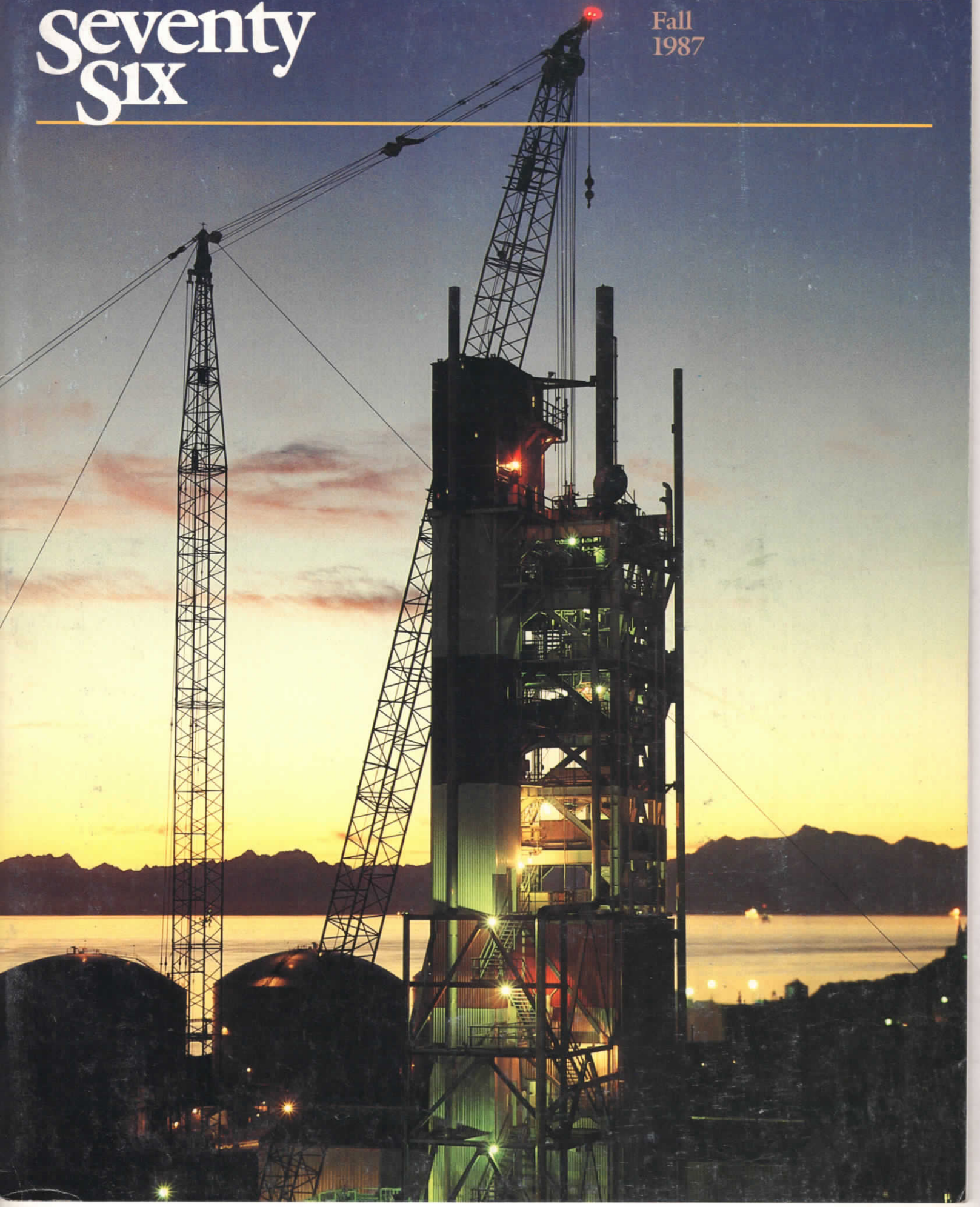
Seventy Six

Fall
1987



Out With The Old, In With The New

At high noon on this mid-August day, Alaska's Kenai peninsula is bathed in brilliant sunshine. Across the deep blue waters of Cook Inlet, Mt. Redoubt—the huge volcanic cone that dominates the Kenai mountain range—sparkles under a mantle of snow. The temperature is a balmy 74 degrees.

The fine weather comes as a welcome change for the staff of Unocal Chemicals' sprawling anhydrous ammonia/urea manufacturing complex, located on the eastern shore of Cook Inlet about 10 miles north of the town of Kenai. This summer has been unusually wet and cool here in south central Alaska. With the first big runs of silver salmon due to hit the peninsula's rivers and streams any day now, the good weather is well-timed.

But it's not the sunshine or the fishing prospects that have people here pumped up today. Something big is afoot at the Kenai plant.

For instance, there's the enormous crane looming up over the 11-story-tall urea synthesis tower—the biggest crane that's been seen around these parts since construction of the original plant. Then there are the three mysterious pieces of equipment that arrived by barge a few weeks ago. Resting on huge dollies not far from the urea structure, the massive vessels look like sections of a futuristic space station.

The behavior of the plant's employees also indicates that something unusual is up. Several groups of workers are milling around outside, spending their break time watching the crane crew prepare for action. A few have cameras around their necks.

When the huge machine's thick steel cables finally begin to move, all eyes gaze upwards. Bit by bit, a large cylindrical vessel begins to emerge from the top of the urea structure. As the vessel is swung out and slowly lowered toward the ground, the camera shutters begin clicking. Some of the workers join in a chorus of whistles and cheers.

What is going on here, you ask? Well, while we leave things hanging, so to speak, a little background information may be in order.

Built in 1968, Unocal's Kenai facility is one of the world's largest producers of ammonia and urea—two primary agricultural fertilizers. The company completed a major expansion of the plant in 1978, doubling its production capacity to 1.3 million tons of ammonia and 1.2 million tons of urea annually. (About half of the ammonia goes into the production of urea.) Feedstock for the plant is natural gas, supplied from Unocal's extensive reserves in the area (see accompanying story).

Employing about 300 full-time workers, the Kenai plant is spread out over 22 acres. In addition to two separate ammonia/urea complexes, the facility has two large urea storage structures, a pair of ammonia storage tanks, a spare parts warehouse, an administration building, a dock and loading facility for ships, and several shops used for ongoing maintenance and repair work.

Clockwise from top: Workers inspect a dismantled "granulator tire," used in the urea production process; securing one of the new urea process vessels to a crane; a section of the Kenai plant, looking south.

"Regular maintenance is very important, since our manufacturing processes are highly complex," says plant manager Bill White. "It's especially critical here in Kenai because of the area's remoteness. We have to deal with any problems or malfunctions that occur ourselves, and a good maintenance program helps hold these to a minimum."

In keeping with this philosophy, the Kenai plant adheres to a strict maintenance schedule. Every 30 months, each of the two ammonia/urea complexes is shut down for inspections, repairs or replacement of any worn parts, and extensive safety checks. The shutdowns, called "turnarounds," are staggered to take place in one of the two complexes every 15 months.

During turnarounds, all pipes, pumps and vessels in the plants are carefully inspected. Relief valves are cleaned and tested, welds are checked by x-raying, catalysts are changed where necessary, and instruments are re-calibrated. "In other words," says White, "we check or overhaul just about everything."

Needless to say, the process involves many man-hours of detailed work. A typical turnaround at Kenai takes a full three weeks. During this time, plant operators and other employees shift to special turnaround tasks. A large number of contract workers and specialists, such as welders and pipe fitters, are also brought in to help.

"The actual number of workers here more than doubles during turnarounds," says plant personnel manager LeRoy Heinrich. "It's always an extremely busy time. And while all this activity is going on, that half of the plant not affected continues to operate normally."

As you may have deduced by now, this day's activity is part of a plant turnaround. But this particular turnaround is far from typical. Although as always, the work affects only half the facility—in this case, the "new" ammonia/urea complex built in 1978—this turnaround is the biggest and most involved ever undertaken at Kenai. In addition to all the normal turnaround work, "major surgery" is being performed on the urea plant.

The plant's central process equipment is housed in an 11-story structure where urea (a solid nitrogen compound) is made by combining liquid ammonia, carbon dioxide and carbamate. A maze of pipes, valves and machinery, the structure houses three massive vessels in which the urea synthesis process takes place. These vessels, referred to in general terms as heat exchangers, form the heart of the urea plant.

"All three vessels are extremely complex pieces of equipment," White says. "They operate at very high temperatures and pressures. These extreme conditions, combined with the corrosive nature of CO_2, make the synthesis process very hard on the vessels' interior metallurgy."

Although they are constructed of specialized alloys to help them withstand these corrosive effects, 10 years of near-continuous operation have taken their toll on the vessels. Their replacement was necessary, and this turnaround period was chosen as the most suitable time.

Clockwise from left: Workers perform repairs on a gas compressor in the ammonia plant; a worn pipe weld is ground out; one of the new vessels is gingerly lifted; senior engineer Malcolm Rooper (right) discusses placement of the vessels with operations engineer Charlie Ross.

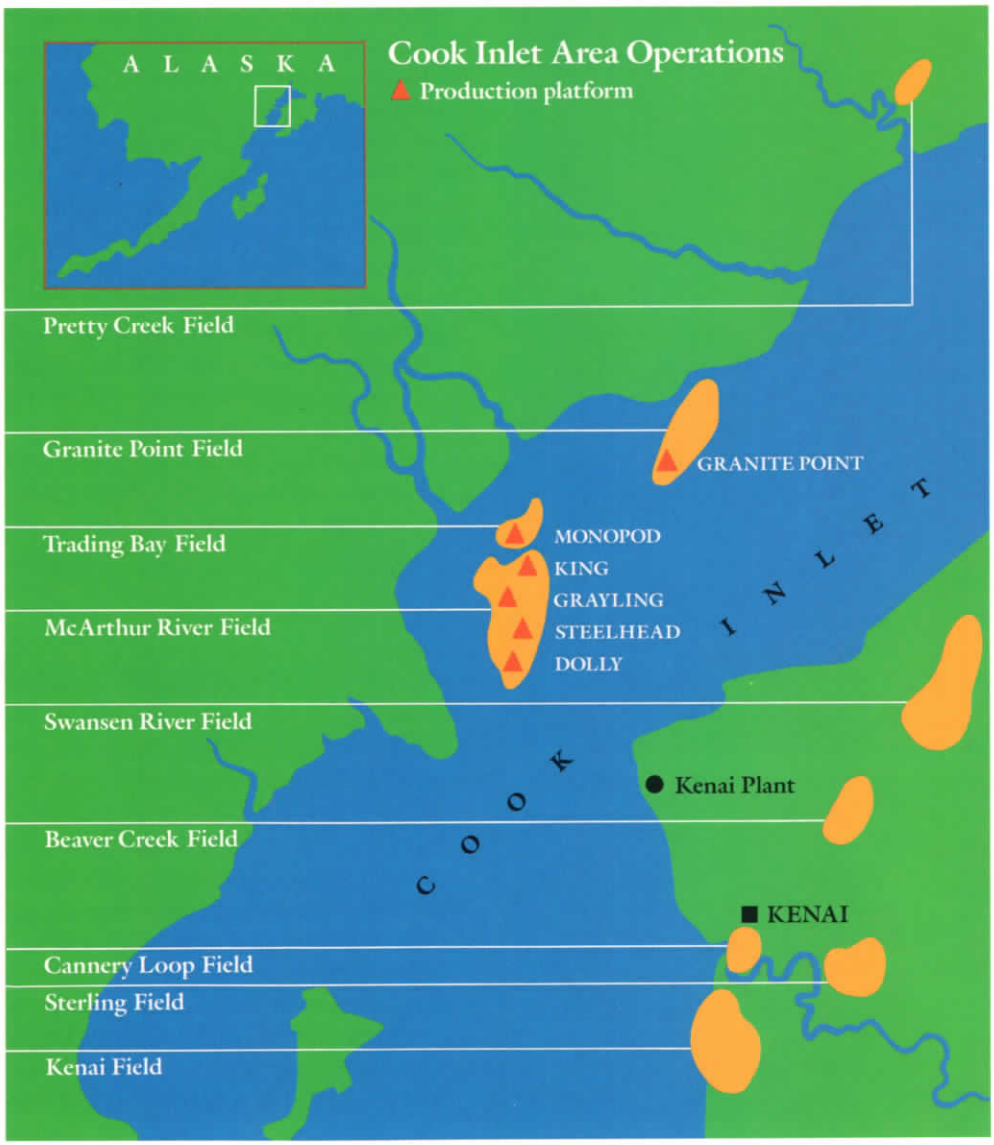
The job began long before reaching the installation stage, however. Replacements for machinery this specialized cannot simply be ordered up from a supply house. Brand new vessels had to be manufactured especially for the Kenai plant. Overall responsibility for this job—from the design and fabrication of the vessels to their installation—was given to the Kenai plant engineering staff.

"Usually operations on this scale have to be farmed out," White says. "But we had the manpower and the skill levels to take on this job in-house. It's been a great project for our engineering staff. They've really been given the opportunity to stretch."

According to Rod Gilge, engineering superintendent at Kenai, the project is by far the largest the plant engineering staff has ever undertaken. Senior engineer Malcolm Rooper was placed directly in charge of the operation, assisted by Fred Miller, Jeff McHone and Dave Haring.

Rooper, who normally concentrates on more routine maintenance tasks at Kenai, has been working full-time on the urea plant project since the fall of 1984. His office overflows with spec sheets, blueprints, diagrams and loose leaf binders filled with data about the new synthesis vessels.

"I'd have to agree that this project has been a challenging one," Rooper says, mulling over the last three years. "The enormity of detail has been staggering, and the hours have been long. But truthfully, it's been nothing but fun for me."



Top, Kenai plant manager Bill White (left) views the action with Tom Sleeman, Unocal Chemicals Division president. Right, the ammonia/urea complex control panel. Far right, maintenance is performed on the urea plant's first-stage evaporator.

The fun and the challenge have come in several ways, from state-of-the-art design requirements for the new vessels to the need for extremely precise, high-tech fabrication techniques. There was also the logistical challenge of transporting and installing equipment that weighs in at hundreds of tons. And to add to the hurdles facing Rooper and his staff, the entire project has been literally global in scope.

To begin with, the process technology for Unocal's Kenai plant is licensed from a Dutch company called Stamicarbon. Working closely with Rooper, the Dutch engineers designed the new vessels expressly to fit the existing urea plant. Once the design phase was complete, Stamicarbon aided in contracting out manufacture of components and the vessels' fabrication.

"This wasn't simply a case of taking the lowest bidders," Rooper says. "Technical capabilities had to be carefully considered, and all bidders were required to give us detailed proposals."

An example involves the interior tubing needed for the new vessels. The tubes had to be made of highly exotic, corrosion-resistant alloys that didn't even exist 10 years ago. "Only a handful of places in the world could make this tubing, and they had to meet very exacting specifications," Rooper says. "Fabrication of the vessels was equally important, because we had to have very precise welds and seals."

After the bids were reviewed, a Swedish company was chosen for the tube manufacture, and an Italian firm for the vessel fabrication. Once the work began, one of Rooper's main responsibilities was to act as liaison between these far-flung parties—an especially difficult task from remote Kenai.

"At times it was almost as if we had a 24-hour operation going," Rooper says. "I would send telexes to Italy or the Netherlands at day's end, and find telexes waiting for me here in the morning."

Telexes did not always suffice, of course. Rooper personally made three trips to Europe to help coordinate engineering and quality control among the various companies.

Once completed, the new vessels had a long voyage to Kenai. After being transported by barge through a system of lakes and canals to Venice, they were loaded on a ship for the trip across the Atlantic and through the Panama canal. Pausing for shipping inspection in Long Beach, California, the vessels then proceeded up the coast to Everett, Washington. From Everett they completed their journey by barge to Kenai, arriving early in August.

Each of the new vessels will employ the same basic process technology as the ones being replaced. But the new ones differ from their predecessors in several important ways.

"For one thing, the metallurgy of the new vessels is much more advanced," Rooper says. "They are fabricated from special alloys consisting of chrome, nickel and molybdenum. The welds and seals are extra strong, and the exterior surfaces are coated with a protective layer of carbon steel. All of this will help to better retard the corrosion problems inherent in urea synthesis."

Reduced corrosion will also extend the life of the equipment. While the old vessels lasted 10 years, the replacements should continue to operate for 20 to 30 years. "We've also upgraded the equipment in terms of performance," Rooper adds.

For Rooper and the rest of the Kenai engineering staff, the actual installation of the new vessels—set to take place over a period of four days—is the high point of the project.

"After all this time and hard work, it's going to be very satisfying to finally see this new equipment put in place," Rooper says. "The job won't be over, of course, until the plant is up and running again. But I think we'll all be able to breathe a little easier."

