American Energy Policy in the 1970s

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Chapter 5

Diving into Deep Water

Shell Oil and the Reform of Federal Offshore Oil Leasing

Tyler Priest

The leasing of offshore territory for oil and gas exploration is one of the most vital but least understood aspects of American energy policy since World War II. For much of this period, offshore leasing was second only to income taxes as a generator of public revenue (usually taking in more from a single offshore lease sale than from all timber sales and onshore mineral leasing for the year combined). More important, it brought forth a huge landscape of industrial development in the ocean. In the Gulf of Mexico in 2012, after more than fifty years of federal leasing, there were nearly three thousand platforms servicing 35,000 wells and more than 30,000 miles of pipeline.

To the extent that historians have revisited the energy crisis of the 1970s, the offshore leasing story has faded amid the discussion about other policy issues, such as price controls and allocations, CAFE standards and other conservation measures, promotion of synthetic fuels, and nuclear power. Many policies introduced did not work as intended or did not endure. On the other hand, policies designed to increase the flexibility of conventional petroleum supplies, such as offshore leasing and the Strategic Petroleum Reserve, did achieve their intentions and remain a key aspect of U.S. energy governance.

Offshore leasing deserves our attention not only for its historical importance but also for its current policy relevance in light of simmering controversies over the management of offshore revenues, proposals to open up new frontier areas (Alaska, Florida, Virginia) to oil and gas exploration, and serious safety and environmental questions following the Macondo/*Deepwater Horizon* oil spill of 2010. The spill focused attention on the past and future of deepwater drilling operations in the Gulf of Mexico. But to assess the risks and challenges of the deepwater Gulf, we must first understand how and why oil companies began exploring there.

The deepwater (1,500 feet or deeper) oil developments in the Gulf of Mexico that began making headlines in the mid-1990s resulted from a major transition in the federal offshore leasing system that dates back to the 1970s. To understand this transition, we must examine how policy changes interacted with evolving technology and oil investment strategies, and how, especially in extractive industries such as offshore oil, environmental factors constrained policy, technology, and strategy.[1] Considering these interactions, in this essay I discuss the evolution of offshore leasing during the 1970s and 1980s from the perspective of Shell Oil, the most aggressive player in the offshore business, the industry's technological leader, and the company most actively involved in shaping federal offshore leasing policy.

Shell Oil's Deepwater Vision

"There's a romance about big, offshore structures," said Pat Dunn, Shell's manager of civil engineering, back in 1989. "There's something about seeing them out there on the frontier."[2] Since the time Shell Oil's New Orleans vice president Bouwe Dykstra teamed up with drilling entrepreneur Doc Laborde to build the submersible drilling vessel *Mr. Charlie*, Shell Oil had carried on a passionate affair with these structures. But as they rapidly evolved, words could hardly describe their mind-boggling size and complexity. In the 1970s, Shell led the industry in dramatically extending the depth threshold for fixed platforms from 350 feet to over 1,000 feet. In the 1980s, Shell's geoscientists and engineers continued to push the offshore frontier in both exploration and production, moving the industry to take another quantum leap, this time off the edge of the continental shelf into truly deep water of 3,000 feet and beyond.

Offshore was more than just a romance for Shell Oil Exploration and Production (Shell E&P). It was its heart and soul, a symbol of long-standing technological leadership, and a main source of income for the entire company. Offshore development was the key component of Shell's multifaceted strategy in the 1970s to expand the quest for energy resources. And the Gulf of Mexico remained the hotbed of activity. There, feverish exploration and platform installation followed the Arab embargo, with Shell's Cognac platform in 1,025 feet of water establishing a benchmark that redefined the concept of deepwater production. Yet, in the midst of the boom, many in the industry believed that the Gulf had begun to play out. Overall production was declining and ultra-deepwater work seemed technologically and economically unfathomable.

