures and distributes fertilizer; mines phosphate and silica; produces oil, ethanol, and natural gas. In 1980, Simplot provided $1 million in start-up funds to a couple of engineers working in the basement of a dentist’s office in Boise, Idaho. Twenty years later, his investment in Micron Technology — a manufacturer of computer memory chips and the largest private employer in Idaho — was worth about $1.5 billion. Simplot is also one of the nation’s biggest landowners. “I’ve been a land hog all my life,” Simplot told me, laughing. While still in his teens, he bought 18,000 acres along the Snake River, paying 50 cents an acre for it with borrowed money. His company now has 85,000 acres of irrigated farmland, and Simplot personally owns more than twice that amount of ranchland. He owns much of downtown Boise and a big hillside home
overlooking the city. At home he flies a gigantic American flag on a pole that's ten stories high. In addition to what he owns, Simplot leases more than 2 million acres of land from the federal government. His ZX Ranch in southern Oregon is the largest cattle ranch in the United States, measuring 65 miles wide and 163 miles long. Altogether, Simplot controls a block of North American land that's bigger than the state of Delaware.

Despite being a multibillionaire, J. R. Simplot has few pretensions. He wears cowboy boots and blue jeans, eats at McDonald's, and drives his own car, a Lincoln Continental with license plates that say "MR. SPUD." He seems to have little patience for abstractions, viewing religion as a bunch of "hocus-pocus" and describing his potato empire matter-of-factly: "It's big and it's real, it ain't bullshit." Recently Simplot has been slowing down. A bad fall made him give up horseback riding at the age of eighty; in 1999 he turned ninety and quit skiing. He stepped down as the chief executive of his company in 1994, but keeps buying more land and scouting new factories. "Hell, fellow, I'm just an old farmer got some luck," Simplot said, when I asked about the key to his success. "The only thing I did smart, and just remember this — ninety-nine percent of people would have sold out when they got their first twenty-five or thirty million. I didn't sell out. I just hung on."

the mistake of standing alone

The production of frozen french fries has become an intensely competitive business. Although the J. R. Simplot Company supplies the majority of the french fries that McDonald's sells in the United States, two other fry companies are now larger: Lamb Weston, the nation's leading producer of fries, and McCain, a Canadian firm that became the number-two fry company after buying Ore-Ida in 1997. Simplot, Lamb Weston, and McCain now control about 80 percent of the American market for frozen french fries, having eliminated or acquired most of their smaller rivals. The three french fry giants compete for valuable contracts to supply the fast food chains. Frozen french fries have become a bulk commodity, manufactured in high volumes at a low profit margin. Price differences of just a few pennies a pound can mean the difference between winning or losing a major contract. All of this has greatly benefited the fast food chains, lowering their wholesale costs and making their retail sales of french fries even more profitable. Burger King's assault on the supremacy of the Mc-

Donald's french fry, launched in 1997 with a $70 million advertising campaign, was driven in large part by the huge markups that are possible with fries. The fast food companies purchase frozen fries for about 30 cents a pound, reheat them in oil, then sell them for about $6 a pound.

Idaho's potato output surpassed Maine's in the late 1950s, owing to the rise of the french fry industry and the productivity gains made by Idaho farmers. Since 1980, the tonnage of potatoes grown in Idaho has almost doubled, while the average yield per acre has risen by nearly 30 percent. But the extraordinary profits being made from the sale of french fries have barely trickled down to the farmers. Paul Patterson, an extension professor of agricultural economics at the University of Idaho, describes the current market for potatoes as an "oligopoly" — a market in which a small number of buyers exert power over a large number of sellers. The giant processing companies do their best to drive down the prices offered to potato farmers. The increased productivity of Idaho farmers has lowered prices even further, shifting more of the profits to the processors and the fast food chains. Out of every $1.50 spent on a large order of fries at a fast food restaurant, perhaps 2 cents goes to the farmer who grew the potatoes.