Installation of the new equipment is a major task in itself. Two of the old vessels must be lifted out the top of the urea structure, while one will be raised onto a dolly and rolled out the bottom. Then the new vessels must be placed in the same fashion.

"Usually when installing new equipment in the plants, we can haul things up piecemeal," Rooper says. "But these modules have to be lifted in whole. It's a tricky job because they're very large and quite heavy."

Quite heavy indeed. One of the new vessels going in through the top, a high-pressure condensor, stands 4½ stories tall and weighs 145 tons. Lifting and lowering something this big—and doing it with the necessary precision—is a job that very few rigging companies could handle.

As with the vessel fabrication, bids were taken for the work, all of which had to be submitted along with technical proposals. The winning firm, a company based in Las Vegas, Nevada, boasted years of experience in large-scale lifting projects—among them the construction of Hoover Dam. The company's largest crane—a twin-tower, 600-ton giant—was shipped to Kenai by barge, accompanied by a 16-person crew.

As Rooper and a group of plant employees watch the crew in action on this bright afternoon, several of them share a smile over the motto painted on the big crane's cab: "Our business is picking up." By the workday's end, with the summer sun still high in the Alaskan sky, two of the old vessels have been lifted out the top of the tower and set gently on the ground. The third will be removed on the following day, after which the new vessels will be put in place.

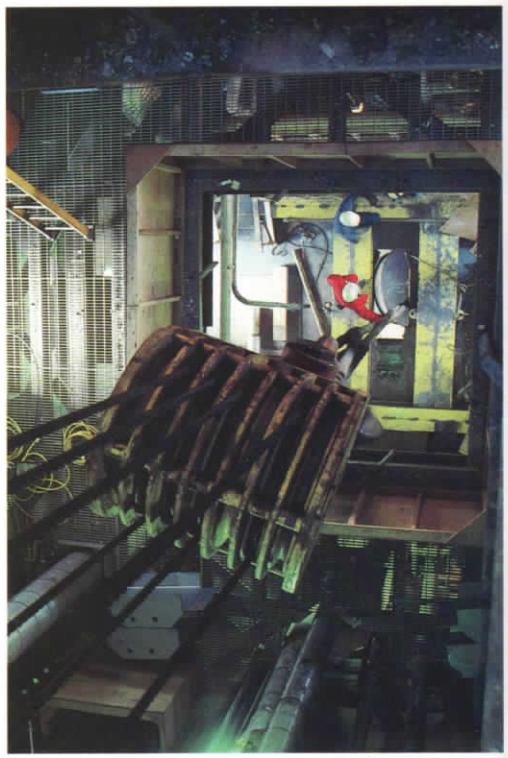
In the weeks to come, new piping and fixtures will be installed in the urea structure. The entire plant will be cleaned, inspected and reassembled, and the adjacent ammonia plant will undergo its normal turnaround. By early October, operations at Kenai will be going full-bore once again—and the big urea plant will be pumping away with a new heart.

"By then, things will be pretty much back to normal around here," Rooper says. "But there always seems to be a new project on the horizon. We're kept on our toes, and that's what keeps this work so interesting."

Bill White shares that sentiment. "We rarely have a period here without some new project in the wings," he says. "It's not always something as major as this, but our staff is always eager for the task."

And when it comes time to replace these new vessels with the next generation?

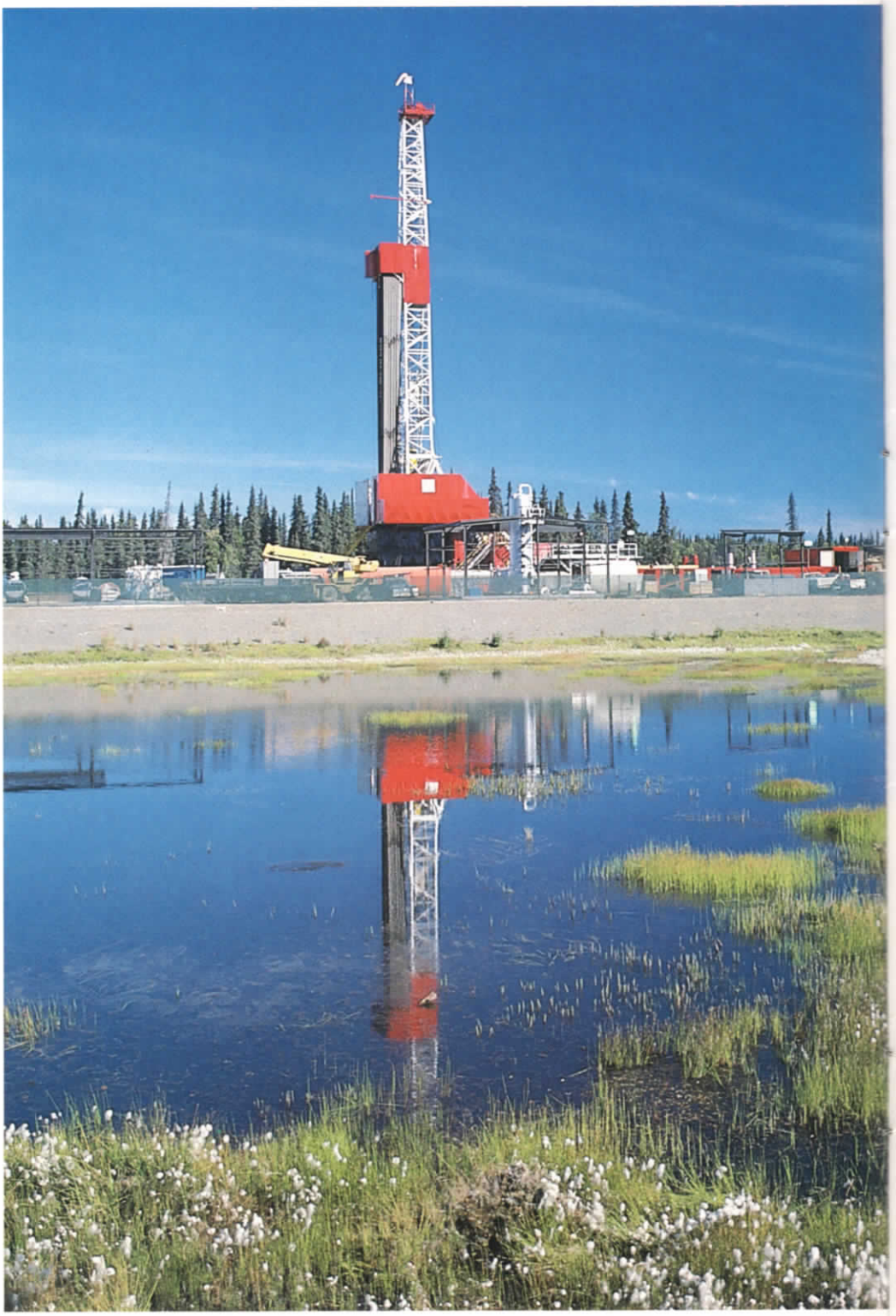
"By then, all of us here should be retired," White says, laughing. "But I might just drop by to watch." *T.S.* 76



Designing, fabricating and installing the new urea process vessels was no small task. But the state-of-the-art equipment should last 20 to 30 years.


PIRELLI

Drilling in Unocal's Cannery Loop gas field will provide a new feedstock source for the company's Kenai fertilizer plant.



Keeping the Gas Flowing

Unocal's Kenai, Alaska fertilizer plant consumes a large amount of natural gas—the feedstock used for anhydrous ammonia and urea manufacture. Since the facility began operating in 1968, most of the required gas has been supplied from Unocal's Kenai gas field, located on the peninsula south of the town of Kenai itself.

Discovered by Unocal back in 1959, the year of Alaska's statehood, the Kenai field remains a large and productive resource. But because the field's reserves will eventually be depleted, the plant's natural gas requirements will begin being supplemented by production from two new sources late this year.

One of these is the new Steelhead platform, located offshore in Cook Inlet. Unocal's 48-percent share of gas production from Steelhead, which is operated by one of the company's co-venturers, will be directed to the Kenai plant via an existing pipeline system.

The second new feedstock source will come from a new onshore gas field being developed by Unocal, the Cannery Loop field. Unocal has a 60-percent interest in production from Cannery Loop, which is located near the Kenai field.

Discovered by Unocal in 1979, the Cannery Loop field has had a complicated development history. Part of the gas deposits happen to lie directly under the town of Kenai, and the fact that drilling must take place in and around town has required a lot of extra permitting work on Unocal's part. Field development has been complicated from a royalty standpoint, since the location involves multiple leaseholders.

Environmental concerns have also slowed development. Much of the area surrounding the town of Kenai consists of ecologically fragile wetlands, some of which are home to flocks of migrating snow geese in the spring and fall. These areas are off limits to drilling crews. And in order to avoid adversely impacting the areas where drilling can proceed, Unocal is employing special pad construction techniques. All wells in the field will also be directionally drilled, which will minimize the number of drilling pads needed.

"It's taken a while to resolve these various concerns, but we've worked everything out satisfactorily," says Alaska District engineer Steve Lambert. "Unocal has been active in this region for a long time, and the people of Kenai realize that we are a conscientious operator. I think that has helped spur the Cannery Loop project along."

Barring any unforeseen problems, gas from Cannery Loop is expected to begin arriving at the Kenai plant before year's end. The company has already drilled two successful wells in the field, and a third is being completed at press time. This newest well is being drilled deeper than the others, into what company geologists hope may be an untapped gas producing zone.

Regardless of the results from this deep drilling, development of Cannery Loop has added significantly to the company's Alaskan gas reserves. And Unocal is planning additional development drilling in Cannery Loop in the coming year.

Given its new sources of natural gas and the longevity of the original Kenai gas field, Unocal's ammonia/urea plant in Kenai will have a steady supply of feedstock for years to come. That in turn will help ensure the plant's continued role as a dependable supplier of ammonia and urea to customers around the world.

"The market for ammonia and urea products is very cyclic from year to year," says Peter Schmid, Unocal Chemicals Division vice president of international marketing. "The international fertilizer market is very competitive. But the need for ammonia and urea products will inevitably expand in the years to come—especially in our principal markets, Latin America and the Pacific Rim region. The Kenai plant therefore can look forward to a bright and busy future." *T.S.* (76)

American Technological Leadership in Crisis

On October 16, Unocal Chairman and Chief Executive Officer Fred L. Hartley delivered the Warren K. Lewis Lecture at Massachusetts Institute of Technology (MIT). Held each year since 1978, the lecture is delivered to MIT's chemical engineering students and faculty by an invited guest. The lecture series memorializes the ideals of Dr. Lewis, who was a founder of the modern discipline of chemical engineering and a long-time faculty member of MIT.

Mr. Hartley's topic was "American Technological Leadership in Crisis." In his speech, reprinted here for Seventy Six *readers, Mr. Hartley emphasized the need to rededicate ourselves and our nation to the pursuit of scientific research, technological innovation and manufacturing excellence—a philosophy long practiced by the most successful companies in America.*

As a chemical engineer myself, it is a privilege to speak to the Department of Chemical Engineering at MIT. Your department has provided national leadership in engineering education for many decades. I understand that more than 10 percent of the nation's teachers of chemical engineering earned at least one degree from MIT, and that more than 10 percent of your department's alumni are senior executives with industrial companies.

That is an impressive record. We certainly recognize the high caliber of MIT graduates at Unocal. Several chemical engineering graduates from MIT work at our research center in Brea, California, and others have risen through the ranks to important managerial positions.

In fact, 25 percent of Unocal's MIT alumni are upper-level managers. Our vice president of corporate human resources, for example, has a doctorate from this department. And our director of environmental sciences earned his doctorate in chemistry from MIT.

My topic this afternoon is "American Technological Leadership in Crisis." Crisis is certainly a strong word to use, but in this case I believe its use is fully justified. For several years now, I have seen disturbing signs that this nation's preeminence in technological innovation has been slipping. Let me give you a few examples.

Item one: Foreign inventors are winning an ever greater share of U.S. patents. From 1965 to 1986, in fact, the share of U.S. patents awarded to foreign inventors rose from about 20 percent to 45 percent. Last year for the first time, inventors at a Japanese company—Hitachi—were awarded more U.S. patents than inventors from any American firm. And seven Japanese companies were among the top 20 companies receiving U.S. patents in 1986.

Item two: Between 1971 and 1984, the number of doctorates granted by U.S. universities in mathematics dropped 42 percent, the number in the physical sciences fell 25 percent, and the number in engineering declined 18 percent. Furthermore, more than half of those engineering degrees and nearly two-fifths of the doctorates in math were actually awarded to foreign students studying in this country. In both cases, that is roughly double the share of doctorates earned by foreign students 15 years ago.

These foreign students deserve credit for their ambition and ability. But we have to ask ourselves, where are the American graduate students?

Item three: Our space program, once the marvel of the world, is in disarray. While NASA attempts to get the space shuttle flying again, the European Space Agency is back in business with its own rocket. Meanwhile, the Soviets are running an aggressive sales campaign to sell launch services, communication satellites, and space photographs to other nations—including the United States.

Item four: America's balance of payments for high-technology products has been in rapid decline since 1980. This includes critical products like semiconductors and computers.

These are a few of the more visible warning signals that America is losing its technological edge. It is a worrisome development, because technological innovation is critical to the economic strength of the nation.

From 1900 to 1970, a steady stream of inventions in science, engineering and management practice led to vast improvements in U.S. economic productivity and, in turn, to America's standard of living. The generally rapid growth in worker productivity came to an abrupt halt in the early 1970s. From 1948 to 1973, output per worker grew at 2.5 percent per year. From 1973 to 1984, output per worker grew just one-half of a percent per year.

For the past 11 years, the nation's merchandise balance of trade has run in the red, hitting a record $156 billion in 1986. As our trade deficit has soared, America has increasingly relied on foreign investment to finance our national consumption.

In 1985, the United States became a debtor nation for the first time in this century. At the end of 1986, this country's public and private debts to foreigners exceeded what foreigners owed to us by over $260 billion. That exceeds the total public debt of Mexico and Brazil *combined*.

The United States is now the world's largest debtor nation—a kind of banana republic. And, sad to say, because of our climate, we can't grow bananas. The Japanese, in addition to buying up our real estate, have now become America's banker by buying up U.S. Treasury bills—in effect financing the federal budget deficit.

Obviously, a slowdown in technological innovation is not the only factor behind these economic setbacks, but I believe it is an important one. And it has grown increasingly important during the past decade, as the U.S. economy has had to face stiff competition in a *world* marketplace. Business scholar Peter Drucker puts it this way:

"The developed world has become one in terms of technology. All developed countries are equally capable of doing everything, doing it equally well and doing it equally fast. All developed countries also share instant information. Companies (and countries) can therefore compete just about everywhere the moment economic conditions give them a substantial price advantage."

The recent developments in superconductivity are a case in point. It is not science fiction to suggest that these new superconducting materials could form the basis for a multi-billion-dollar market in a decade or two.

At the moment, the United States is racing with Japan and several European countries to develop the manufacturing technology needed for commercial application of these new superconducting ceramics. (I will describe Unocal's research effort with these materials a little later in my talk.)

My point is that technological innovation is not just a matter of professional achievement and national prestige. In the final analysis, lagging technology leads to a less competitive economy, and that means fewer jobs and lower pay for many Americans.

Unocal's Poco Graphite subsidiary produces the highest quality specialty graphites in the world. The materials have important uses in the biomedical, semiconductor and advanced manufacturing fields.

Unocal is a world leader in the development of petroleum refining technologies—among them, the company's patented Unicracking process. Pictured here is the Unicracker at Unocal's Los Angeles Refinery.

Analysts have put forward a number of explanations for America's crisis in technological leadership. Some point to the deplorable state of scientific and technical education in this country, especially on the pre-college level. Others suggest that government regulations and tax policies tend to inhibit technological innovation, or that the nation's investment in non-military research and development has tapered off.

No doubt, these are part of the problem. But I also see a deeper, more disturbing factor involved. In my view, America has become *a shortsighted society,* committed to making the quick buck and taking the easy path. Too many people want to live off the productive achievements of the past—consuming but not creating, spending but not saving, winning without working.

We see this in our federal government, which runs up mind-boggling budget deficits year after year. We see this every day on Wall Street, where the so-called whiz kids play the stock market like a national casino, rather than invest in the nation's future. And we see this in industry, where many business executives must focus on financial manipulations and marketing gimmicks in an effort to show a quick profit and ward off corporate raiders. They seem unwilling to do the hard work and take the prudent financial risks necessary for long-term growth.

In other words, the shortsighted view is forced on the managers of wealth creation by financial leeches who seek to dominate corporate destinies.