In the mid-1970s, Shell and other companies began to shift their long-range sights to other unexplored U.S. offshore provinces, such as the Atlantic basin, California, and Alaska. But political controversies, environmental opposition, and dry holes delayed or limited drilling in most of these areas. Desperate for new reserves, Shell once again staked its future on the Gulf. It embraced advanced seismic technologies, gambled on deepwater leases, and developed new deepwater platform and subsea systems that enabled production beyond the continental shelf. The deepwater play of the 1980s was a tough sell to some of Shell's directors, who were understandably concerned about taking such giant, costly, and speculative steps into the virtual unknown. This might have been the greatest risk Shell Oil in the United States had ever faced. The big question, held out since the early days of offshore after World War II, was revisited: Even if the technology could be developed, would deepwater ever pay? Strong leadership in exploration and production, driven by an abiding confidence in Shell's marine engineering capabilities and faith in the potential of the Gulf to yield large new fields, persuaded the company to take the risk. But to make the risk pay off, the terms of access to offshore territory had to be changed.

The willingness to take on massive technological challenges against conventional wisdom was ingrained in the corporate culture of Shell E&P. Research was closely integrated with operations and engineering, and personnel moved fluidly back and forth between the Bellaire lab and the area offices. Long before the "team concept" or "matrix form" of organization came into vogue, Shell E&P management had encouraged the formation of task forces—collections of people with different skills working on a problem together. This mutual support system emboldened managers to go into big projects with a certain level of technical understanding, confident they would come out with more knowledge than before.

Shell's leadership never wavered in their commitment to offshore. The top two men who led Shell's initial thrust into deeper offshore terrain in the 1970s, president Harry Bridges and his executive vice president, John Redmond, were technically oriented managers who drew faithfully on the talents of the organization. John Bookout, who first replaced the retiring Redmond as leader of Shell E&P and then Bridges at the top of the company, further sharpened Shell Oil's focus on the offshore frontier. Bookout believed in the offshore and was fully conversant with Shell's evolving capabilities in this area. Upon becoming executive vice president of Shell E&P and then Shell's CEO, Bookout emphasized offshore development and campaigned hard to have the U.S. federal government open up the nation's continental shelves to oil exploration. His counterparts in the industry regarded him as one of the brightest and best-informed men among them. In 1981 they elected him chairman of the National Petroleum Council, the industry group that acts as semiofficial consultant to the U.S. secretary of energy. And in 1984 he became chairman of the American Petroleum Institute, the first Shell Oil president since Max Burns in the 1950s to head that prestigious trade association. Bookout's exceptional strength as a leader and wide respect both within and outside the company were instrumental in convincing Shell's board to continue moving deeper offshore.

Top Shell E&P management under Bridges and Bookout was composed of people who had distinguished themselves technically during a period when offshore had taken center stage in the company. Bookout's executive vice president for Shell E&P, Charlie Blackburn, was a petrophysicist and protégé of Gus Archie, the man who invented the field of petrophysics. As vice president of the southern Shell E&P region, Blackburn ran the bidding in the important federal offshore lease sales in the Gulf of Mexico in 1970 and 1972, when Shell first deployed its revolutionary "bright spot" seismic technology, which used advanced digital imaging to pinpoint oil and gas deposits. He also had managed Shell's deft handling of a major platform blowout in Bay Marchand in 1970–1971.[3] Bookout's exploration and production vice presidents, all technically accomplished, contributed in their own way to Shell's offshore vision. On the exploration side, geophysicist Billy Flowers was a prime mover in getting Shell to apply state-of-the-art

geophysics offshore. Geologist Bob Nanz, a pillar in the research organization for many years, orchestrated Shell's crusade for greater access to federal offshore lands. Exploration vice presidents Jack Threet and Tom Hart, veterans of exploration in many frontier basins with both Shell Oil and the Royal Dutch/Shell Group, also helped push the company into the deep waters of the Gulf of Mexico. The strong emphasis on technology, so touted by earlier exploration leaders in the company, continued unimpeded under Bookout's exploration program.