Idaho's potato farmers now face enormous pressure to get bigger — or get out of the business. Adding more acreage increases total revenues and allows more capital investment; but the risks get bigger, too. The latest potato harvesting equipment — bright red, beautiful machines manufactured in Idaho by a company called Spudnik — can set a farmer back hundreds of thousands of dollars. It costs about $1,500 an acre to grow potatoes in Bingham County. The average potato farmer there, who plants about four hundred acres, is more than half a million dollars in the hole before selling a single potato. In order to break even, the farmer needs to receive about $5 per hundredweight of potatoes. During the 1996–97 season, potato prices fell as low as $1.50 per hundredweight. That year was a disaster for Idaho potato farmers, perhaps the worst in history. Record harvests nationwide and a flood of cheap imports from Canada created an enormous glut of potatoes. For many farmers, letting potatoes rot in the field would have been more profitable than selling them at such low prices. That was not a viable option, however; rotting potatoes can damage the land. Prices have recovered since then, but remain unusually low. An Idaho potato farmer's annual income is now largely determined by the weather, the world market, and the whims of the giant processors. "The only thing I can really control," one farmer told me, "is what time I get out of bed in the morning."
Over the past twenty-five years, Idaho has lost about half of its potato farmers. During the same period, the amount of land devoted to potatoes has increased. Family farms are giving way to corporate farms that stretch for thousands of acres. These immense corporate farms are divided into smaller holdings for administrative purposes, and farmers who've been driven off the land are often hired to manage them. The patterns of land ownership in the American West more and more resemble those of rural England. "We've come full circle," says Paul Patterson. "You increasingly find two classes of people in rural Idaho: the people who run the farms and the people who own them."

The headquarters of the Potato Growers of Idaho (PGI) is a strip-mall office suite, not far from a potato museum in Blackfoot. The PGI is a nonprofit organization that supplies market information to farmers and helps them negotiate contracts with processors. Bert Moulton, a longtime PGI staff member, is a big man with a crew cut who looks like a Goldwater Republican but sounds like an old-fashioned populist. Moulton thinks forming some sort of co-op, an association to coordinate marketing and production levels, may be the last hope for Idaho's potato farmers. At the moment, most farmers live in areas where there are only one or two processors buying potatoes — and oddly enough, those processors never seem to be bidding for potatoes on the same day. "Legally, the processors aren't supposed to be talking to one another," Moulton says. "But you know that they do." Not long ago, the major french fry companies in Idaho were owned by people with strong ties to the local community. J. R. Simplot was highly regarded by most Idaho farmers; he always seemed willing to help carry them through a lean year. Moulton says the fry companies now tend to be run by outsiders, by "MBA's from Harvard who don't know if a potato grows on a tree or underground." The multinational food companies operate tender fry plants in a number of different regions, constantly shifting production to take advantage of the lowest potato prices. The economic fortunes of individual farmers or local communities matter little in the grand scheme.

A few years ago, the PGI tried to create a formal alliance with potato farmers in Oregon and Washington, an effort that would have linked producers in the three states that grow most of the nation's potatoes. The alliance was undermined by one of the big processors, which cut lucrative deals with a core group of potato farmers. Moulton believes that Idaho's farmers deserve some of the blame for their own predicament. Long regarded as the aristocrats of rural Idaho, potato farmers remain stubbornly independent and unwilling to join forces. "Some of them are independent to the point of poverty," he says. Today there are roughly 1,100 potato farmers left in Idaho — few enough to fit in a high school auditorium. About half of them belong to the PGI, but the organization needs at least three-quarters of them as members to gain real bargaining power. The "joint ventures" now being offered by processing companies provide farmers with the potato seed and financing for their crop, an arrangement that should dispel any lingering illusions about their independence. "If potato farmers don't band together," Bert Moulton warns, "they'll wind up sharecroppers."

The behavior of Idaho's potato growers often betrays a type of faulty reasoning described in most college-level economics textbooks. "The fallacy of composition" is a logical error — a mistaken belief that what seems good for an individual will still be good when others do the same thing. For example, someone who stands at a crowded concert may get a better view of the stage. But if everyone at the concert stands up, nobody's view is improved. Since the end of World War II, farmers in the United States have been persuaded to adopt one new technology after another, hoping to improve their yields, reduce their costs, and outsell their neighbors. By embracing this industrial model of agriculture — one that focuses narrowly on the level of inputs and outputs, that encourages specialization in just one crop, that relies heavily on chemical fertilizers, pesticides, fungicides, herbicides, advanced harvesting and irrigation equipment — American farmers have become the most productive farmers on earth. Every increase in productivity, however, has driven more American farmers off the land. And it has left those who remain beholden to the companies that supply the inputs and the processors that buy the outputs. William Heffernan, a professor of rural sociology at the University of Missouri, says that America's agricultural economy now resembles an hourglass. At the top there are about 2 million ranchers and farmers; at the bottom there are 275 million consumers; and at the narrow portion in the middle, there are a dozen or so multinational corporations earning a profit from every transaction.