Over the long term, technology-based companies must obey a simple law: Innovate for growth and continuity, or stagnate, decline and ultimately disappear. That is why at my company—Unocal—technological innovation has been a top priority for nearly a century.

Every year, we reinvest a significant share of our earnings in an ongoing research program, led by a talented team of scientists, engineers and support personnel. Some 800 of them work at our modern research facility in Brea, California, about 30 miles southeast of Los Angeles.

This investment strategy—with its emphasis on research and development—helped us grow into one of the world's major industrial companies. In recent years, we have continued to follow this strategy despite an increasingly difficult business environment.

In 1985, for example, we were forced to defend the company against a hostile takeover attempt, launched by a corporate raider. To win the battle, we took on more than $4 billion of new debt—debt that we must service and gradually pay off.

In 1986, OPEC's price war led to a collapse in crude oil prices, further squeezing the company's cash flow. Prices are higher now but still significantly below their 1985 levels.

Despite these financial challenges, we continue to support a strong research program, and we continue to get results. Let me give you a few examples. In particular, I would like to review some of our recent work in geothermal energy and oil shale development, graphite production, petroleum exploration and refinery process technology.

I will also touch on two longer-term research projects—superconductivity and biotechnology. I realize that these are very active fields of research here at MIT, but you may find it interesting to see how a major industrial company approaches them.

Unocal is an acknowledged leader in the development of innovative technologies for the petroleum refining industry. As a matter of fact, Unocal technology is now being used in hundreds of facilities around the world.

It is often said that necessity is the mother of invention, and that is certainly true of Unocal's refinery process technology. At first, we needed to develop effective techniques for processing California's heavy, high-sulfur crude oils. Later, we also needed to invent processes to meet increasingly stringent state and federal environmental regulations.

One of our most successful developments is Unocal's patented Unicracking technology. This process uses hydrogen and special catalysts to convert heavy, sulfur-laden crude oil components into clean, high-grade transportation fuels.

It took a 10-year research and development effort before our first Unicracker was operational in 1964. Since then, we have continued to improve and expand this technology, modifying it to refine heavier and heavier feedstocks into an ever broader array of products.

We operate two Unicrackers in our own refineries, while 56 more have been installed—or are being installed—in refineries of other companies under process licenses from Unocal.

The specific reasons for installing Unicrackers vary widely. Three Unicrackers, for example, are now operating in the Peoples' Republic of China, and a fourth is under construction. Two of these facilities are designed to emphasize production of diesel fuel for China's growing truck fleet.

The others are designed to produce feedstocks for petrochemical plants. These plants will produce synthetic fibers, enabling the Chinese to reduce their reliance on cotton fabrics. This, in turn, will allow them to convert more of their limited farmland to the production of food.

The Chinese decided to install Unicrackers after evaluating competing technologies offered by several other companies. We won the deal in part because of the credibility our technology had established among many other licensees.

In the early 1970s, Unocal researchers developed Unicracking/HDS, an innovative process to remove sulfur and a substantial portion of metallic contaminants from heavy residual fuel oils. Currently, eight large commercial plants are licensed.

During the past two decades, the company has also developed or shared in the development of half a dozen gas desulfurization processes, including the Beavon Sulfur Recovery Process, Selectox, and Unisulf.

In 1984, the Environmental Protection Agency recognized our Recycle Selectox process as "the best available demonstrated technology" for controlling emissions of sulfur oxide from small, onshore sulfur plants. Incidentally, we have installed this system on one of our own platforms, offshore California. When combined with our BSR Selectox process, this technology can recover more than 99 percent of the sulfur impurities in natural gas.

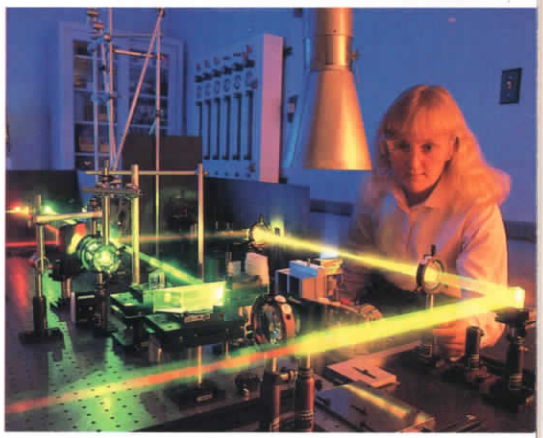
The success of Unocal's refinery process technologies is in part due to our large family of catalysts. Over the years, we have significantly improved the activity and stability characteristics of these materials.

Our new HCK and HCH catalysts are a good example. Because they are about three times as active as the older catalysts they replace, HCK and HCH will last longer and remove more nitrogen from the same volume of feedstock. In fact, such catalysts are removing about 10 million pounds of nitrogen per year at our San Francisco Unicracker alone.

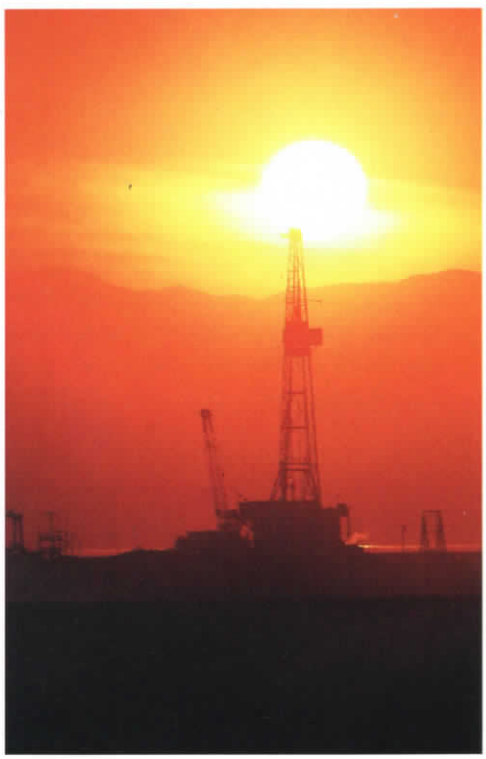
In addition to refinery process technologies, Unocal is also a world leader in the development of two important alternative energies—oil shale and geothermal power.

During the past 25 years, Unocal has pioneered the development of geothermal energy in this country. Today, we are the world's largest producer of geothermal power, harnessing enough hot steam or water from beneath the earth's surface to generate 24 million kilowatt-hours of electricity a day. That is enough electricity to meet the needs of about 1.2 million people, roughly half the population of the Boston metropolitan area.

It is also the energy equivalent of nearly 13 million barrels of crude oil per year. And it is a clean, efficient energy alternative for America.



A research chemist at Unocal's Science & Technology Division tests fuel combustion by using high-energy lasers.



A drilling rig "makes hole" at the company's Salton Sea geothermal project. Scaling and corrosion problems caused by the area's highly saline geothermal fluids have been overcome through an intensive research program.

Beneath the Salton Sea in Southern California lies one of the largest geothermal hot water fields in the world. Until recently, we could not harness this energy because of serious scaling and corrosion problems caused by the saline geothermal fluids in this field. After some 10 years of research, we have solved both of these problems, and we are now moving ahead to fully develop this resource.

The scaling problem was primarily caused by silica precipitation. We have played a major role in developing a crystallizer/clarifier technology to control it, and Unocal now stands at the forefront of the industry in the use of this specialized technology.

We successfully tested this system in a 10,000-kilowatt pilot plant that has been in operation at the Salton Sea since 1982. Two years later, we successfully tested a second production technology method that keeps the silica in solution. We are currently evaluating these two technologies.

Solving the scaling problem was only half the battle. Corrosion was affecting all of the piping, from the production well to the power plant to the reinjection well. To solve the corrosion problem, we obviously needed to upgrade the piping. We proceeded to test more than 120 alloys and other materials before finding a combination that did the job.

We are now expanding our geothermal operations at the Salton Sea. A company subsidiary is currently operating a 10,000-kilowatt pilot power plant, and a second subsidiary is constructing a 47,500-kilowatt plant in the same area. These represent our first ventures into the electrical generating side of the geothermal energy business.

Shifting to another alternative energy source, Unocal has been searching for an efficient way to unlock the energy of oil shale for more than 40 years. During the past 15 months, we passed a major milestone in this quest. In December of 1986, we began shipping high-quality synthetic crude oil from our Parachute shale project in western Colorado to our Chicago refinery.

The Parachute facility—designed to produce 10,000 barrels of raw shale oil per day—is the first commercial-scale shale oil venture in the nation. The plant has been running at about half rate while we conduct further experiments and design modifications to obtain full capacity. To date, we have shipped about 375,000 barrels of high-quality syncrude. We plan to operate the plant continuously in 1988.

The Parachute Creek shale project incorporates innovative technology that could be very important to the nation's energy future. It consists of an underground room and pillar mine, an upflow retort and an upgrading plant. The shale ore is mined and crushed, then fed into a large pump that pushes rock upward through the Unocal retort, counterflow to hot recycle gases. The 1,000-degree Farenheit heat decomposes the kerogen in the rock to produce raw shale oil, gas and spent shale rock.

We began construction of this plant in January of 1981. During start-up operations in 1983, we ran into problems with the scraper system, which was supposed to convey the hot, spent shale smoothly and uniformly from the top of the retort to the cooling system. The original scraper design simply did not work well. Although we solved the basic scraper problem through a series of design changes, we are continuing to improve the system.

Unocal's engineers also had to overcome problems with cooling the retorted shale, which is very fragile. As the hot, spent shale is scraped off the retort pile and fed by gravity into the cooling system, it "decrepitates," or breaks up. This generated an excessive amount of fines, whose consist is relatively impermeable. As a result, the original design for contact-cooling with water proved inadequate.

In response, we developed a new cooler design that, together with operational changes, has enabled us to achieve adequate contact-cooling at design shale throughput.

We still have a big job ahead of us to get the plant operating at full capacity, but we think we are now well on the way. The potential rewards are enormous. Unocal's landholdings alone contain over three billion barrels of synthetic crude oil. All told, the western United States contains approximately 600 billion barrels of recoverable shale reserves. That exceeds the proven crude oil reserves of all of OPEC! As we successfully demonstrate our oil shale technology on a commercial scale—10,000 barrels per day—it will make a tremendous difference to the energy reserves of Unocal, and our country.

As you know, Unocal is a major producer of conventional crude oil and natural gas, here in the United States and in several countries around the world. Lower prices and competing suppliers, both foreign and domestic, have increased our need to discover more cost-efficient ways to find and develop these resources.

In Thailand, for example, we produce enough natural gas and condensate to meet more than 30 percent of that nation's commercial energy demand. The reserves are located in fields composed of many faulted reservoirs in the Gulf of Thailand.

In order to map this highly complex geology in greater detail, we are using powerful computers to process huge seismic data bases and generate three-dimensional models of underground structures. Our geophysicists then use interactive computer systems to interpret these models and select the most promising drill sites.

Unocal's drilling engineers have also been busy. During the past few years, five major improvements in drilling technology came to the marketplace, including top-drive drilling systems, new drilling fluids, improved drill bits, and special equipment to monitor and control the direction of the well in near real time.

By combining *all* of these innovations in our drilling operations—and we were one of the first companies to do so—we have cut drilling costs in the Gulf of Thailand from over $4 million to about $2 million per well.

On the chemicals side, a Unocal subsidiary produces the best specialty graphites in the world. These materials, made from petroleum coke, have important uses in biomedical implants, semiconductors, electrical discharge machining and advanced manufacturing processes.

This year, we have introduced a new product we call Glassmate. We took a premium graphite and further treated it to make it resistant to oxidation at elevated temperatures. As a result, it is very useful in handling molten glass.

I am sure everyone in this room is aware of the recent, remarkable advances that have been made in developing ceramic compounds that exhibit superconductivity at temperatures exceeding 90 degrees Kelvin (–183 degrees Centigrade). And you probably know that these superconducting ceramic compounds include yttrium or lanthanum (and possibly other lanthanides) as a key ingredient.

What you may not realize is that Unocal is the world's largest producer of lanthanides. At Mountain Pass, California (about 60 miles southwest of Las Vegas), we are mining one of the largest known deposits of lanthanides on the globe. It is, in fact, the only resource in North America developed solely for the production of these elements. Through a partnership with a Canadian company, we are also a leading producer of yttrium.

Obviously, commercial development of these superconducting ceramic compounds could provide revolutionary improvements in machine design, transportation systems and energy utilization. At Unocal, we plan to be part of this developing new industry. We want to develop and market our own oxide mixtures, not just sell the raw materials to the ceramic makers.

Recently, we acquired special equipment for our research facility in Brea, California, and have begun making and testing our own superconducting materials. To date, we have produced materials that show superconducting properties at 90 K. In support of this effort, we have established a multidisciplinary team to study the role of lanthanides in these superconductive ceramics.

In the Gulf of Thailand, where Unocal produces large amounts of natural gas, use of innovative technologies has cut drilling expenses by half.

Unocal explorationists employ advanced computer technology to aid in the search for oil and gas. Here, two geophysicists create a three-dimensional model of a subsurface rock structure.

Unocal also has a research program in biotechnology. As a matter of fact, it is headed up by a 1984 graduate of MIT's chemical engineering department. Not coincidentally, we started our biotech effort that same year—he helped convince us to do it!

This research program seeks to use microbes as live catalysts in controlled reactors. Our initial goal was to use microbes to remove nitrogen, sulfur and other impurities from heavy crude oil. A major advantage of this method is that the process can occur at ambient conditions, while conventional techniques require very high temperatures and pressures.

Recently, we demonstrated this process on a bench scale, achieving sulfur and nitrogen removal rates about one-tenth those of conventional hydrotreating techniques. It also requires at least 10 times the reactor volume of conventional catalytic hydrotreating. One of our key challenges is to reduce this volume requirement through creative engineering.

One very promising application of biotechnology is in solving certain environmental problems that currently confront our industry and the nation. Landfills are a good example. A landfill is basically a large, complicated anaerobic bioreactor that releases methane. The microbial events within this "reactor" could be controlled so that the released methane could be harnessed as an energy source.

The potential benefits are significant. Six landfills in the Los Angeles area alone could produce enough methane to equal 34 million barrels of crude oil, on an energy-equivalent basis.

I hope this brief review has convinced you that we have no shortage of exciting and important technological challenges in the earth resources industry—challenges to satisfy the most enthusiastic and creative engineer. As you can see, by continuing to invest in innovative projects with the potential for long-term growth, Unocal (along with many other American companies) has managed to maintain its technological edge over the years.

But it is not easy in our shortsighted society, which, as I noted earlier, emphasizes the quick buck at the expense of long-term, innovative projects. And the fact remains that, for the nation as a whole, other countries are rapidly catching up with us and, in certain areas, surpassing us in technological capabilities.

What can America do to recapture technological leadership? I believe that government, industry and the educational sector all have roles to play.

Government must create a tax and regulatory environment conducive to technological innovation. The National Cooperative Research Act of 1984, which provides limited antitrust protection for certain kinds of joint R&D ventures, was a step in the right direction. Unocal, in fact, was one of the first companies to file under this act as a founding member of PERF—The Petroleum Environmental Research Forum. Formed in 1986, PERF is made up of 22 oil companies. These firms have joined together to pool their funds, ideas, and technical expertise in order to expedite the study and solution of environmental problems facing the industry.

The Technology Competitiveness Act, now before Congress, would significantly expand the role of the Commerce Department in supporting technological innovation in this country. Key provisions include the establishment of centers for the transfer of manufacturing technology and a special program to encourage private-sector ventures in advanced technology. This would also be a step in the right direction. The Tax Reform Act of 1986, on the other hand, reduced the tax credit for research and experimentation by 20 percent. That was a step backwards!

To help nurture technological innovation, government should *expand* tax incentives for privately sponsored R&D, not reduce them. Government, however, can only do so much. Industry and the universities must continue to open lines of communication and cooperation.

More university researchers, for example, could make a special effort to bring promising research results with potential commercial applications to the attention of industry. And industry should increase its financial sponsorship of university research projects of potential value to its activities.

Earlier in my talk, I mentioned the large number of foreign graduate students studying math, science and engineering in the United States. Now America is an open society, and we certainly welcome bright, hard-working students from other lands to study in this country.

But perhaps it is time, as some have suggested, that we begin charging foreign students who have adequate sources of funds at least full cost—if not a premium—for obtaining science and engineering degrees in the United States. So far, this has been a very cheap way for foreign nations to import U.S. technological expertise.

We also need to get a lot smarter about when and how we share research results with foreign companies. We should certainly demand the *same* access to their research that we—particularly through our universities and through licensing agreements—routinely give to them.

And those of us in industry and government must learn to better manage R&D programs to bring out world-class creativity. We must move more quickly to exploit emerging technologies. It is especially important that we do a better job of turning basic research into commercial products—exactly what the Japanese seem to do best.