Managers on the production side also had demonstrated exceptional technical abilities and offshore experience. For most of Bookout's presidency, Gene Bankston and Don Russell headed the production organization. In the late 1950s, Bankston (vice president for production, 1972–79) had contributed to developing the "big picture" policies on how management decisions should be made in Shell E&P and the economic model that supported the first push into what then was considered deep water (past 200 feet). Russell (vice president for production,1980–86) had been a star researcher at Shell's Bellaire exploration and production research laboratory in the area of reservoir engineering and had helped develop more rigorous quantitative methods for evaluating offshore leases. In the late 1960s, he also had been regional production manager in New Orleans. Under Bankston and Russell, Shell E&P refined and improved its sophisticated methods for preparing economic scenarios for given offshore prospects, using statistical projections of volumes, prices, profitability, drilling costs, and success ratios. As offshore development moved into deeper water, and as competition for leases intensified, production economics became ever more important to formulating bids.

Whereas the 1960s marked the great leap forward in exploration technology, the 1970s witnessed similar progress in offshore production technology. In this area, Shell was well prepared to take the lead. First of all, it was committed to the Gulf of Mexico, which at the beginning of the decade accounted for over 50 percent of the company's domestic crude oil and natural gas liquids production. Shell knew offshore Gulf of Mexico as well as any company in the business. It was the only area in the Shell E&P organization that had kept engineers and technical teams in place continuously over the post–World War II period. In 1971 the marine divisions in New Orleans and Los Angeles were renamed the Offshore East Division and Offshore West Division, respectively, and then in 1979 combined into one large Offshore

Division, the company's largest. In 1972, Shell confirmed its commanding presence in Louisiana by moving 1,500 employees into a giant, new, fifty-one-story skyscraper in downtown New Orleans, called One Shell Square. Housing Shell's Southern Exploration and Production region, it towered above the New Orleans skyline and laid claim to the distinction of the tallest building in the Deep South.[4]

During this period, Shell Oil concentrated on expanding deepwater production capability. In 1972 exploration activity in the Gulf began to taper off. There was still a lot of development in so-called shallow water (out to 300-foot depths), but the industry was not really expanding into deeper water. Lease sales had been postponed because of rising environmental concerns over offshore development and the fallout over several platform disasters. Yet there was another factor that contributed to the lull. The industry was still trying to figure out how to operate at greater depths in the proven oil province of the Gulf of Mexico. Fixed platforms had become standard for waters extending out to 350 feet, but moving deeper—toward 600 feet and beyond—introduced fundamentally new problems. Steel jackets would be more slender and therefore more susceptible to stresses caused by wave dynamics and metal fatigue, which could be safely ignored in shallow water. So Shell continued to explore alternatives for producing at these depths. By the early 1970s the company had elite engineering groups working on a range of different technologies, including subsea wells, fixed platforms, and tension-leg platform designs. Some professional competition existed between the various groups, but it was congenial, for everyone realized that they were striving toward a common goal.

Shell's civil engineering group in the head office and at Bellaire kept finding ways to extend the depth capability of platforms on a more cost-effective basis than could be done with subsea systems. First organized in 1965 and headed by Bob Bea, the Central Engineering Group assumed the task of designing and overseeing fabrication and installation of all of Shell Oil's offshore structures. Previously the operating divisions (e.g., New Orleans, Houston) had performed the engineering. But with the increasing challenges of offshore engineering and Shell Oil's expanding portfolio of leases, a more specialized and concentrated effort was needed. During its first year, the Central Engineering Group designed and managed the construction of thirty-three platforms in water depths ranging from 30 to 300 feet in offshore Louisiana and Texas. This was the most ever designed and constructed in a single year in Shell Oil's history. Dunn declared, "The period 1964–1972 was, in my opinion, the most active in terms of platform technological development in the whole history of the offshore."[5]

Shell stayed at the forefront of innovation, but advances in deepwater production also resulted from the acquisition of knowledge and skills by the industry as a whole. The introduction of the digital computer in the early 1960s had revolutionized design techniques, and bigger launch barges were built to assist the installation of increasingly ponderous platforms. Onshore support industries and communities had sprung up all along the Gulf Coast, in such places as Morgan City and Lafayette, Louisiana, helping to spread and standardize skills among offshore operators. Lessons learned from the destruction of platforms by three devastating hurricanes in the 1960s and several platform disasters in 1969–70, including Union Oil's notorious blowout in the Santa Barbara Channel, accelerated the industry's learning process and helped build technical consensus around all kinds of new design criteria.[6]

The demonstration of successful projects in the tough North Sea environment, furthermore, helped improve practices in the Gulf. In the early 1970s, several North Sea platforms installed in 500 feet of water, under the most inhospitable conditions, provided invaluable knowledge about wave dynamics and metal fatigue. The North Sea also provided an example of how quickly costs rose with increasing depth. Offshore leaders such as Shell Oil knew that safe, reliable platforms could be built in much deeper water—but at a steep price. The big question was, could they afford it?