**food product design**

The taste of McDonald's french fries has long been praised by customers, competitors, and even food critics. James Beard loved McDonald's fries. Their distinctive taste does not stem from the type of potatoes that McDonald's buys, the technology that processes them, or the restaurant equipment that fries them. Other chains buy their french fries from the same large processing companies, use Russet
plants. International Flavors & Fragrances (IFF), the world’s largest flavor company, has a manufacturing facility off Exit 8A in Dayton, New Jersey; Givaudan, the world’s second-largest flavor company, has a plant in East Hanover. Haarmann & Reimer, the largest German flavor company, has a plant in Teterboro, as does Takasago, the largest Japanese flavor company. Flavor Dynamics has a plant in South Plainfield; Frutarom is in North Bergen; Elan Chemical is in Newark. Dozens of companies manufacture flavors in the corridor between Teaneck and South Brunswick. Indeed, the area produces about two-thirds of the flavor additives sold in the United States.

The IFF plant in Dayton is a huge pale blue building with a modern office complex attached to the front. It sits in an industrial park, not far from a BASF plastics factory, a Jolly French Toast factory, and a plant that manufactures Liz Claiborne cosmetics. Dozens of tractor-trailers were parked at the IFF loading dock the afternoon I visited, and a thin cloud of steam floated from the chimney. Before entering the plant, I signed a nondisclosure form, promising not to reveal the brand names of products that contain IFF flavors. The place reminded me of Willy Wonka’s chocolate factory. Wonderful smells drifted through the hallways, men and women in neat white lab coats cheerfully went about their work, and hundreds of little glass bottles sat on laboratory tables and shelves. The bottles contained powerful but fragile flavor chemicals, shielded from light by the brown glass and the round plastic caps shut tight. The long chemical names on the little white labels were as mystifying to me as medieval Latin. They were the odd-sounding names of things that would be mixed and poured and turned into new substances, like magic potions.

I was not invited to see the manufacturing areas of the IFF plant, where it was thought I might discover trade secrets. Instead, I toured various laboratories and pilot kitchens, where the flavors of well-established brands are tested or adjusted, and where whole new flavors are created. IFF’s snack and savory lab is responsible for the flavor of potato chips, corn chips, breads, crackers, breakfast cereals, and pet food. The confectionery lab devises the flavors for ice cream, cookies, candies, toothpastes, mouthwashes, and antacids. Everywhere I looked, I saw famous, widely advertised products sitting on laboratory desks and tables. The beverage lab is full of brightly colored liquids in clear bottles. It comes up with the flavor for popular soft drinks, sport drinks, bottled teas, and wine coolers, for all-natural juice drinks, organic soy drinks, beers, and malt liquors. In one pilot kitchen I saw a dapper food technologist, a middle-aged man with an elegant tie beneath his lab coat, carefully preparing a batch of cookies with white
frosting and pink-and-white sprinkles. In another pilot kitchen I saw a pizza oven, a grill, a milk-shake machine, and a french fryer identical to those I'd seen behind the counter at countless fast food restaurants.

In addition to being the world's largest flavor company, IFF manufactures the smell of six of the ten best-selling fine perfumes in the United States, including Estée Lauder's Beautiful, Clinique's Happy, Lancôme's Trésor, and Calvin Klein's Eternity. It also makes the smell of household products such as deodorant, dishwashing detergent, bath soap, shampoo, furniture polish, and floor wax. All of these aromas are made through the same basic process: the manipulation of volatile chemicals to create a particular smell. The basic science behind the scent of your shaving cream is the same as that governing the flavor of your TV dinner.

The aroma of a food can be responsible for as much as 90 percent of its flavor. Scientists now believe that human beings acquired the sense of taste as a way to avoid being poisoned. Edible plants generally taste sweet; deadly ones, bitter. Taste is supposed to help us differentiate food that's good for us from food that's not. The taste buds on our tongues can detect the presence of half a dozen or so basic tastes, including: sweet, sour, bitter, salty, astringent, and umami (a taste discovered by Japanese researchers, a rich and full sense of deliciousness triggered by amino acids in foods such as shellfish, mushrooms, potatoes, and seaweed). Taste buds offer a relatively limited means of detection, however, compared to the human olfactory system, which can perceive thousands of different chemical aromas. Indeed "flavor" is primarily the smell of gases being released by the chemicals you've just put in your mouth.