In particular, this means that we must focus a lot more attention on the basics of manufacturing and a lot less on marketing campaigns, leveraged buyouts, and other quick buck schemes. And we have to emphasize to young scientists and engineers that manufacturing is an important career path.

As Paul Gray, the President of MIT, said in a recent speech:

"Despite its obvious importance, the manufacturing function is not highly valued in American industrial organizations. We have not—at least in the last three decades—drawn our industrial leaders from engineers...We must turn ourselves around. We must teach engineering students and their employers to value people who are expert in how things are made—and how well things are made."

To accomplish this, we need strong leadership from educators, government officials, and business executives. Let me assure you, we will try to do our part at Unocal. Indeed, the top two executives of the company are engineers who have spent a good portion of their careers in the production and manufacturing sides of our business. So I think we realize the importance of how things are made, and how well things are made.

America can no longer rest on its technological laurels, working in its economic comfort zone. We have got to get back to the hard, vital work of developing and making the best products we possibly can.

In closing, let me say—corny as it might sound in this cynical age—that you should be proud to be engineers. In my view, engineers are the builders and inventors of modern industrial society. They are the problem solvers who make things work and get things done.

It isn't easy but, given time and opportunity, we generally succeed. And as we succeed, we create products and processes that make human life richer, safer and more satisfying.

Thank you. ⑯

A firm commitment to scientific research helps keep Unocal on the cutting edge of an industry increasingly driven by technological innovation.

TOXICOLOGY: the bottom line is health and safety

Chemicals have helped to transform our lives with advancements in medicines, fuels, packaging, fabrics, pesticides, and a wide range of other products. At the same time, accidents and mishandling of toxic chemicals have sometimes been disastrous, generating headlines and strong public reaction calling for government regulation.

In industry, this has put a new focus on the science of toxicology. Just as pharmacology is the study of the potential beneficial effects of chemicals, especially drugs, toxicology is the study of the potential harmful, or toxic, effects.

"Our job is to help employees and customers understand chemical hazards so that they can produce and use our products safely," says Dr. Rich Clark, manager of toxicology and product safety for Unocal.

Dr. Clark joined Unocal in 1982 to manage the increasing toxicology activity in the Corporate Medical Department. At that time, the company was preparing to refine syncrude derived from oil shale and to market its products. The federal Toxic Substances Control Act (TSCA) required that the syncrude and products be registered as new chemicals. Unocal initiated the necessary testing program to support registration, and Dr. Clark was put in charge of the toxicology portion of it.

His responsibilities soon increased. California passed a workers' right-to-know law, followed by the publication of the federal Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard. Legislation which affects how companies determine and communicate chemical hazards continues to be enacted—as research continues to create more useful and remarkable chemicals.

Dr. Clark has four other toxicologists working with him. Their job is to bring good science and good sense to the understanding of chemical hazards. All received their training in specialized toxicology programs, which combine studies in chemistry, biology, physiology and other disciplines. Four of the staff hold advanced academic degrees. Dr. Paul Ferguson, senior toxicologist, and Dr. Clark are certified by the American Board of Toxicology.

"The bottom line on everything we do in the Medical Department, including toxicology, is protecting employee health," says Dr. Reynold Schmidt, corporate medical director. "We're interested in preventing health problems from occurring in the first place—and, if they do occur, minimizing their impact. Toxicology is one of the resources available in the department to help meet this objective."

"Everything is toxic, everything is safe. It is the dosage that is critical." Those words, paraphrasing the 16th-century Swiss alchemist and physician Paracelsus, state the basic principle of the modern science of toxicology.

In other words, exposure to a toxic chemical does not necessarily mean that an individual will suffer toxic effects. The critical factor is how much of the chemical—the dosage—is involved. And what this means is that by handling chemicals properly, we can both reap the benefits and avoid the potentially harmful consequences.

At Unocal's Los Angeles Refinery, Dr. Tom Keenan, left, and senior industrial hygienist Emilie Wheeler, right, observe unit operator Les Fejer taking a laboratory sample from the Unionfining Reforming Unit. Evaluation of such procedures helps identify potential chemical exposures to employees.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"For most toxic effects, there is a threshold of exposure," explains Dr. Ferguson. "Below that threshold there is no toxic effect because the body processes can handle the chemical adequately. Information on 'no-effect' levels helps us determine safe workplace levels of exposure."

But many people are not aware of this concept. They hear the word "chemical" and immediately think of something that is poisonous and made in a laboratory. Yet, chemicals form the basis of life. And people are routinely exposed to chemicals—both toxic and non-toxic—in their food, water and air.

So, why isn't everybody sick? Because the human body tolerates, and in some cases requires, low doses of many chemicals that are potential toxins in higher doses.

Iron, for example, is essential for the body's production of red blood cells and normal metabolism. However, when taken in high doses, such as accidental overdoses of iron supplements, the iron salts may cause serious damage to the digestive tract and reduce the function of other organ systems.

Many people have the misconception that natural chemicals are somehow better, or less hazardous than man-made chemicals. But whether a chemical is natural or man-made does not determine its toxicity. The world's most potent poison, botulinum toxin, occurs naturally. Salt, a common natural chemical, is necessary for human health—but can be deadly in high doses.

Aflatoxin, a potent liver carcinogen in animals, is a common natural contaminant of peanuts and peanut butter. "But there is little evidence that these foods are major causes of liver cancer in the human population," notes Dr. Clark. "In fact, liver cancer rates in the United States are low."

Ethyl alcohol also illustrates the concept of a "threshold of exposure." The body tolerates small quantities, but large doses of alcohol lead to the well-known symptoms of mental confusion, incoordination, nausea and eventually unconsciousness. Alcohol's toxic effects can include harm to the fetus if used during pregnancy. Long-term toxic effects include damage to the liver and nervous system.

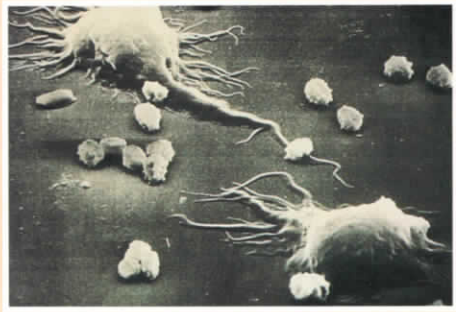
Everything has risks associated with it—driving a car, traveling by airplane, swimming, eating in restaurants, living in an earthquake zone. People have learned to balance the risks against the benefits—and this thinking can also apply to the use of man-made chemicals, which offer considerable benefits. And that's what toxicology is all about—understanding chemical risk so that it can be managed.

Unocal's toxicologists are part of an integrated occupational health team which also includes physicians, industrial hygienists, epidemiologists and health educators. "The team approach has worked well at Unocal," notes Dr. Schmidt.

Many projects at Unocal require expertise from more than one discipline within the Medical Department. The toxicologist identifies those chemicals that can produce harmful effects. The industrial hygienist measures workplace exposures to such chemicals and recommends appropriate engineering changes and protective equipment.

The physician is in the crucial role of observing employee health. The epidemiologist analyzes the health statistics of groups of workers to spot unusual trends. And the health educator promotes preventive health practices and assists in chemical health hazard communication.

By relying on each other's expertise and staying abreast of new developments in research, Unocal's health professionals develop thorough hazard assessments of chemicals. One of the major activities of the toxicology group is the preparation of chemical hazard information for Material Safety Data Sheets (MSDSs).



The toxicology group: from left, Donna Seid, Dr. Tom Keenan, Dr. Rich Clark, DeriJann Crofts and Dr. Paul Ferguson. Facing page, the electron microscope reveals two specialized body cells (called macrophages) consuming foreign particles in the lung as part of the body's defense system.

OSHA requires that information about product or workplace chemicals must be made available to employees, customers and members of the communities where the company operates. The MSDSs help fulfill that requirement and are used to help train employees about the chemicals they work with.

Unocal's Chemicals Division has been compiling MSDSs since the early '70s. But OSHA's most recent Hazard Communication Standard has brought some significant changes—notably in the definition of hazardous mixtures.

"If a material contains a toxic component at greater than one percent and no toxicity testing has been done, we must assume that the material has the same hazardous properties as the toxic component," notes Dr. Clark. "We are also required to have written procedures describing how we determine the health hazards of a chemical."

In addition to the chemical hazard information supplied by the toxicologists, Unocal's MSDSs carry information gathered from other experts involved in the review process, which is coordinated by Environmental Sciences. The information includes maximum exposure levels, first aid, safe handling procedures, fire hazard, spill and leak procedures, and emergency phone numbers.

In assessing hazard, the toxicologists begin by reviewing what is already known about a chemical. "My job involves one of the basic responsibilities of our group—keeping up with the scientific literature on the health hazards and effects of chemicals," says DeriJann Crofts, toxicology information specialist.

Crofts reviews published abstracts, searches computer data bases, and indexes pertinent articles in a computerized system for quick reference. She has catalogued some 5,000 articles—and adds another 75 or so every month. In addition, the toxicology group has created extensive files on hundreds of chemicals that pertain to Unocal's various businesses, and generates new information as needed to keep up with current research.

Each staff toxicologist handles separate product lines for whom he or she manages product safety information and responds to requests from operating divisions and customers. Crofts handles lanthanide products. Dr. Ferguson works on geothermal and oil shale materials. Donna Seid is assigned to the Chemicals Division. Dr. Tom Keenan handles petroleum and graphite products.

"Determining the hazards of petroleum products requires an understanding of the refining history of the streams that go into the products," says Dr. Keenan. The various refinery streams derived from crude oil are mixtures of hundreds of hydrocarbons. Evaluating the hazard of these complex mixtures is not as straightforward as looking at pure chemicals. And different refining processes may alter the chemical composition and the toxicity of the streams.

"We look at the entire production process, so employees can have the necessary information to guide safe handling of these materials throughout the various stages of refining," Dr. Keenan explains.

Thousands of MSDSs have been completed for Unocal products and process chemicals. Now most of the operating divisions require only updates and new information for new products. But the Petrochemical Group is a special case—turning out 80 to 100 custom solvent blends every month to meet the special and changing needs of its customers.

"I'm assisting the Petrochemical Group in developing a computerized information system for their solvent-blend MSDSs," says Donna Seid, toxicologist. "Since the health hazards of each of the solvents must be mentioned in the MSDS for each custom blend, we want to make the process of compiling the information as efficient as possible."

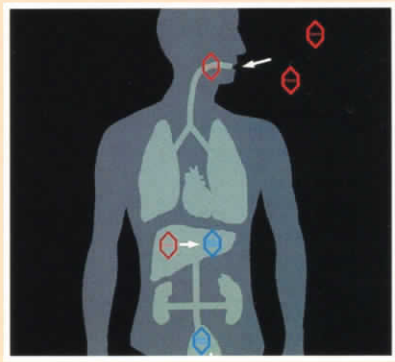
The number of requests for toxicology assistance from the field and corporate staff groups continues to grow," says Dr. Clark. "Most of the requests are related to OSHA requirements and compliance with the Toxic Substances Control Act. TSCA has far-reaching implications for the way we do business, and it's not even fully implemented yet."

TSCA is enforced by the Environmental Protection Agency, as are many other pieces of legislation which can require companies to do extensive testing of new and existing products. This can represent a significant investment of time and resources. Unocal has no toxicity testing facilities of its own, so it contracts all work to commercial laboratories.

"The nature and extent of required toxicity testing depends on the type of product and its intended use," notes Dr. Ferguson, who manages Unocal's animal toxicity testing program. "As the company's researchers become more aware of this, they are incorporating toxicology earlier on in the development of new products."

Controlled testing to assess chemical toxicity is essential to protecting human health. "There are hundreds of thousands of chemicals out there, and it's difficult to understand the health hazards without testing them in some kind of a biological system," Dr. Clark explains. "You obviously can't use people. So the traditional approach has been to use small laboratory animals like rats."

There have been some "test-tube" toxicity tests developed using cell and tissue-culture techniques, but extrapolation of the results to possible effects on human beings is difficult and uncertain. "When it comes right down to making hard decisions about what the health effects are, most toxicologists are not comfortable unless they can review test data relating to a whole organism," says Dr. Clark.

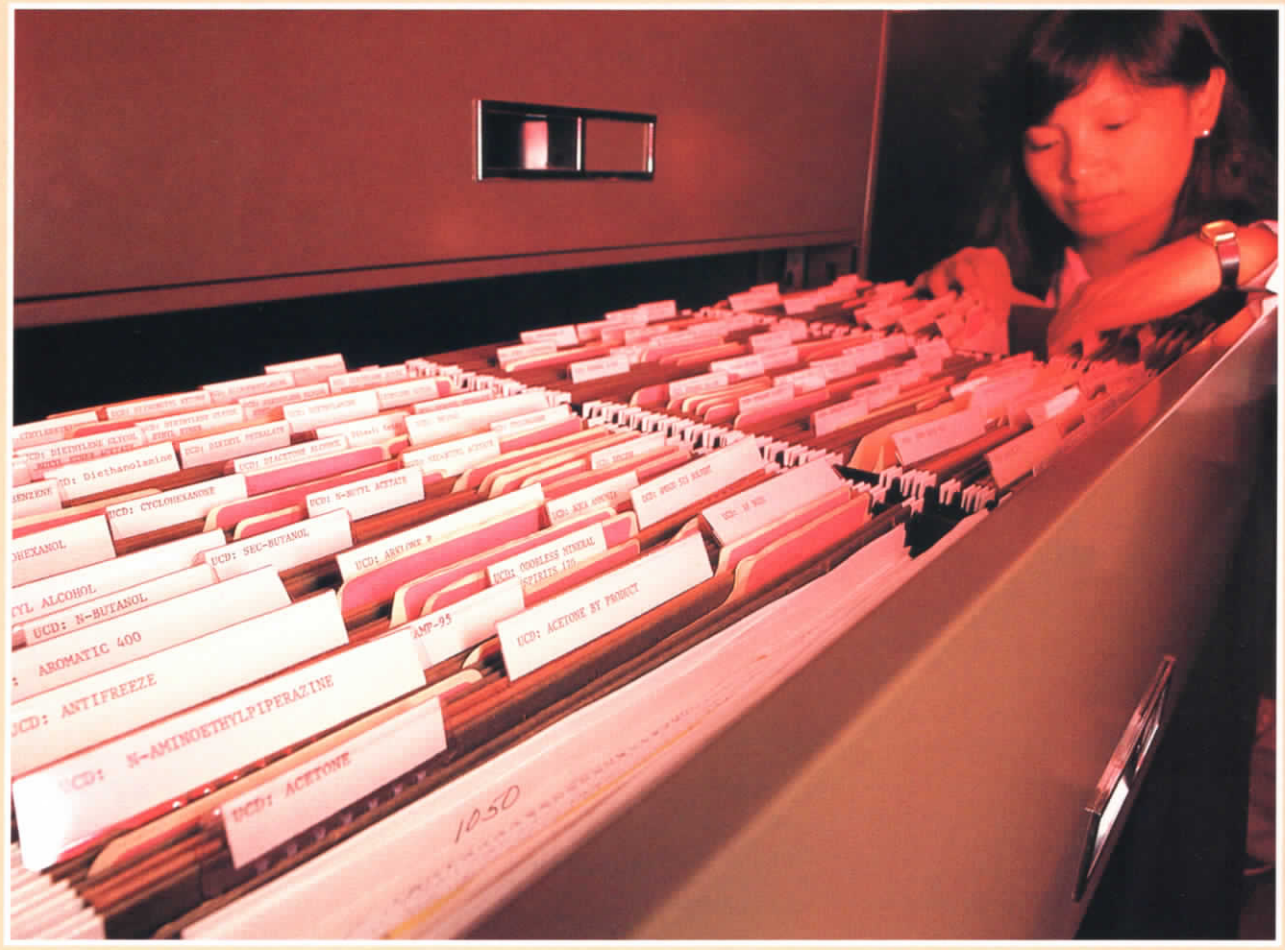


Toxicity: A Question Of Dosage

The basic principle of toxicology—that everything is both toxic and non-toxic, depending on the dosage—is illustrated in the following chart. Each amount represents an estimated single dose of the pure chemical taken by an average man.

Chemical	Toxicity Rating	Estimated lethal dose*
Sugar	Practically non-toxic	More than 2 pounds (1,820 grams)
Ethyl alcohol	Practically non-toxic	½ quart (490 grams)
Malathion	Slightly toxic	2–3 ounces (96 grams)
Aspirin	Slightly toxic	100 tablets (70 grams)
Caffeine	Toxic	½ ounce—more than 100 cups of coffee (14 grams)
Botulinum toxin	Highly toxic	Less than 7 drops (0.0007 grams)

**Based on lethal doses determined in laboratory animals.*



Donna Seid finds information at her fingertips in the company's extensive toxicology files. Facing page, a chemical's effects on the body vary with the "route of exposure"—swallowing, inhaling, or skin contact.