The Arab oil embargo of 1973 provided the answer. The skyrocketing price of crude oil and an aggressive federal leasing system gave new impetus to offshore expansion. With prices at $10 per barrel instead of $3 per barrel, companies found they could justify much more expensive offshore drilling and development. And the federal government eagerly encouraged them. Under the mandate of Project Independence, the Nixon administration increased the pace of leasing in the Gulf of Mexico and resumed Outer Continental Shelf (OCS) sales off the Atlantic, Pacific, and Alaskan coasts, all of which had been closed to drilling after the Santa Barbara blowout. In 1973, even before the embargo, the government had held sales in the central Gulf, offshore Texas, and in the so-called MAFLA region—offshore Mississippi, Alabama, and Florida. After the embargo, interior secretary Rogers Morton announced that the government aimed in 1975 to lease 10 million acres of offshore property to oil companies, as much as had been handed out in the entire twenty-year history of OCS leasing. Most people outside the government regarded this goal as totally unrealistic. It also raised the hackles of environmentalists, who geared up for confrontation in California and along the Atlantic coast. Nevertheless, the announcement accelerated plans to offer deepwater tracts in the Gulf, where environmental opposition hardly registered.

In anticipation of deepwater sales in the Gulf, Shell E&P's seismic surveys located several attractive features for testing, and some confirmation drilling was completed. One of the most attractive prospects, codenamed "Cognac" by Shell, was on tracts in the Mobile South area. The amplitude reflections, or bright spots, on the seismic records gave a high probability of finding several oil and gas plays on the structure. "The prospect was full of bright spots," said Mike Forrest, the discoverer of the method and geophysical project leader for the Offshore Division at the time. Shell's technical analysts estimated that the field might contain 150 million barrels. Although not large by Middle Eastern standards, this was a potentially major field for the Gulf of Mexico.[7]

Cognac, which was located in 1,000-foot depths, would establish a new offshore frontier, one far deeper than the 200-foot depths that had so concerned some Shell executives in the late 1950s. It would be another giant and risky step, with expensive drilling and facility costs. Shell managers also expected high bids for the tracts, as much as $100 million for a single 5,000-acre tract. This worried president Bridges. He felt that the board of directors needed to be more fully apprized about the methods used for evaluating the bidding before they could consider and approve the company's move into such deep waters. Heretofore, the board had been advised, but not in great detail. It was a security problem. Bids reached into the millions of dollars, and the bidding was competitive. But because of the escalating cost and added risk, Bridges decided to give the board a more detailed strategy presentation.[8]

As the price and competition for offshore leases increased significantly, the process of deciding which tracts to bid on in a lease sale and how much to bid had become an increasingly lengthy and secretive process involving the work of hundreds of people over a period of several years. After the Department of Interior called for nominations on tracts, Shell and other companies would submit a list of tracts to the government, based on the ongoing collection

of seismic and geological data and information from previous lease sales. As the sale approached, Shell would undertake intensive seismic work, with a geophysicist and geologist assigned to each prospect—the geophysicist analyzing the seismic data and mapping out the subsurface structure, and the geologist acting as the evaluator, determining which possible oil or gas reservoirs should be pursued and estimating the volumes of oil or gas on each tract. Beginning in the late 1960s the technical team also worked with other parts of Shell E&P—production, economics, platform design, and drilling—to establish a most probable tract value within a range of values, discounting for operational and geological risks. The list of proposed tracts was then culled through a district review and then a division review. A month before the sale, a final division review was held and general bids were attached to the tracts. The head office then reviewed the bids with all the Shell E&P vice presidents, and finally with the executive vice president and president, who placed the final numbers on the sealed bids. The fewer people involved at this stage, the better, since a competitor would need to bid only $1 higher to take a given tract away from Shell.[9]