The act of drinking, sucking, or chewing a substance releases its volatile gases. They flow out of the mouth and up the nostrils, or up the passageway in the back of the mouth, to a thin layer of nerve cells called the olfactory epithelium, located at the base of the nose, right between the eyes. The brain combines the complex smell signals from the epithelium with the simple taste signals from the tongue, assigns a flavor to what's in your mouth, and decides if it's something you want to eat.

Babies like sweet tastes and reject bitter ones; we know this because scientists have rubbed various flavors inside the mouths of infants and then recorded their facial reactions. A person's food preferences, like his or her personality, are formed during the first few years of life, through a process of socialization. Toddlers can learn to enjoy hot and spicy food, bland health food, or fast food, depending upon what the people around them eat. The human sense of smell is still not fully understood and can be greatly affected by psychological factors and expectations. The color of a food can determine the perception of its taste. The mind filters out the overwhelming majority of chemical aromas that surround us, focusing intently on some, ignoring others. People can grow accustomed to bad smells or good smells; they stop noticing what once seemed overpowering. Aroma and memory are somehow inextricably linked. A smell can suddenly evoke a long-forgotten moment. The flavors of childhood foods seem to leave an indelible mark, and adults often return to them, without always knowing why. These "comfort foods" become a source of pleasure and reassurance, a fact that fast food chains work hard to promote. Childhood memories of Happy Meals can translate into frequent adult visits to McDonald's, like those of the chain's "heavy users," the customers who eat there four or five times a week.

The human craving for flavor has been a largely unacknowledged and unexamined force in history. Royal empires have been built, unexplored lands have been traversed, great religions and philosophies have been forever changed by the spice trade. In 1492 Christopher Columbus set sail to find seasoning. Today the influence of flavor in the world marketplace is no less decisive. The rise and fall of corporate empires - of soft drink companies, snack food companies, and fast food chains - is frequently determined by how their products taste.

The flavor industry emerged in the mid-nineteenth century, as processed foods began to be manufactured on a large scale. Recognizing the need for flavor additives, the early food processors turned to perfume companies that had years of experience working with essential oils and volatile aromas. The great perfume houses of England, France, and the Netherlands produced many of the first flavor compounds. In the early part of the twentieth century, Germany's powerful chemical industry assumed the technological lead in flavor production. Legend has it that a German scientist discovered methyl anthranilate, one of the first artificial flavors, by accident while mixing chemicals in his laboratory. Suddenly the lab was filled with the sweet smell of grapes. Methyl anthranilate later became the chief flavoring compound of grape Kool-Aid. After World War II, much of the perfume industry shifted from Europe to the United States, setting in New York City near the garment district and the fashion houses. The flavor industry came with it, subsequently moving to New Jersey to gain more plant capacity. Man-made flavor additives were used mainly in baked goods, candies, and sodas until the 1950s, when sales of processed food began to soar. The invention of gas chromatographs and mass spectrometers - machines capable of detecting vol-
at ile gases at low levels — vastly increased the number of flavors that could be synthesized. By the mid-1960s the American flavor industry was churning out compounds to supply the taste of Pop Tarts, Bac-Os, Tab, Tang, Filet-O-Fish sandwiches, and literally thousands of other new foods.

The American flavor industry now has annual revenues of about $1.4 billion. Approximately ten thousand new processed food products are introduced every year in the United States. Almost all of them require flavor additives. And about nine out of every ten of these new food products fail. The latest food innovations and corporate realignments are heralded in publications such as Food Chemical News, Food Engineering, Chemical Market Reporter, and Food Product Design. The growth of IFF has mirrored that of the flavor industry as a whole. IFF was formed in 1958, through the merger of two small companies. Its annual revenues have grown almost fifteenfold since the early 1970s, and it now has manufacturing facilities in twenty countries.