Several types of tests are performed. Acute toxicity tests check for the immediate health effects of exposure to a chemical. Subchronic tests are conducted over a period of weeks, exposing the subject animals to repeated doses of the chemical. Chronic tests check for long-term effects, such as cancer.

A teratology study is done to determine the potential of the chemical for causing birth defects. And additional studies may be done to see if the chemical affects reproductive ability.

"You're looking at a process of four or five years and several million dollars for each material if a complete series of tests is required," says Dr. Clark.

In addition to assisting in the company's compliance with existing regulations, the toxicology group also monitors new toxics legislation in order to present industry's viewpoint and make a case for good science in the face of public fear.

"Proposition 65 is a good example of public misunderstanding of toxicology," says Dr. Ferguson. The proposition, recently passed in California, forbids the discharge of any amount of known carcinogens into actual or potential sources of drinking water. It also limits the discharge of reproductive toxins to one one-thousandth of an experimentally determined no-effect level. The proponents of Proposition 65 have announced intentions to advocate such legislation on a national scale.

"Who can vote against safe drinking water?" asks Dr. Ferguson. "No one wants carcinogens or toxic substances in their drinking water. But the basis for Proposition 65 is not scientifically defensible, because it implies that even very low levels of chemicals in our drinking water are harmful.

"Too often, society's attitude has been that unexplained health problems probably have something to do with man-made chemicals," he continues. "Yet, chemical-related diseases are a low percentage of all human diseases."

Dr. Ferguson is part of a Proposition 65 technical working group chaired by Dr. Michael Cardin of Unocal Environmental Sciences. The group, referred to as the Scientific and Technical Committee, represents a coalition of industry, agriculture and business. It provides recommendations and technical evaluations to the governor's Science Advisory Panel, which is currently working to compile the list of chemicals to be regulated under the proposition. The committee also comments on proposed guidelines and regulations requiring scientific input.

"I'm hoping Proposition 65 will be a turning point—that public debate on implementation will increase public understanding of how to evaluate and regulate chemical hazards," says Dr. Ferguson. "With better understanding, chemical hazards can be placed in proper perspective. In turn, unnecessary fears of chemicals in the workplace and the environment can be reduced."

The creative use of chemicals has contributed to making our lives healthier and more enjoyable than in centuries past. By helping to minimize risk to those working with or using Unocal chemicals, the toxicologists are playing a vital role in the continuing effort to improve the quality of life. *B.P.* ⑯

Fertilizers and pesticides bring great benefits to farming when the hazards of their use are understood and appropriate precautions are taken. Facing page, the toxic effects of chemicals increase with dosage above the threshold, or "no-effect" level.

AN INVALUABLE SERVICE

The emergency telephone number listed on all Unocal Material Safety Data Sheets is for the Los Angeles Regional Poison Center. The center receives calls from all over the country on its 24-hour emergency hotline.

"From our standpoint, the poison center provides an invaluable service," says DeriJann Crofts, toxicology information specialist. OSHA regulations require that every MSDS carry the telephone number of a responsible party who can be reached 24 hours a day. Unocal, by using the center to meet this requirement, assures that callers will always get an immediate response.

All of Unocal's MSDSs are on file at the poison center, and Crofts works to keep them updated. Soon, the MSDSs will carry an 800 telephone number, which will give callers toll-free access to the center's services.

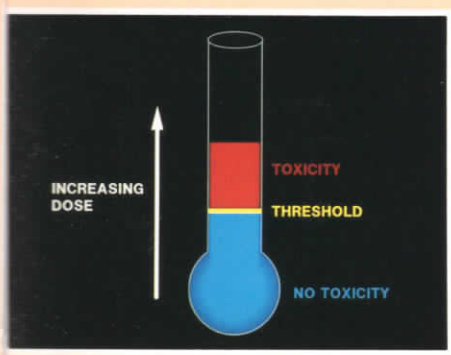
Over the past few years, Unocal has become increasingly involved in the center's work. Dr. Clark, manager of toxicology and product safety, often consults with the center's Medical Advisory Committee.

Operated by the Los Angeles County Medical Association, the Los Angeles Regional Poison Center opened in 1957 as a service to physicians and received 76 calls in its first month. Now a public service, it averages more than 200 calls for help a day, and more than 6,000 a month.

The center's telephones are answered by nine registered nurses who have a myriad of poison information resources to draw from—a computer data bank, books, and experience. They know how to handle emergencies, and can calm an alarmed caller while eliciting the necessary facts. They can then recommend first aid or reassure the caller that there is no problem. The great majority of calls from the public involve incidents with children under three years old.

The center also gets calls from physicians looking for specific information to help them treat their patients. There's just too much information about poisons for any one physician to be an expert on everything, explains Corinne Ray, center administrator since 1970.

The public emergency number for the Los Angeles Regional Poison Center is (213) 484-5151. 76



Conflict and Compromise:

THE MAKING OF THE U.S. CONSTITUTION

In September 17, 1987, the United States of America marked the bicentennial of the signing of its Constitution—one of the world's most revered and remarkable documents. Through two difficult centuries, the Constitution has formed the framework of our enduring democracy, providing a system of checks and balances to serve both individual rights and the good of the nation as a whole. The document which forms the basis of United States law has proved strong and flexible, able to meet the continuing challenges of preserving democracy in a dynamic society.

National celebrations of the bicentennial will continue for four years, through the 1991 bicentennial of the Bill of Rights. Seventy Six *helps kick off the festivities with the story of the Philadelphia Convention, where the U.S. Constitution was composed and adopted.*

It was called, simply, the Philadelphia Convention. Fifty-five delegates from 12 states journeyed to Philadelphia in May of 1787 to discuss the "exigencies of the Union." What emerged four months later, after a sweltering summer of debate, conflict and compromise, was a blueprint for liberty and the just rule of law—the United States Constitution.

It was a time of crisis for the young nation. Although the British had been defeated, and the Declaration of Independence had been signed more than a decade before, in the spring of 1787 the United States of America was a nation united in name only.

The Articles of Confederation, drafted in 1777, presumed to establish "a firm league of friendship" among the states. What the Articles did not do was create a central authority with sufficient power to govern the nation effectively.

Under the loosely framed Articles, Congress had no power to collect taxes, raise armies, or regulate commerce. In the absence of an overriding authority, the states assumed the power of independent nations. They were free to issue their own currency, levy their own taxes—while ignoring the national debt—and restrict trade with neighboring states.

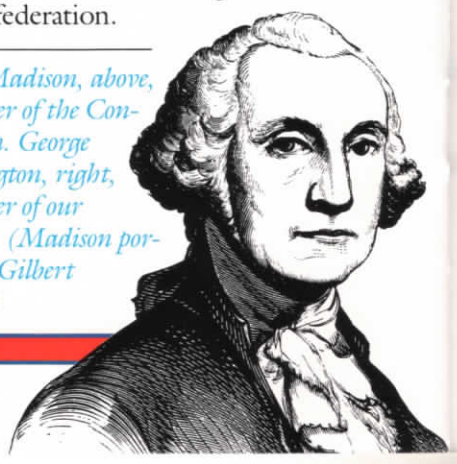
The war for independence had unified the colonies in mutual defiance of Great Britain. "We must all hang together, or, most assuredly, we shall all hang separately," Benjamin Franklin had noted at the signing of the Declaration of Independence in 1776. But the Union was rent by strong conflicting interests once independence was won. Every state was burdened by enormous debts, and the taxes imposed fell heavily on the citizenry.

In the fall of 1786, Captain Daniel Shays, a Revolutionary War veteran, led an armed revolt against the state courts of Massachusetts to prevent foreclosures on tax-delinquent farmers. The rebellion was eventually suppressed by the state militia, but the incident sparked fears of similar uprisings in other states.

The Bettmann Archive

George Washington was alarmed by the mounting chaos. "There are combustibles in every state which a spark might set fire to," he wrote to James Madison, a young scholar-politician from Washington's home state of Virginia. At the urging of Washington, Madison, and other influential leaders, Congress called for a meeting of state delegates to discuss revising the Articles of Confederation.

James Madison, above, the father of the Constitution. George Washington, right, the father of our country. (Madison portrait by Gilbert Stuart.)



The delegates to that historic convention, who would later come to be known as the "Founding Fathers," were an elite, eclectic group of statesmen, scholars, planters and merchants. Most were young, more than half were lawyers, and 42 had been elected to Congress. Many of the delegates already had national reputations.

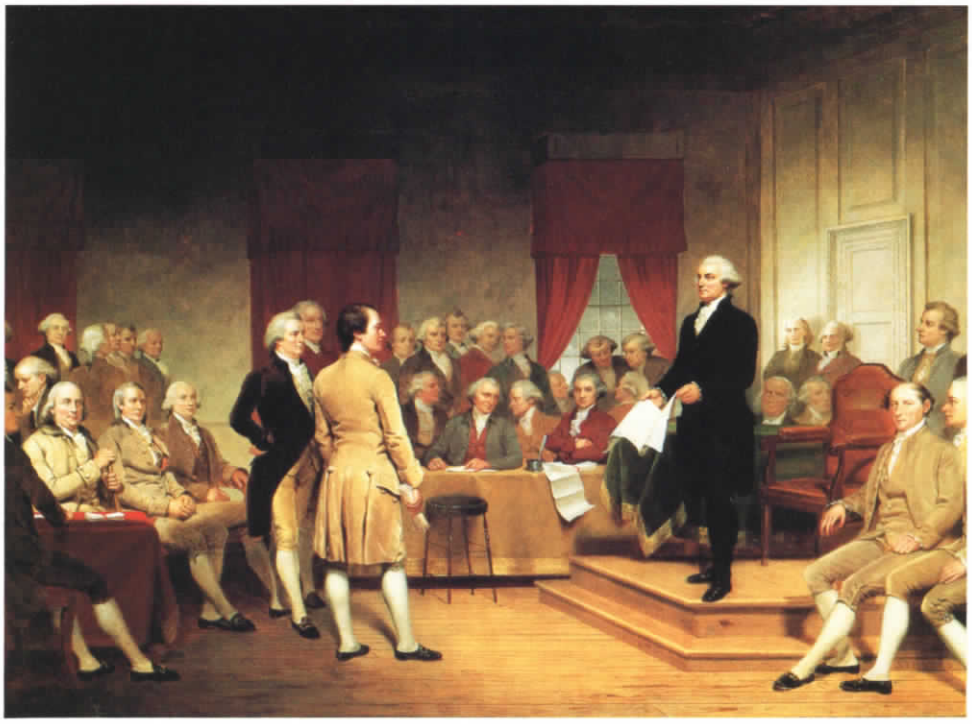
George Washington attended. So did Alexander Hamilton, James Madison and Benjamin Franklin. But Patrick ("Give me liberty or give me death") Henry boycotted the gathering, saying he "smelled a rat in Philadelphia tending toward monarchy."

When Thomas Jefferson, who was overseas serving as U.S. envoy in Paris, learned who would be at the convention, he called them "an assembly of demigods." Certainly, they were men of strong opinions and diverse political philosophies.

At one extreme were men such as Alexander Hamilton, a spokesman for the aristocratic principle, who believed in an all-powerful central authority composed of a ruling elite. Hamilton favored a senate and chief executive appointed for life.

At the other pole were the agrarian democrats, like George Mason of Virginia, who favored the weakest possible federal government consistent with a confederation of states. Mason, a wealthy landowner, also championed the rights of the individual against the tyranny of the state and argued tirelessly for the inclusion of a Bill of Rights in the original framing of the Constitution. (The Bill of Rights was added four years later in 1791.)

Somewhere in between these two extremes were men like Washington, Monroe and Franklin, who favored a strong central government that would abridge—but not eliminate—the sovereignty of the states.



Virginia Museum of Fine Arts, Richmond

Although the delegates were sharply divided over the exact form that any new system of government should take, the pressure for compromise was strong. If the convention failed to agree on something better than the clearly unworkable Articles, the Union itself might not survive. "What a triumph for our enemies," George Washington wrote, "to find that we are incapable of governing ourselves, and that systems founded on the basis of equal liberty are merely ideal and fallacious."

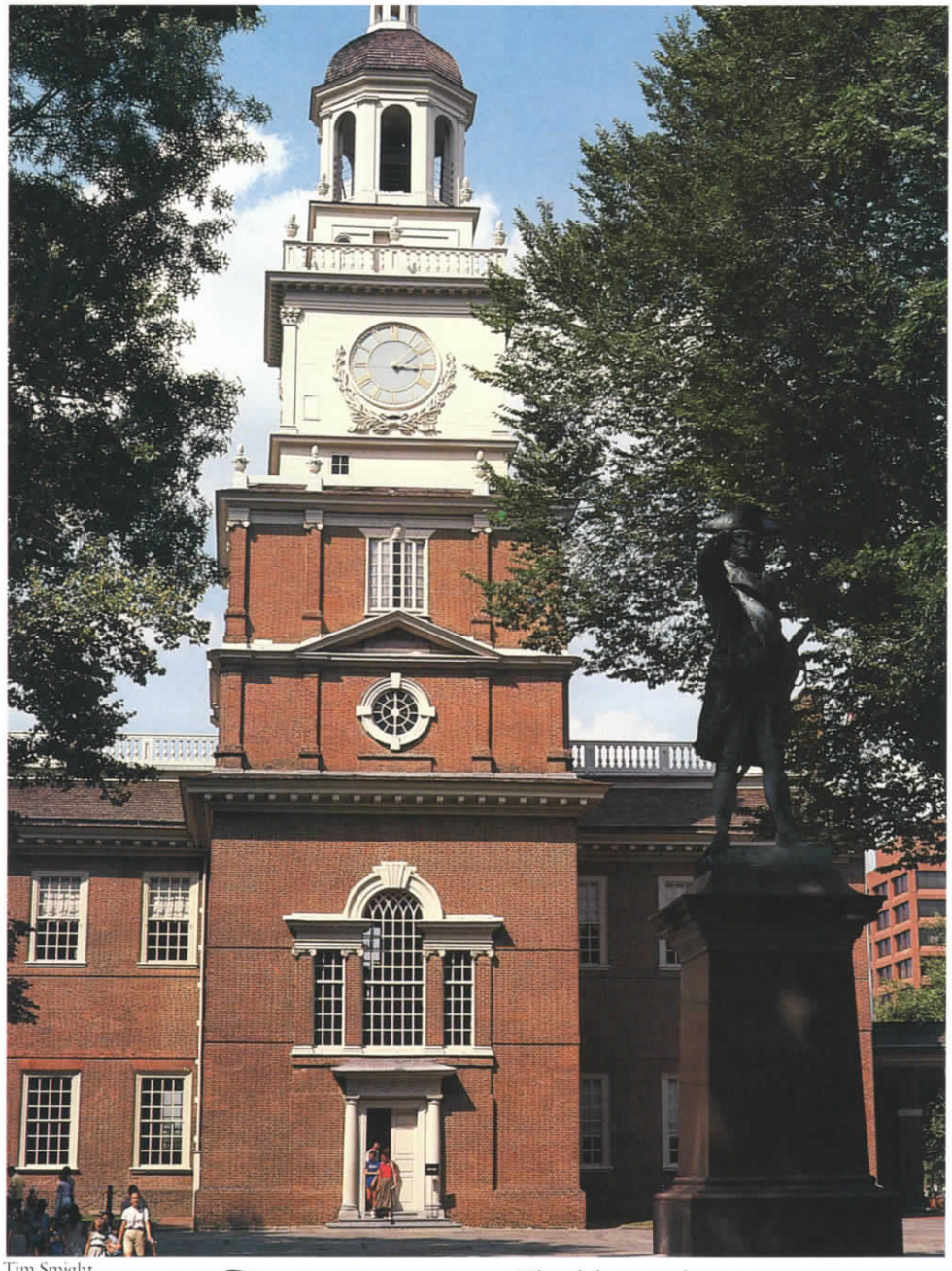
The convention got down to business in late May of 1787, the delegates gathering at what was then called the State House (now Independence Hall). They chose a large, airy chamber for their daily debates—the same room where the Declaration of Independence had been signed. The room was about forty feet square, with a high ceiling and wide, high windows on two sides. The delegates sat at tables covered in green felt.

George Washington, nominated to preside over the convention, was installed in a chair facing the delegates. Washington, then 55, enjoyed enormous prestige as a hero in the War for Independence. As president of the convention, Washington did not feel free to enter the debates—but his formidable presence served to remind the delegates of the gravity of their mission.

One of the first decisions of the delegates was a momentous one: they agreed to keep the content of their debates secret. No information was to be released to the press. No vote would be binding until a final agreement was struck.