The meeting with the board on Cognac took place several months before the scheduled March 1974 offshore Louisiana lease sale. Redmond and Nanz made the presentation, outlining Shell's detailed methods of evaluating prospects. They also reviewed the application of Shell Oil's bright spot technology for the very first time. The main objective of the presentation was to show the board that Shell's bids were based on the value of a particular tract to Shell and never at an amount just to be higher than a competitor. After the strategy presentation, Redmond and Nanz discussed the specific tracts they were targeting and the bidding levels. As usual, they did not name the individual tracts or specify their location. But Cognac was one of the prospects reviewed, and the price per tract was around $108 million. The board approved the recommendations and, as Redmond remembered, "we were sure that the strategy presentation had helped in gaining their confidence and support."

Shell E&P had enough confidence and support from the board to bid alone in the approaching March sale. But in this case Shell took on bidding partners. Traditionally the company had not bid with partners, preferring to go it alone and protect its technology. As the prices for leases soared, however, Shell decided to lay off some of the front-end financial risk by taking on partners.[10] This decision also was forced by smaller operators, who were priced out of the picture and had been pressuring the majors to give them some representation in the bidding. But in Shell's case these smaller partners had little input. They did not know what kind of technical work was involved, nor did they even know where the lease was or how much was being spent. Their participation was essentially an investment in Shell's proven record offshore.

Shell Oil bid strong in the March 1974 sale and got most of what it wanted. The U.S. government opened up more than two hundred tracts (940,000 acres) in the central Gulf, including forty-two deepwater tracts (199,000 acres) on the continental slope offered for the first time.[11] Oil companies spent a record $2.16 billion in bonuses in the landmark sale. Only thirteen of the deepwater tracts were bid on, but the eleven bids that were accepted pulled in an impressive $321 million. Exxon was the top spender in the sale ($245 million for six tracts), but the Shell Oil group made the biggest bet on deepwater production—spending $214.3 million in bonuses for three adjoining blocks on the Cognac prospect, officially called Mobile South No. 2, and paying over $112 million for the most prized of the three blocks. Shell did not, however, win all of the blocks on the prospect. A group led by Amoco won the fourth block with a bid of $81 million, beating out Shell by about $10 million.[12]

The Cognac prospect was so far beyond working depths that Shell Oil did not even have a rig that would drill it at the time of the lease sale.[13] The company soon found a semisubmersible, *Pacesetter II*, and reequipped it with added mooring, larger conductors, and other modifications. Not until June 1975 did Shell have the rig ready to drill on the prospect in 1,000 feet of water, more than twice the depth in the Gulf previously plumbed for commercial production. In July the first exploratory well for Shell by *Pacesetter II* struck oil, and the well log showed 140 feet of pay, more than enough to go forward with a platform.[14]

During the next year, eleven more tests were drilled on the four blocks; eight discovered oil and gas. As it turned out, Amoco had obtained the best acreage. From Shell's perspective, the logical way to develop the field was to unitize the operations of the two groups of partners. But Amoco used its reserve estimates as a strong bargaining chip. After two years of difficult negotiations, Shell and Amoco formed a joint venture with Shell as operator (Shell 42.8 percent, Amoco 21 percent). By 1977, when the agreement was signed, Shell was already building the jacket, strengthening the company's

bargaining leverage over Amoco, which had not yet figured out how to develop its interests. "They didn't have a design, and we were already building the bottom section of the platform," explained production manager Sam Paine. "So we knew we had them. We traded hard. We didn't back off. And they finally agreed with us."[15]

When Shell bought the leases at the March 1974 sale, however, its engineers had not yet come up with a design concept for producing in 1,000 feet of water. A year earlier, Dunn's civil engineering group had begun to analyze the problems of designing and installing a fixed platform for such a water depth. To withstand the day-to-day waves of deep ocean water as well as the extreme winds and waves of hurricanes, it would have to be mammoth-size and heavily reinforced, dwarfing anything ever built. The base of the structure also had to be sturdy enough to withstand tremendous forces from mudslides. Design, however, was the easy part. Finding a way to install it was the main challenge. Along the Gulf Coast there were no construction yards and launch barges even remotely big enough, or tow-out water depths deep enough, to handle a one-piece, 1,040-foot-tall steel jacket.