The quality that people seek most of all in a food, its flavor, is usually present in a quantity too infinitesimal to be measured by any traditional culinary terms such as ounces or teaspoons. Today’s sophisticated spectrometers, gas chromatographs, and headspace vapor analyzers provide a detailed map of a food’s flavor components, detecting chemical aromas in amounts as low as one part per billion. The human nose, however, is still more sensitive than any machine yet invented. A nose can detect aromas present in quantities of a few parts per trillion — an amount equivalent to 0.000000000000003 percent. Complex aromas, like those of coffee or roasted meat, may be composed of volatile gases from nearly a thousand different chemicals. The smell of a strawberry arises from the interaction of at least 350 different chemicals that are present in minute amounts. The chemical that provides the dominant flavor of bell pepper can be tasted in amounts as low as .02 parts per billion; one drop is sufficient to add flavor to five average size swimming pools. The flavor additive usually comes last, or second to last, in a processed food’s list of ingredients. As a result, the flavor of a processed food often costs less than its packaging. Soft drinks contain a larger proportion of flavor additives than most products. The flavor in a twelve-ounce can of Coke costs about half a cent.

The color additives in processed foods are usually present in even smaller amounts than the flavor compounds. Many of New Jersey’s flavor companies also manufacture these color additives, which are used to make processed foods look appealing. Food coloring serves many of the same purposes as lipstick, eye shadow, mascara — and is often made from the same pigments. Titanium dioxide, for example, has proved to be an especially versatile mineral. It gives many processed candies, frosting, and icing their bright white color; it is a common ingredient in women’s cosmetics; and it is the pigment used in many white oil paints and house paints. At Burger King, Wendy’s, and McDonald’s, coloring agents have been added to many of the soft drinks, salad dressings, cookies, condiments, chicken dishes, and sandwich buns.

Studies have found that the color of a food can greatly affect how its taste is perceived. Brightly colored foods frequently seem to taste better than bland-looking foods, even when the flavor compounds are identical. Foods that somehow look off-color often seem to have off tastes. For thousands of years, human beings have relied on visual cues to help determine what is edible. The color of fruit suggests whether it is ripe, the color of meat whether it is rancid. Flavor researchers sometimes use colored lights to modify the influence of visual cues during taste tests. During one experiment in the early 1970s, people were served an oddly tinted meal of steak and French fries that appeared normal beneath colored lights. Everyone thought the meal tasted fine until the lighting was changed. Once it became apparent that the steak was actually blue and the fries were green, some people became ill.

The Food and Drug Administration does not require flavor companies to disclose the ingredients of their additives, so long as all the chemicals are considered by the agency to be GRAS (Generally Regarded As Safe). This lack of public disclosure enables the companies to maintain the secrecy of their formulas. It also hides the fact that flavor compounds sometimes contain more ingredients than the foods being given their taste. The ubiquitous phrase “artificial strawberry flavor” gives little hint of the chemical wizardry and manufacturing skill that can make a highly processed food taste like a strawberry.

A typical artificial strawberry flavor, like the kind found in a Burger King strawberry milk shake, contains the following ingredients: amyl acetate, amyl butyrate, amyl valerate, anethol, amyl formate, benzyl acetate, benzyl isobutyrate, butyrac acid, cinnamyl isobutyrate, cinnamyl valerate, cognac essential oil, diacetly, dipropyl ketone, ethyl acetate, ethyl amylketone, ethyl butyrate, ethyl cinnamate, ethyl heptanoate, ethyl heptylate, ethyl lactate, ethyl methylbenzylycdate, ethyl nitrate, ethyl propionate, ethyl valerate, heliotropin, hydroxyphenyl-2-butanone (10 percent solution in alcohol), α-ionone, isobuty ́l anthranilate, isobuty ́l butyrate, lemon essential oil, maltol, 4-methylacetophenone, methyl anthranilate, methyl benzoate, methyl cinnamate, methyl heptine carbonate, methyl naphthyl ke-
töne, methyl salicylate, mint essential oil, neroli essential oil, nerol, neryl isobutyrate, orris butter, phenethyl alcohol, rose, rum ether, γ-undecalactone, vanillin, and solvent.

Although flavors usually arise from a mixture of many different volatile chemicals, a single compound often supplies the dominant aroma. Smelled alone, that chemical provides an unmistakable sense of the food. Ethyl-2-methyl butyrate, for example, smells just like an apple. Today's highly processed foods offer a blank palette: whatever chemicals you add to them will give them specific tastes. Adding methyl-2-peridylketone makes something taste like popcorn. Adding ethyl-3-hydroxybutanoate makes it taste like marshmallow. The possibilities are now almost limitless. Without affecting the appearance or nutritional value, processed foods could even be made with aroma chemicals such as hexanal (the smell of freshly cut grass) or 3-methyl butanoic acid (the smell of body odor).