One can easily imagine the media uproar such a decision would provoke today; even then it was controversial. When Thomas Jefferson heard about the rule of secrecy, he wrote a letter protesting "so abominable a precedent."

Above, "Washington Addressing the Constitutional Convention," painted by Julius Brutus Stearns.



Tim Smight

Culver Pictures

The delegates, however, were convinced that keeping the debates secret would allow them to speak more candidly and to change their minds more freely. Madison observed years later that "no constitution would ever have been been adopted by the Convention if the debates had been made public...had the members committed themselves publicly at first, they would have afterward supposed consistency required them to maintain their ground, whereas by secret discussion no man felt himself obliged to retain his opinions any longer than he was satisfied of their propriety and truth."

The starting point for discussing a stronger central government was the Virginia Plan, devised in large measure by James Madison—who would later be called the "father of the Constitution." Madison, then 36, was the son of a wealthy Virginia planter. He was a small, soft-spoken man whose large eyes gave him an owlish look. Madison was not only a skilled politician but a political scholar. Having studied past attempts to create stable democracies, he tried to design a system with sufficient checks and balances to prevent any majority interest from wielding tyrannical powers.

The Virginia Plan called for dividing the government into three branches—a legislature of two houses, an executive and judiciary. Although most delegates accepted the basic principles of the plan, the specifics were bitterly contested.

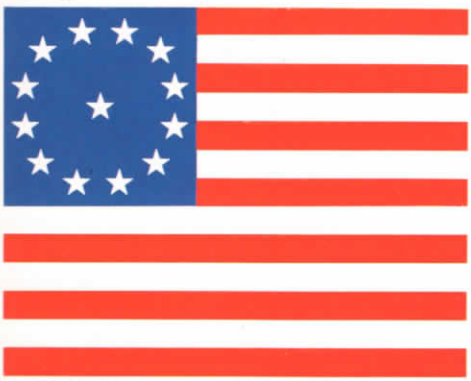
The crucial points of contention lay in the proposal for what sort of power each house of the legislature would have, and on what numerical and voting basis representatives would be chosen. The large states favored representation based on population. The small states wanted to preserve the equal voice they enjoyed in the confederacy.

The issue of how the members of the legislature would be selected was another sticky point. Many of the delegates were suspicious of direct elections; democracy was often equated with mob rule. Elbridge Gerry of Connecticut lashed out against elections by the people. "The evils we experience," Gerry said, "flow from the excess of democracy. The people are the dupes of pretended patriots."

A compromise was struck on the selection of representatives. Members of the lower chamber, the House of Representatives, would be elected by the people. Members of the Senate, the upper house, would be chosen by state legislatures—a clause in the Constitution that survived until 1913, when the 17th Amendment gave the selection to the people.

Independence Hall, above left, the site of the Philadelphia Convention.

The issue of population-based representation, however, nearly tore the convention apart. After weeks of wrangling, it was clear that the small states would never agree to any plan that seemed to leave them at the mercy of their more populous neighbors. Gunning Bedford of tiny Delaware attacked the large states for acting in their self-interest, accusing them of trying to break up the Union.



With the convention on the verge of collapse, an ingenious compromise was proposed. Roger Sherman of Connecticut suggested that each state have proportional representation in the lower house and an equal vote in the upper house. Benjamin Franklin then proposed a concession to the large states, which were determined not to let the small states tell them how to spend their money: all money bills would originate in the lower house.

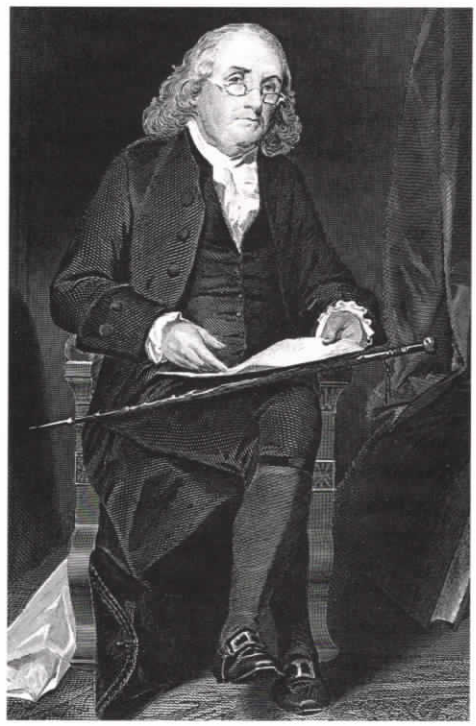
On July 16, the "Great Compromise," as it came to be called, was adopted. It saved the convention from collapse, and quite possibly, the Union from dissolution.

Emboldened by this breakthrough, the delegates next attacked the issue of the chief executive. In discussing what title the chief executive should have, the convention pondered various choices, such as "Protector" and "His Excellency." Benjamin Franklin favored "His Mightiness, the President of the United States." Fortunately, the delegates settled for the simpler "Mr. President."

Franklin, then 81 and in declining health, was one of the more colorful characters at the convention. Racked by severe pain from kidney stones, he often rode to the State House in a sedan chair borne by local convicts—a mode of transportation he found less jarring than horse-drawn coach.

In the debate over the presidency, one of the most flamboyant delegates came to the fore, 35-year-old Gouverneur Morris of Pennsylvania. Six feet tall, he stumped around on a peg leg, the result of a carriage accident. Morris declared that the president "must not be the flunky of Congress." Morris saw "the one great object of the executive [to serve as the] guardian of the people against legislative tyranny."

On the issue of whether the president could be impeached, Morris opposed until Franklin pointed out that this left assassination as the only option for removing a bad president. "My opinion has changed," Morris said.



Culver Pictures

Benjamin Franklin, above right, favored "His Mightiness." Left, an early version of Old Glory.

By the end of August, the convention had agreed to give Congress the power to regulate foreign trade and interstate commerce, borrow money, and collect taxes.

On the morning of September 17, the delegates gathered in the big square east room to sign the Constitution. Out of 55 who had attended at one time or another, only 41 were present. Members sat while the Constitution was read aloud.

At the close of the proceedings, Franklin remarked, "I consent, Sir, to this Constitution because I expect no better and because I am not sure it is not the best."

In summing up the achievement of the U.S. Constitution, the historian Samuel Eliot Morrison wrote: "The Federal Constitution set up what every earlier political scientist had thought impossible, a sovereign union of sovereign states. This reconciling of unity with diversity, this practical application of the federal principle, is undoubtedly the most original contribution of the United States to the history and technique of human liberty." 76

Story by Clark McCann, Unocal staff writer

HELP US REMAKE HISTORY

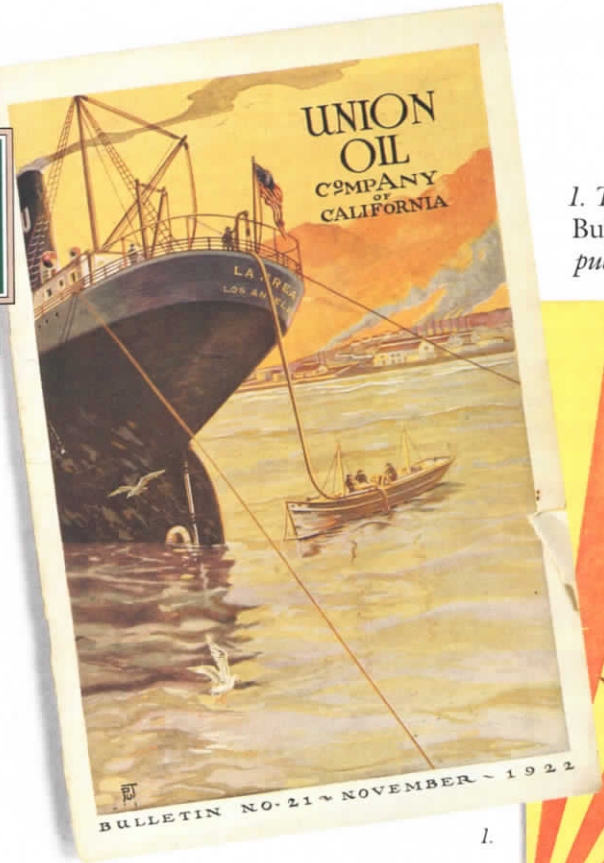
We're making history—and we need your help!

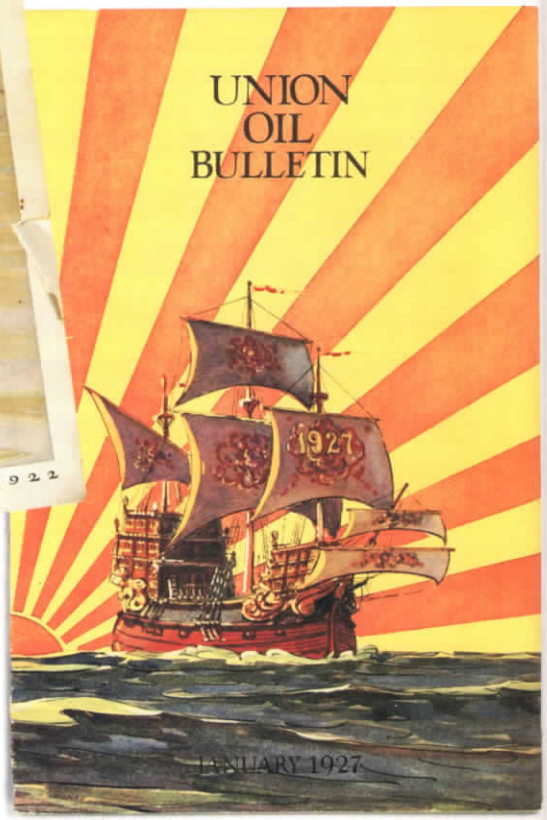
In 1990, Unocal will be celebrating 100 years as an independent earth resources company. We will be documenting the company's colorful history in many ways in the months leading up to the centennial celebrations. And we'd like to do the best job we can. So we are asking now for your help in adding to the company archives.

The archives already provide an impressive look back over Unocal's history. Critical business documents are stored in company records centers, historical artifacts are on display at the California Oil Museum in Santa Paula, and collections of photographs and publications are housed in Unocal Center and in the Schaumburg office.

However, we know that many items of interest must have fallen through the cracks over the years—and we hope some of our readers can supply more information and artifacts. We're looking for letters, publications, photographs, souvenirs—anything that sheds a little more light on the company's past. If you have an anecdote that illuminates a significant company event or describes how things were done, write us a letter. The more information we get, the better.

The history we're documenting is a lively one. Our company's founders were in on the oil boom at the beginning—with Lyman Stewart making his first investment in 1859, just a few months after the world's first successful oil well was drilled not far from his home in Pennsylvania.





1. Two covers from the Union Oil Bulletin, *a company publication first published in March of 1921.*

2. Medal of Honor awarded to Union Oil Company of California in the early 1900s "for investigations in the field of motor lubricants and distinct improvements made therein."

3. In the 1930s, drivers kept current with Union Auto Fuses.

4. Also in the 30s, they used to "travel right with Travel-Lite," prefocused 6-8 volt Travel-Lite Auto Bulbs.

3.

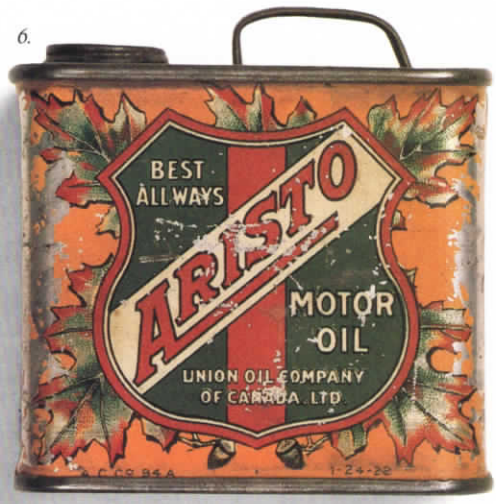
4.

5.

5. A Los Angeles oil field, late 1800s.

6. A can of Aristo Motor Oil, circa 1922. One advertisement claimed, "It could sell for twice as much and not be a better oil."

6.



7.

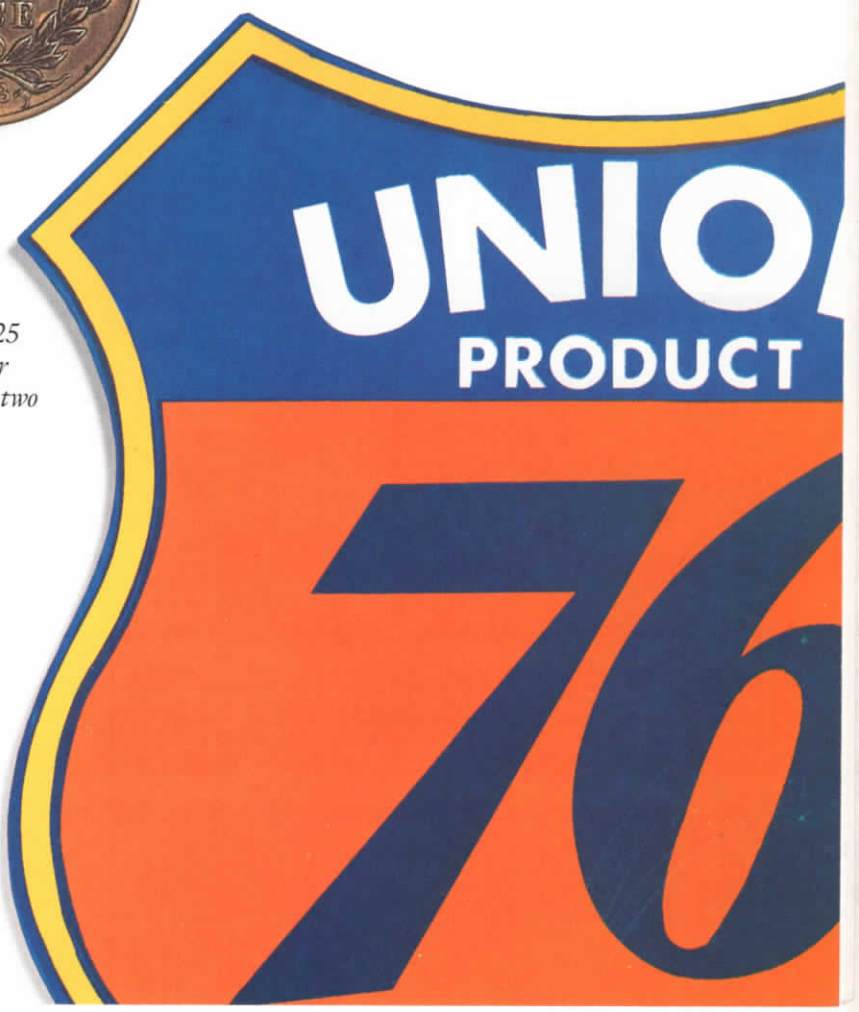
7. Service, anyone? In the 1940s, women took non-traditional jobs as service station attendants to help the war effort.

8.

8. This 76 lucky medal was distributed by Union Oil to advertise the company's gasoline in 1932.

9. In 1960 the premium gold credit card appeared, quite a step up from one forerunner—a 1925 card made of paper and valid for only two months.

9.