The only conceivable solution at the time was to build and install the jacket in sections small enough to be floated and lifted by available equipment, then mate the sections in the water. Such a project would be incredibly complex, requiring untried procedures. At the same time, Exxon was working on installing the "Hondo" platform in 850 feet of water in the Santa Barbara Channel. Exxon engineers decided to launch the jacket in two pieces and then mate them horizontally in protected water. The mated jacket would then be uprighted on the bottom. Shell engineers considered a Hondo-style mating operation but ruled it out because of the risks of this time-consuming procedure in the hurricane-prone Gulf. Instead, they settled on a unique and innovative concept: building and launching the jacket in three pieces, mated vertically, or "stacked," under water. Launching each section would be a separate and relatively quick operation. And the mating would take place deep enough to be protected from strong wave action.

This was easier said than done. "It took many agonizing hours of planning, thinking, re-thinking the problems," said Gordon Sterling, who supervised the detailed engineering design of the structure. "How would the base section be connected safely and securely to the middle and top sections? How would the base be leveled on the Gulf floor? There were many other questions. But the answers started coming." Shell's project managers assigned an elite team of specialists to engineer various parts: engineering and pile hammer design; base section launch; electronic instrumentation package for guiding and monitoring each step of the installation; hydraulically actuated mud mats for leveling the base section; and ballasting, pile cementing, and flooding systems for installation. Said Dan Godfrey, the engineer in charge of fabricating the base, "Whether a man was working on the base, the middle or the top section of this construction effort, no one—even old timers in the yard—had ever been a part of something so special."[16]

Shell awarded the contract for building and installing the Cognac structure to J. Ray McDermott, one of the leading offshore construction firms in the Gulf. In April 1975, even before exploration drilling had started, steel was ordered, and in December fabrication of the base section began at McDermott's Bayou Boeuf yard in Morgan City. Slowly, tons and tons of steel filtered into the yard. Joint by joint, brace by brace, the base began to take form like a giant jigsaw puzzle. It grew even larger than initially planned. The discovery of huge reserves and the exploding U.S. demand for oil in the mid-1970s compelled Shell to speed up development. Consequently, the original jacket, designed for a forty-well, single-rig platform, was enlarged to accommodate two drilling rigs and sixty-two wells. In turn, the total weight of the jacket increased from 19,000 tons to 49,000 tons, with an attendant escalation in costs.

On a fast-track schedule, a project of such unprecedented magnitude and complexity was bound to run into problems and setbacks. The general design for the jacket as a single piece was essentially a deepwater application of the basic American Petroleum Institute (API) drilling-production platform used in shallower waters. But translating the design into metal called for exceptional accuracy in fabrication to ensure that the pieces would fit when mated. All measurements had to be temperature-calibrated to take into account the expansion and contraction of the steel, from the hot Louisiana sun to the cold depths of the Gulf of Mexico. Braces even millimeters out of alignment, for example, had to be replaced. "In terms of construction tolerances, there's absolutely no comparison with any other job," Godfrey noted. "If the sections don't mate, you can write off the whole thing."[17]

Shell and McDermott employed space-age technology to ensure that the sections would fit. A survey by Boeing Aerospace predicted how well the sections would match under varying offshore conditions. An on-site construction survey used infrared devices to check Boeing's figures. The fit of jacket members was checked with photogrammetry, a computerized method of correlating photographed targets developed by the U.S. Army for high-altitude mapping. Even the most sophisticated measuring techniques, however, could not completely eliminate uncertainty.[18]