The 1960s were the heyday of artificial flavors. The synthetic versions of flavor compounds were not subtle, but they did not need to be, given the nature of most processed food. For the past twenty years food processors have tried hard to use only "natural flavors" in their products. According to the FDA, these must be derived entirely from natural sources — from herbs, spices, fruits, vegetables, beef, chicken, yeast, bark, roots, etc. Consumers prefer to see natural flavors on a label, out of a belief that they are healthier. The distinction between artificial and natural flavors can be somewhat arbitrary and absurd, based more on how the flavor has been made than on what it actually contains. "A natural flavor," says Terry Acree, a professor of food science at Cornell University, "is a flavor that's been derived with an out-of-date technology." Natural flavors and artificial flavors sometimes contain exactly the same chemicals, produced through different methods. Amyl acetate, for example, provides the dominant note of banana flavor. When you distill it from bananas with a solvent, amyl acetate is a natural flavor. When you produce it by mixing vinegar with amyl alcohol, adding sulfuric acid as a catalyst, amyl acetate is an artificial flavor. Either way it smells and tastes the same. The phrase "natural flavor" is now listed among the ingredients of everything from Stonyfield Farm Organic Strawberry Yogurt to Taco Bell Hot Taco Sauce.

A natural flavor is not necessarily healthier or purer than an artificial one. When almond flavor (benzaldehyde) is derived from natural sources, such as peach and apricot pits, it contains traces of hydrogen cyanide, a deadly poison. Benzaldehyde derived through a different process — by mixing oil of clove and the banana flavor, amyl acetate — does not contain any cyanide. Nevertheless, it is legally considered an artificial flavor and sells at a much lower price. Natural and artificial flavors are now manufactured at the same chemical plants, places that few people would associate with Mother Nature. Calling any of these flavors "natural" requires a flexible attitude toward the English language and a fair amount of irony.

The small and elite group of scientists who create most of the flavor in most of the food now consumed in the United States are called "flavorists." They draw upon a number of disciplines in their work: biology, psychology, physiology, and organic chemistry. A flavorist is a chemist with a trained nose and a poet's sensibility. Flavors are created by blending scores of different chemicals in tiny amounts, a process governed by scientific principles but demanding a fair amount of art. In an age when delicate aromas, subtle flavors, and microwave ovens do not easily coexist, the job of the flavorist is to conjure illusions about processed food and, in the words of one flavor company's literature, to ensure "consumer likeability." The flavorists with whom I spoke were charming, cosmopolitan, and ironic. They were also discreet, in keeping with the dictates of their trade. They were the sort of scientist who not only enjoyed fine wine, but could also tell you the chemicals that gave each vintage its unique aroma. One flavorist compared his work to composing music. A well-made flavor compound will have a "top note," followed by a "dry-down," and a "leveling-off," with different chemicals responsible for each stage. The taste of a food can be radically altered by minute changes in the flavoring mix. "A little odor goes a long way," one flavorist said.

In order to give a processed food the proper taste, a flavorist must always consider the food's "mouthfeel" — the unique combination of textures and chemical interactions that affects how the flavor is perceived. The mouthfeel can be adjusted through the use of various fats, gums, starches, emulsifiers, and stabilizers. The aroma chemicals of a food can be precisely analyzed, but mouthfeel is much harder to measure. How does one quantify a french fries' crispiness? Food technologists are now conducting basic research in rheology, a branch of physics that examines the flow and deformation of materials. A number of companies sell sophisticated devices that attempt to measure mouthfeel. The TA.XT2i Texture Analyzer, produced by the Texture Technologies Corporation, performs calculations based on data derived from as many as 250 separate probes. It is essentially a mechanical mouth. It gauges the most important rheological properties of a food — the bounce, creep, breaking point, density, crunchiness, chewiness, gumminess, lumpiness, rubberiness, springiness, slipperi-
ness, smoothness, softness, wetness, juiciness, spreadability, springback, and tackiness.