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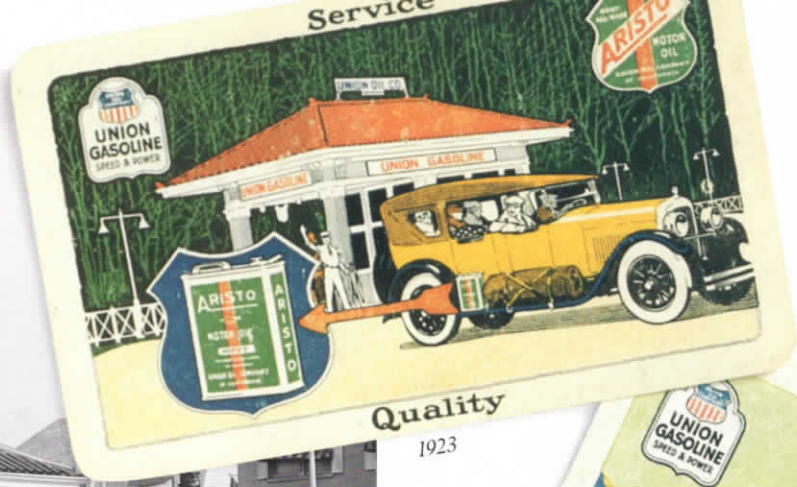


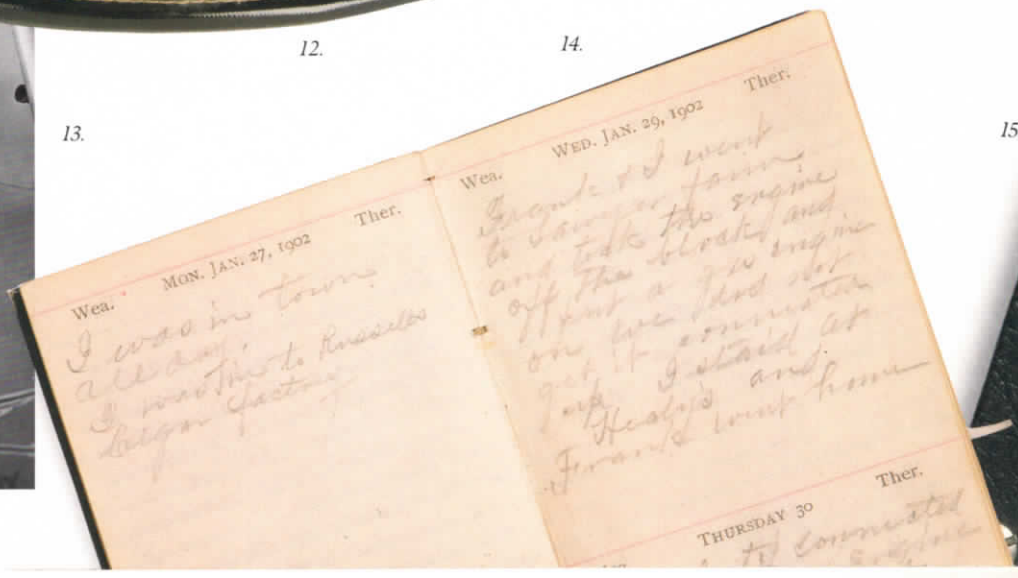
10.

1923

1924

12.

13.



14.

15.

10. Plastic pocket calendars were distributed as promotional items.

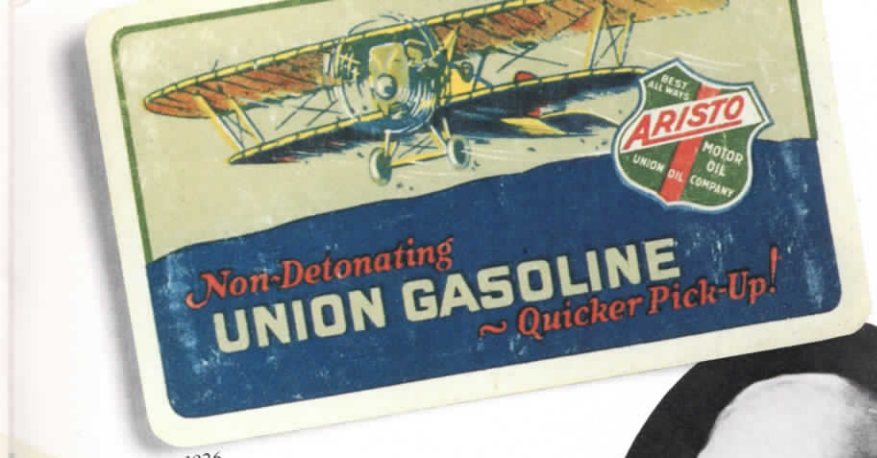
11. You "filled 'er up" with Union Gasoline at stations like this one in the 1920s.

12. This hat was worn by a Union gas station attendant around 1933.

13. July, 1929. Marvel Crosson set a new women's altitude record of 24,000 feet in her Union-sponsored Ryan Broughaam airplane.

14. In the summer of 1883, Wallace Hardison became partners with Lyman Stewart. This is the diary he kept in 1902.

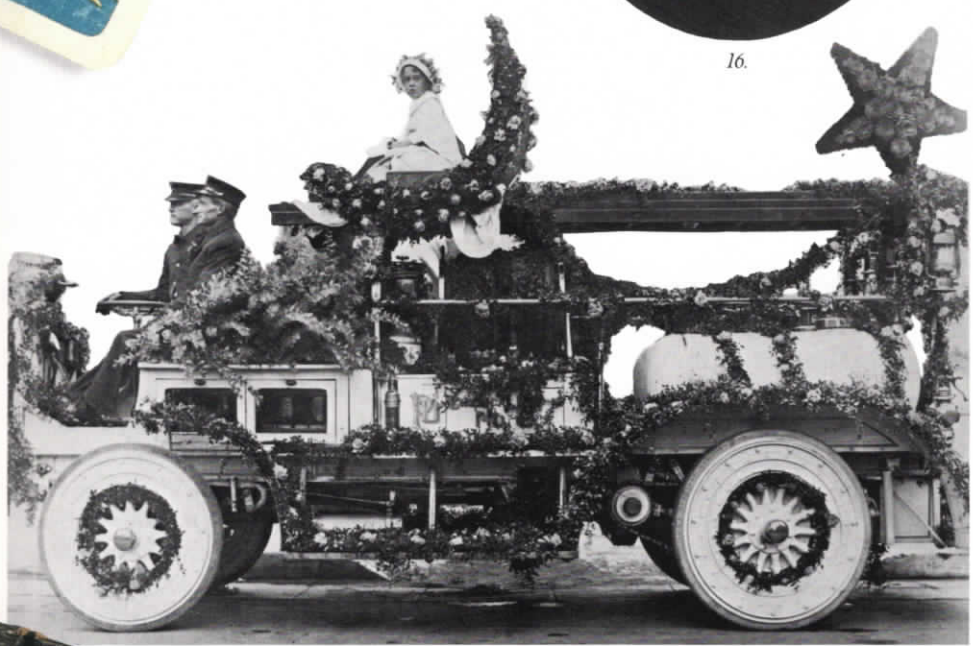
15. A Union Oil product book from the 1920s.



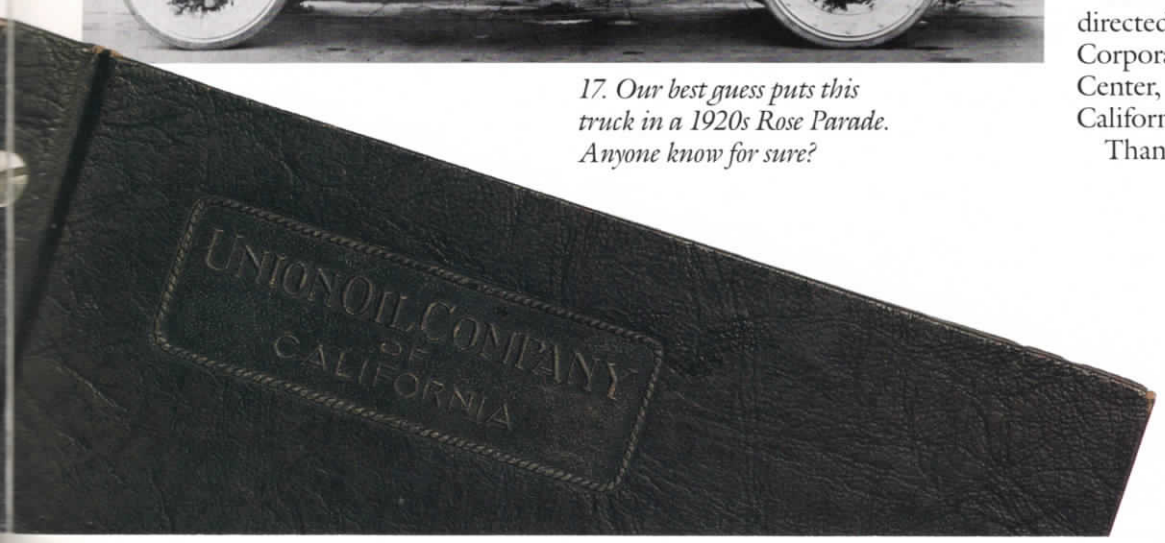
1926

16. *Pennsylvania oil man Lyman Stewart, founding father of Union Oil.*

16.



17. Our best guess puts this truck in a 1920s Rose Parade. Anyone know for sure?



In 1883, Stewart and his partner Wallace Hardison transferred their operations west to test the promise of a potential oil boom in California. It took uncommon determination back in those days, when oil hunters relied on luck and instinct more than science. But Stewart and Hardison met with enough success to combine three of their operations to form Union Oil Company of California on October 17, 1890.

Stewart, Hardison and the people who worked with them had the vision to stick with the difficult and challenging job of finding crude oil, refining it into useful products, and getting it to market. Stewart's development of the oil burner boosted fuel oil into a competitive market position with coal. With the advent of the automobile and increasing needs for gasoline and lubricants, the potential for growth became almost limitless. Before long, the now-familiar Sign of the 76 appeared along roadways and became synonymous with the finest in products and service.

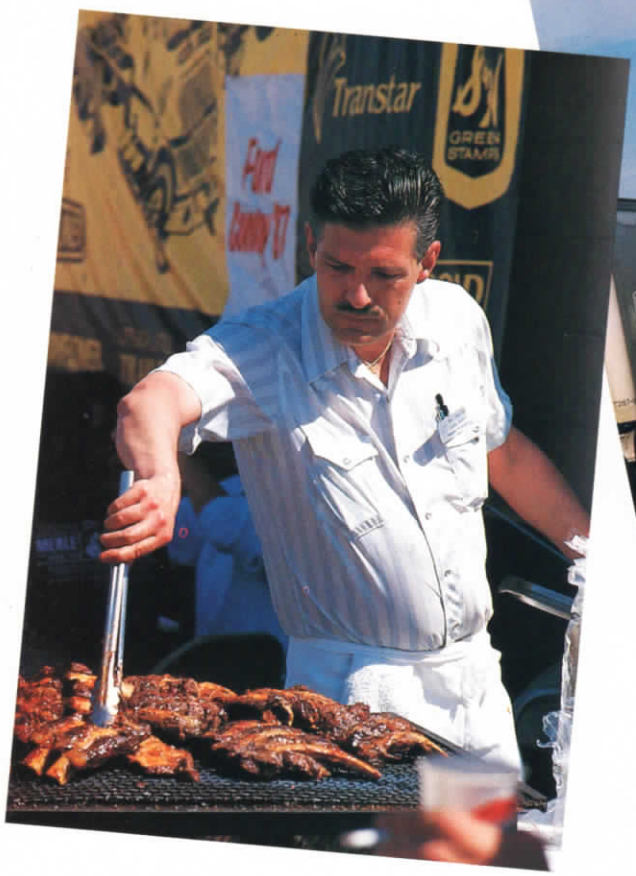
Over the years, the company has thrived—driven by dynamic leadership and the individual talents of employees, and supported by the loyalty of customers and shareholders. A strong emphasis on planning for the long term and a dedication to innovation and research have kept Unocal in the forefront of industry developments.

In the coming months, as we approach our centennial year, you will be hearing and reading more about the company's history. We hope you'll play a role by helping us gather all the material necessary to tell the story.

Please write to us with a brief description of any historical items you would like to donate or lend. Include your phone number. We will follow-up.

All letters and inquiries should be directed to: Karen Sikkema, Director, Corporate Communications, Unocal Center, P.O. Box 7600, Los Angeles, California 90051.

Thank you!

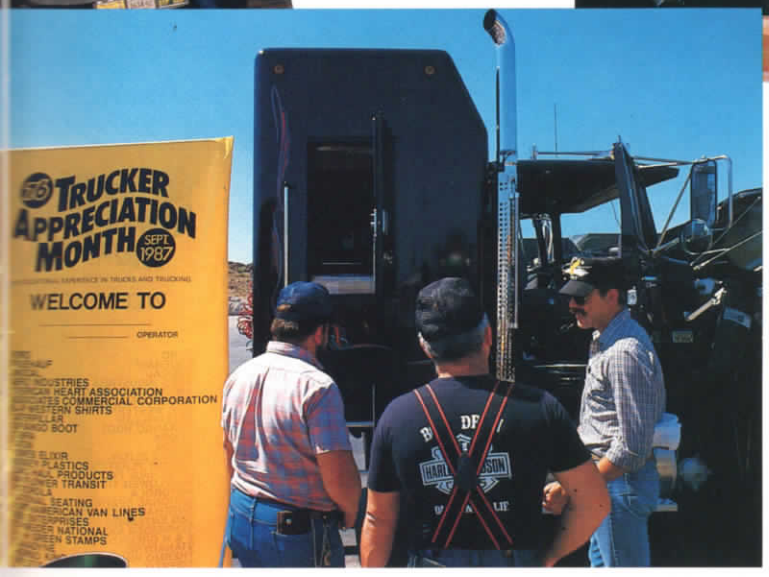


Saying Thank You to Truckers

Kingman, Arizona, a town of 9,500 located in the northwest corner of the state, sits astride Interstate 40 near the California border. Outside of Kingman, the arid land is empty and silent. But I-40 itself is a different story. As one of the nation's major east-west trucking arteries, the interstate courses with activity around the clock. An endless procession of big rigs roars over the twin ribbons of highway, carrying all manner of goods, products and agricultural produce between California and points east.

To the drivers of these long-haul trucks, Unocal's large and bustling 76 Auto/TruckStop in Kingman is a familiar and welcome oasis. Situated at the junction of I-40 and Highway 90, which snakes north to Las Vegas, the Kingman facility is one of the most heavily patronized truckstops in the west. As do all Unocal 76 Auto/TruckStops nationwide, it offers fuel, food, maintenance, a store and other services to truckers and motorists, all in one convenient location.

At mid-afternoon on a Friday in September, activity here was at a peak. More than 100 trucks were parked side by side on the sprawling lot. Others moved in and out in a continuous stream, pausing to fill their tanks at the canopied fuel islands. The air reverberated with the sounds of rumbling diesel engines and whooshing brakes.



Some truckers, especially those westbound drivers nearing the end of a cross-country run, were understandably anxious to get back on the road. Here they could fuel up, take care of other needs and move out quickly—one of the attractions of a 76 Auto/TruckStop. But on this afternoon, something out of the ordinary caused many drivers to linger awhile.

A large section of the lot had been roped off and festooned with flags. Three gleaming new trucks, their hoods and doors open and beckoning, were on display, along with a brand new trailer. Various other trucking exhibits and booths were set up nearby, ringing an area decked out with chairs, picnic tables and a stage. Most enticing of all, a large barbeque was smoking away, manned by a cook who looked like a master griller.

As the mouth-watering aromas of ribs, corn on the cob and garlic bread began wafting through the air, a country and western band took the stage and kicked into a rollicking version of an aptly titled tune: "Highway 40 Blues." When curious drivers wandered over from their trucks to investigate the commotion, their road weariness seemed to melt away like butter on the roasted ears of corn. Especially after they learned that the food, entertainment and exhibits were all for them, and all free of charge.

The occasion was the Kingman Auto/TruckStop's observance of "Trucker Appreciation Month," a first-ever national event staged in September by Unocal at dozens of the company's auto/truckstops across the nation.

"A large number of professional drivers are loyal customers of ours," says Rial Greenman, supervisor of national auto/truckstop promotions. "Their support has helped Unocal build the largest network of truckstops in the nation. We decided that holding a Trucker Appreciation Month would be a good way to say thank you."

Unocal's auto/truckstop system currently has 148 outlets located on U.S. interstate highways. Over the years, many of these auto/truckstops—each of which is run by an independent operator—have held driver appreciation events on their own. But an event on national scale had never been attempted.

To ensure that drivers would have ample opportunity to take part in Trucker Appreciation Month festivities, a series of three-day events was scheduled throughout the month at 56 participating Unocal truckstops across the nation. September was chosen because the weather would still be warm enough for outdoor activities, but the main tourist season would be over.

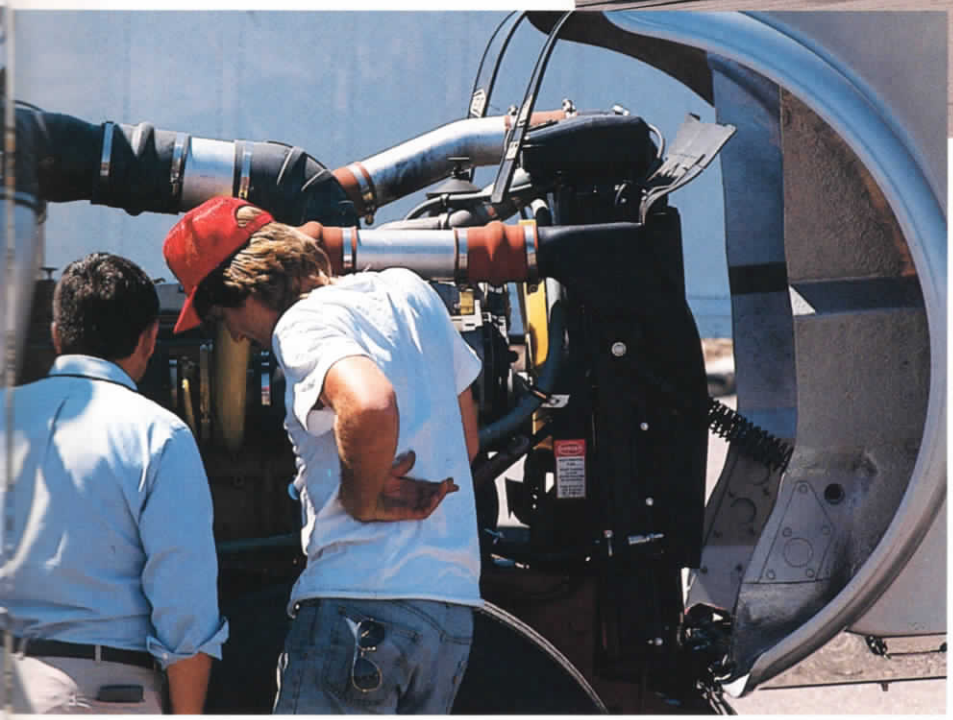
"We wanted truckers to know that these events were being held especially for them," Greenman explains.