Some of the most important advances in flavor manufacturing are now occurring in the field of biotechnology. Complex flavors are being made through fermentation, enzyme reactions, fungal cultures, and tissue cultures. All of the flavors being created through these methods — including the ones being synthesized by funguses — are considered natural flavors by the FDA. The new enzyme-based processes are responsible for extremely lifelike dairy flavors. One company now offers not just butter flavor, but also fresh creamy butter, cheesy butter, milky butter, savory melted butter, and super-concentrated butter flavor, in liquid or powder form. The development of new fermentation techniques, as well as new techniques for heating mixtures of sugar and amino acids, have led to the creation of much more realistic meat flavors. The McDonald's Corporation will not reveal the exact origin of the natural flavor added to its french fries. In response to enquiries from Vegetarian Journal, however, McDonald's did acknowledge that its fries derive some of their characteristic flavor from “animal products.”

Other popular fast foods derive their flavor from unexpected sources. Wendy's Grilled Chicken Sandwich, for example, contains beef extracts. Burger King's BK Broiler Chicken Breast Patty contains “natural smoke flavor.” A firm called Red Arrow Products Company specializes in smoke flavor, which is added to barbecue sauces and processed meats. Red Arrow manufactures natural smoke flavor by charring sawdust and capturing the aroma chemicals released into the air. The smoke is captured in water and then bottled, so that other companies can sell food which seems to have been cooked over a fire.

The Vegetarian Legal Action Network recently petitioned the FDA to issue new food labeling requirements for foods that contain natural flavors. The group wants food processors to list the basic origins of their flavors on their labels. At the moment, vegetarians often have no way of knowing whether a flavor additive contains beef, pork, poultry, or shellfish. One of the most widely used color additives — whose presence is often hidden by the phrase “color added” — violates a number of religious dietary restrictions, may cause allergic reactions in susceptible people, and comes from an unusual source. Cochineal extract (also known as carmine or carminic acid) is made from the desiccated bodies of female Dactylopius coccus Costa, a small insect harvested mainly in Peru and the Canary Islands. The bug feeds on red cactus berries and color from the berries accumulated in the females and their unhatched larvae. The insects are collected, dried, and ground into pigment. It takes about 70,000 of them to produce one pound of carmine, which is used to make processed foods look pink, red, or purple. Dannon strawberry yogurt gets its color from carmine, as do many frozen fruit bars, candies, fruit fillings, and Ocean Spray pink-grapefruit juice drink.

In a meeting room at IFF, Brian Grainger let me sample some of the company's flavors. It was an unusual taste test; there wasn't any food to taste. Grainger is a senior flavorist at IFF, a soft-spoken chemist with graying hair, an English accent, and a fondness for understatement. He could easily be mistaken for a British diplomat or the owner of a West End brasserie with two Michelin stars. Like many in the flavor industry, he has an Old World, old-fashioned sensibility which seems out of step with our brand-conscious, egocentric age. When I suggested that IFF should put its own logo on the products that contain its flavors — instead of allowing other brands to enjoy the consumer loyalty and affection inspired by those flavors — Grainger politely disagreed, assuring me such a thing would never be done. In the absence of public credit or acclaim, the small and secretive fraternity of flavor chemists praises one another's work. Grainger can often tell, by analyzing the flavor formula of a product, which of his counterparts at a rival firm devised it. And he enjoys walking down supermarket aisles, looking at the many products that contain his flavors, even if no one else knows it.

Grainger had brought a dozen small glass bottles from the lab. After he opened each bottle, I dipped a fragrance testing filter into it. The filters were long white strips of paper designed to absorb aroma chemicals without producing off-notes. Before placing the strips of paper before my nose, I closed my eyes. Then I inhaled deeply, and one food after another was conjured from the glass bottles. I smelled fresh cherries, black olives, sautéed onions, and shrimp. Grainger’s most remarkable creation took me by surprise. After closing my eyes, I suddenly smelled a grilled hamburger. The aroma was uncanny, almost miraculous. It smelled like someone in the room was flipping burgers on a hot grill. But when I opened my eyes, there was just a narrow strip of white paper and a smiling flavorist.

**millions and millions of fries**

*At the height of the potato harvest, I visited the Lamb Weston plant in American Falls, Idaho. It’s one of the biggest fry factories in*
the world and makes french fries for McDonald's. It has a production capacity more than three times larger than that of the Simplot plant in Aberdeen. It is a state-of-the-art processing facility where raw commodities and man-made additives are combined to make America's most popular food.

Lamb Weston was founded in 1950 by F. Gilbert Lamb, the inventor of a crucial piece of french fry-making technology. The Lamb Water Gun Knife uses a high-pressure hose to shoot potatoes at a speed of 117 feet per second through a grid of sharpened steel blades, thereby creating perfectly sliced french fries. After coming up with the idea, Gil Lamb tested the first Water Gun Knife in a company parking lot, shooting potatoes out of a fire hose. Lamb sold his company to ConAgra in 1988. Lamb Weston now manufactures more than 130 different types of french fries, including: Steak House Fries, CrissCut Fries, Hi-Fries, Mor-Fries, Burger Fries, Taterbabies, Taterboy Curley QQQ Fries, and Rus-Elites Special Dry Fry Shoestrings.

Bud Mandeville, the plant manager, led me up a narrow, wooden staircase inside one of the plant's storage buildings. On the top floor, the staircase led to a catwalk, and beneath my feet I saw a mound of potatoes that was twenty feet deep and a hundred feet wide and almost as long as two football fields. The building was cool and dark, kept year-round at a steady 46 degrees. In the dim light the potatoes looked like grains of sand on a beach. This was one of seven storage buildings on the property.

Outside, tractor-trailers arrived from the fields, carrying potatoes that had just been harvested. The trucks dumped their loads onto spinning rods that brought the larger potatoes into the building and let the small potatoes, dirt, and rocks fall to the ground. The rods led to a rock trap, a tank of water in which the potatoes floated and the rocks sank to the bottom. The plant used water systems to float potatoes gently this way and that way, guiding different sizes out of different holding bays, then flushing them into a three-foot-deep stream that ran beneath the cement floor. The interior of the processing plant was gray, massive, and well-lit, with huge pipes running along the walls, steel catwalks, workers in hardhats, and plenty of loud machinery. If there weren't potatoes bobbing and floating past, you might think the place was an oil refinery.

Conveyor belts took the wet, clean potatoes into a machine that blasted them with steam for twelve seconds, boiled the water under their skins, and exploded their skins off. Then the potatoes were pumped into a preheat tank and shot through a Lamb Water Gun Knife. They emerged as shoestring fries. Four video cameras scrutinized them from different angles, looking for flaws. When a french fry with a blemish was detected, an optical sorting machine time-sequenced a single burst of compressed air that knocked the bad fry off the production line and onto a separate conveyor belt, which carried it to a machine with tiny automated knives that precisely removed the blemish. And then the fry was returned to the main production line.

Sprays of hot water blanched the fries, gusts of hot air dried them, and 25,000 pounds of boiling oil fried them to a slight crisp. Air cooled by compressed ammonia gas quickly froze them, a computerized sorter divided them into six-pound batches, and a device that spun like an out-of-control lazy Susan used centrifugal force to align the french fries so that they all pointed in the same direction. The fries were sealed in brown bags, then the bags were loaded by robots into cardboard boxes, and the boxes were stacked by robots onto wooden pallets. Forklifts driven by human beings took the pallets to a freezer for storage. Inside that freezer I saw 20 million pounds of french fries, most of them destined for McDonald's, the boxes of fries stacked thirty feet high, the stacks extending for roughly forty yards. And the freezer was half empty. Every day about a dozen railroad cars and about two dozen tractor-trailers pulled up to the freezer, loaded up with french fries, and departed for McDonald's restaurants in Boise, Pocatello, Phoenix, Salt Lake City, Denver, Colorado Springs, and points in between.

Near the freezer was a laboratory where women in white coats analyzed french fries day and night, measuring their sugar content, their starch content, their color. During the fall, Lamb Weston added sugar to the fries; in the spring it leached sugar out of them; the goal was to maintain a uniform taste and appearance throughout the year. Every half hour, a new batch of fries was cooked in fryers identical to those used in fast food kitchens. A middle-aged woman in a lab coat handed me a paper plate full of premium extra longs, the type of french fries sold at McDonald's, and a salt shaker, and some ketchup. The fries on the plate looked wildly out of place in this laboratory setting, this surreal food factory with its computer screens, digital readouts, shiny steel platforms, and evacuation plans in case of ammonia gas leaks. The french fries were delicious — crisp and golden brown, made from potatoes that had been in the ground that morning. I finished them and asked for more.