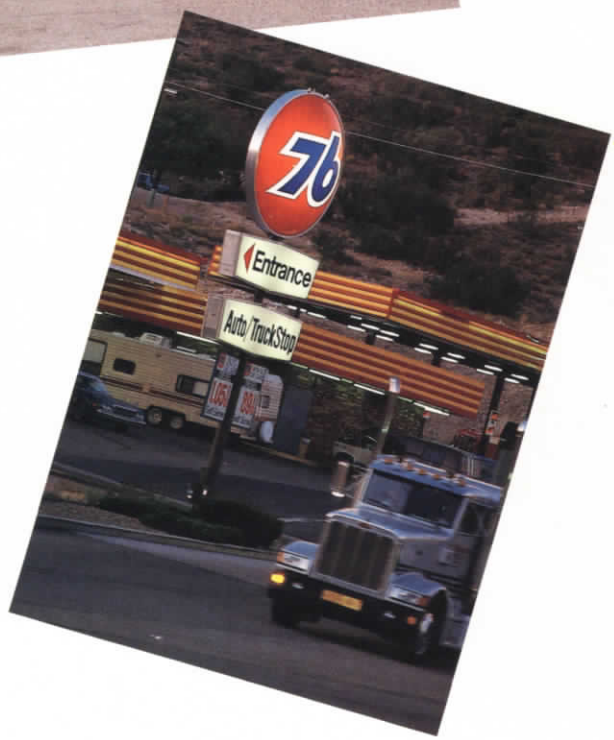
Each event, organized and run by the individual truckstop operators, featured free food and entertainment, exhibits, drawings and contests for professional drivers. Unocal provided national support through advertising in *Road King*, a magazine published by the company and distributed to 225,000 professional truck drivers. Unocal also donated prizes and helped line up more than 20 exhibitors and corporate sponsors. Total value of the food, entertainment and prizes provided by Unocal and these sponsors topped $1 million.

Hundreds of items, from CB radios and truck accessories to boots and clothing, were given away at each participating auto/truckstop. The festivities culminated on October 16, with a national prize drawing held at the American Trucking Association headquarters in Washington, D.C. Among 40 major items awarded by co-sponsors that day were a brand new Ford truck, a Fruehauf trailer, five National Seating Cush-N-Aire seats, three Eaton truck transmissions, and 20 pairs of Unocal radial truck tires.

One of the two grand prizes—a Ford CLT-9000 tractor, equipped to driver specifications—was won by owner-operator Nick Cassizzi of Alexander, North Carolina. The other grand prize—a Fruehauf Enduro Reefer trailer, fully equipped by Thermo King and Aero Industries—was won by trucker Alan Rice of Corning, Arkansas.

Each Trucker Appreciation Month event also served as an informational and educational exchange for truckers.





In addition to providing exhibits and displays, sponsors had representatives on hand to talk with drivers about truck and trailer care, trucking technology and safety. Financial consultants were present at some locations, along with fleet representatives to discuss job opportunities.

Each event also had a booth manned by one or more health care experts. Drawn from local hospitals, fire departments and Red Cross branches, these volunteers offered advice and information on such topics as health maintenance, fitness and nutrition. Free blood pressure tests were also offered to drivers. The impetus for the health care booths was an ongoing health information program that Unocal has developed for professional truck drivers over the past year.

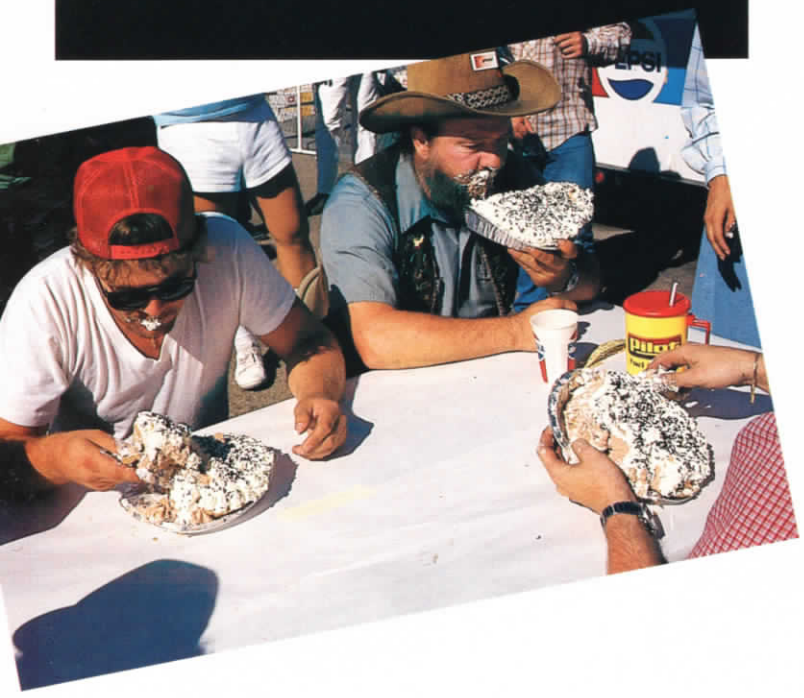
"Truckers are an important and unique population that can benefit greatly from health education," says Mary Schmitz, a health educator in Unocal's medical department. "We felt that a health program aimed at truckers would be a valuable service, and a way to help differentiate our truckstops from the competition."

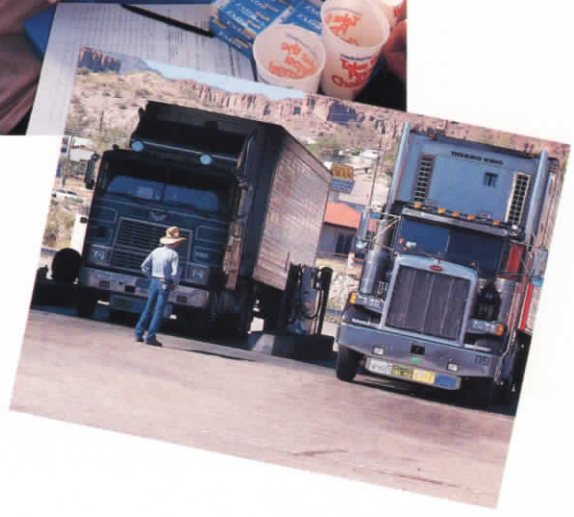
Working with Clint Mercer, manager for national auto/truckstop programs and merchandising, Schmitz interviewed dozens of professional drivers at Unocal truckstops during the past year. Additional input came from the truckstop operators.

"We were amazed at the high level of interest among truckers about health issues," Schmitz says. "Because of the particular demands and nature of their work, truck drivers have many unique health concerns."

Among the problems mentioned most by drivers were back ailments, intestinal disorders, cramps and fatigue. "The long hours of driving can be quite strenuous, and there is also a lot of job-related stress," Schmitz says. "Truckers are often away from their families, are confined to their cabs for long periods, and have irregular meal and sleep patterns."

Using the survey results, the medical department produced a series of brochures for distribution at Unocal auto/truckstops—all geared to meet the special health care needs of professional drivers. Topics covered included nutrition, alcohol and drugs, blood pressure, stress and back pain.





Providing health care booths at the Trucker Appreciation Month events was a natural extension of the health information program. In addition to giving health tips and blood pressure tests, volunteers staffing the booths also had drivers fill out extensive medical questionnaires. Blood pressure test results and questionnaires from all 56 events were sent to Unocal Center in Los Angeles for evaluation by the medical department. The data will be used to develop additional health education materials for truckers.

All in all, the combination of information, prizes, food and fun dispensed during Trucker Appreciation Month helped make the event a resounding success from coast to coast. More than 100,000 drivers participated in the festivities. Many have expressed their thanks and appreciation, both to Unocal and the individual auto/truckstop operators.

"Several drivers made a point of coming by to thank me personally," says Bruce Dorbeck, operator of a 76 Auto/TruckStop in Tallulah, Louisiana. "We had a fantastic turnout, and the response shows that we're getting our message across: we care about our customers."

"Our operators have been very enthusiastic about the program," adds Greenman. "Trucker Appreciation Month required a lot of planning and cooperation on their part, and it paid off in many ways. Some locations have reported their largest fuel sales volumes ever."

A second Trucker Appreciation Month is already being planned for 1988, and it may become an annual event. That would suit Jerry Gatlin, operator of the Kingman 76 Auto/TruckStop, just fine.

"Many truckers who stop here are steady customers," Gatlin said, as he greeted drivers during the festive afternoon in Kingman. "To show that we value and appreciate their business, I think we've got to give something back to them. Events like this, along with Unocal's national support, help to accomplish that." *T.S.* 76

SERVICE UNOCAL 76 AWARDS

CORPORATE

35 YEARS **John Flynn,** Unocal Center

30 YEARS **Joseph B. Jenkins,** Unocal Center
D.H. Richardson, Midland, Tx.

25 YEARS **Earl L. Robles,** Unocal Center

20 YEARS **Paul L. Dunn,** Schaumburg, Il.
Ronald E. Jenkins, Unocal Center
Christina L. Perez, Unocal Center
Eugene S. Prochnow, Unocal Center
Carolyn C. Tellez, Unocal Center

15 YEARS **Ana M. Arvizu,** Unocal Center
Gilbert M. Davis, Unocal Center
Don L. Hartley, Coalinga, Ca.

10 YEARS **Dennis E. Butler,** Houston, Tx.
Karen K. Dundas, Unocal Center
Richard R. Myers, Houston, Tx.
Charles H. Saito, Unocal Center
Robert M. Schlax, Unocal Center

ENERGY MINING

10 YEARS **Terrence L. Larson,** Parachute, Co.

REAL ESTATE

20 YEARS **Robert A. Hawkins,** Unocal Center

SCIENCE & TECHNOLOGY

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25 YEARS **Darryl L. Jones,** Brea, Ca.

20 YEARS **Robert G. Alex,** Brea, Ca.
Paul J. Durning, Brea, Ca.
Gary C. Graham, Brea, Ca.
Gaylen M. Knutson, Brea, Ca.
Paul D. Orosz, Brea, Ca.
Richard L. Sloggy, Brea, Ca.
Marcia R. Spriggins, Brea, Ca.

15 YEARS **Robert L. McCollom,** Brea, Ca.
Michael J. Tuffley, Brea, Ca.

10 YEARS **William C. Allen,** Brea, Ca.
Joseph P. Gee, Brea, Ca.
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ENERGY RESOURCES

OIL & GAS

35 YEARS **Raymond L. Hazard,** Placentia, Ca.
C.R. Marshall, Santa Paula, Ca.
Joseph Eugene Navarre Jr., Houma, La.
Lawrence F. Sprague, Coalinga, Ca.

30 YEARS **William H. Coats,** Woodward, Ok.
Bren Clark Dehn, Ventura, Ca.
A.M. Escalante, Jackson, Ms.
Harry L. Simon, Lafayette, La.

25 YEARS **Herbert J. Adams Jr.,** Houma, La.
Adolph A. Anders, Houston, Tx.
Harry J. Arnold, Taft, Ca.
Malcolm P. Clark, Orcutt, Ca.
David S. Crawford, Unocal Center
Donald V. Dunn, Orcutt, Ca.
Chester E. Haase, Santa Maria, Ca.
Richard E. Howe, Anchorage, Ak.
Janet A. Lane, Pasadena, Ca.
Paul P. LeBlanc, Lafayette, La.
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Paul Legendre, Houma, La.
Kenneth L. Mon, Brea, Ca.
Walter S. Temple, Unocal Center

20 YEARS **Robert G. Beason,** Moab, Ut.
Susan D. Bond, Midland, Tx.
Betty B. Harris, Midland, Tx.
Sharon J. Hitt, Houma, La.
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Dalton L. Hudson, Healdton, Ok.
Benita J. Miller, Midland, Tx.
Diana Morales, Unocal Center
John E. Oneil Jr., Orcutt, Ca.
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Ronald L. Spratt, Houston, Tx.
Fred D. Tuttle, Orcutt, Ca.
Judy L. Winder, Pasadena, Ca.

15 YEARS **John David Amundsen,** Anchorage, Ak.
Willie J. Bland, Orcutt, Ca.
Houston L. Coor, Gillette, Wy.
August T. Fernandez, Orcutt, Ca.
Ronald A. Frison, Anchorage, Ak.
Robert M. Garrett, Orcutt, Ca.
Donald J. Gaspard, Lafayette, La.
Thomas L. Hough, Clay City, Il.
S. Allen Jackson, Pasadena, Ca.
Ronnie C. Lancaster, Van, Tx.
Dianna F. Lecompte, Houma, La.
Manuel H. Nunez, Orcutt, Ca.
Norris L. Proctor, Moab, Ut.
Dennis L. Roberts, Ventura, Ca.
Jesse Ruiz, Orcutt, Ca.

10 YEARS **John Alvara,** Orcutt, Ca.
Robert W. Ball, Grayling, Mi.
Paul A. Bourgeois Jr., Lafayette, La.
Patricia A. Bradford, Orcutt, Ca.
Virginia E. Brock, Ventura, Ca.
Edward Castillo, Orcutt, Ca.
Jan A. Dyckes, Ventura, Ca.
Tim J. Espinosa, Compton, Ca.
James A. Foster, Santa Paula, Ca.
Gustavo G. Garcia, Bakersfield, Ca.
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Stephen L. Heiter, Bakersfield, Ca.
Johnny S. Johnson, Taft, Ca.
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David R. Lomenick, Healdton, Ok.
Tony R. Martinez, Coalinga, Ca.
Justin P. Matthews, Lafayette, La.
John D. Mayhew, Ventura, Ca.
Saul A. Navarro, Bakersfield, Ca.
Michael P. Nelson, Ventura, Ca.
Chester E. Newman, Lafayette, La.
Dixon A. Oriola, Ventura, Ca.
Jefferey R. Parker, Piru, Ca.
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Frank F. Duffy, Wilmington, Ca.
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Kenneth H. Lawson, Beaumont, Tx.
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Betty A. Shea, Schaumburg, Il.
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Robert A. Dowd, Schaumburg, Il.
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R. Charles Gagnon, Schaumburg, Il.
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E. Robert Kern, Columbus, Oh.
John Laborn, Schaumburg, Il.
Randolph R. McKay, Wilmington, Ca.
John Francis McNeely, Schaumburg, Il.
Gail McWhorter, Schaumburg, Il.
Ned L. Melvin, Atlanta, Ga.
Stanley A. Miller, Wilmington, Ca.
Thomas P. Mitchell, Beaumont, Tx.
John Ontiveros, San Francisco, Ca.
Les W. Schalla, Schaumburg, Il.
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Paul D. Durham, Chicago, Il.
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Varut Komalarajun, Wilmington, Ca.
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Lyons Oil, Inc., Plainview, Mn.
Oilfield Lubricant Service, Inc., Houma, La.

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Marilyn L. Berg, Brea, Ca.
Thomas G. Burg, Kenai, Ak.
James E. Cooper, Kenai, Ak.
Kenneth R. Cox, Kenai, Ak.
William H. Egbert, Kenai, Ak.
Timothy E. Elder, Kenai, Ak.
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Nathaniel Forte, Charlotte, N.C.
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Theodore Jackson, Bridgeview, Il.
Randall L. Knowles, Kenai, Ak.
John O. Landua, Kenai, Ak.
Keith E. Laurie, Kenai, Ak.
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John G. Overway, Kenai, Ak.
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Cover: A huge crane looms over the 11-story-tall urea process unit at Unocal Chemicals' Kenai, Alaska fertilizer plant. The plant underwent a major upgrade this summer. Story on page 1. **Photo by Chris Arend.**

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