These doubts would never be completely laid to rest until the sections were mated in the water. Installation was even trickier and more worrisome than fabrication. There could be virtually no margin for error. Over half of the three hundred man-years of engineering logged on the entire project dealt with installation procedures.[19] In the summer and fall of 1977 the massive base section was installed, and the following summer the middle and top sections were fastened together with the base. For the numerous engineers who had labored for years over the installation, the successful mating of the sections brought relief and jubilation. In September 1979, more than five years after the leases were bought, the Cognac platform began producing oil and gas. By the summer of 1981 all the wells had been drilled, permanent production facilities had been installed, and the world's deepest platform-to-shore oil pipeline had been laid. At the end of 1982, according to one Shell Oil brochure, Cognac was producing 72,000 barrels of oil and 100 million cubic feet of gas per day.

Cognac was the most sophisticated fixed platform installation ever completed; at $240 million, the platform was also the most costly. From start to finish, the overall project cost Shell and its co-owners nearly $800 million. Other companies built subsequent platforms in similar depths with less steel and launched them in one piece from larger barges for much less money. But these projects could not have happened without the deepwater precedent established by Cognac. It marked an unparalleled advance in the technology of offshore structures, setting records for the deepest water, largest number of wells, and heaviest steel platform, among numerous other innovations. In 1980 the American Society of Civil Engineers honored Cognac with it annual Outstanding Civil Engineering Achievement award, the first ever received by an oil company. Along with Exxon's Hondo and developments in the North Sea, Cognac opened a new era for truly enormous, offshore engineering/construction projects. It introduced the "team" or "project line" concept to the industry, marrying disciplines such as naval architecture, structural engineering, and mechanical engineering. Company engineers also worked closer with the fabrication and installation contractors than ever before, taking project management to a whole new level.

Controversies, Delays, and Disappointments

As the energy crisis of the mid-1970s intensified, and as onshore prospects in the United States declined, U.S. oil companies looked increasingly offshore to expand domestic reserves. But even with Cognac paving the way deeper into the Gulf of Mexico, many oilmen, including Shell Oil's own, believed that after twenty-five years of development only lean prospects remained in the Gulf. The best hope for increasing national reserves, they insisted, was to open up the unexplored sedimentary basins off the east and west coasts and off Alaska.[20]

The industry's drive to explore these areas, however, collided with opposition from environmentalists and coastal communities. Of the 19,000 wells drilled in U.S. waters up to 1975, only four had caused major oil spills. But those four had been relatively recent and spectacular. As the industry moved into deeper, rougher waters, environmentalists feared that the likelihood of spills increased—with potentially ruinous consequences for marine ecology and recreational beaches along places like Long Island and Southern California. New England fishermen, furthermore, did not want oil companies invading their territory. Governors and politicians from coastal states, unprepared to cope with the onshore consequences of an aggressive leasing program, objected to providing costly services and facilities for offshore development. They wanted to be consulted about the federal leasing program, which they increasingly argued would be inconsistent with the requirements of state coastal and marine management programs. "People seem to want new oil sources developed, but they don't want it where they live," complained Bookout. "We have been far less willing to open up our continental shelves than most countries."[21]

Bookout emerged as a vocal and articulate spokesman for expanded access to "frontier" areas. "Offshore represents the major domestic potential yet to be explored," he repeatedly emphasized. Other Shell executives also spoke out. Already sensitized to environmental concerns and convinced of the need to establish a more open relationship with the public, Shell Oil sent its exploration and production managers out to plead the case to government officials and coastal communities. Exploration vice president Nanz spearheaded the effort, organizing and presenting detailed information before numerous groups on what he called the "Offshore Imperative." Nanz and other Shell representatives participated in industry efforts organized by the API and coordinated with the National Ocean Industries Association (NOIA) to help overcome local and government resistance to offshore development. "We did a lot of work with fishing groups in different areas, because they were one of our primary opponents," remembered O. J. Shirley, Shell's Southern E&P Region safety and environmental conservation manager, who was active in these efforts. "We worked with the governor of Massachusetts in trying to get access to Georges Bank. We worked with New Jersey people for access to the mid-Atlantic. It was easy to identify who our adversaries were, and we tried to get an opportunity to speak to them."[22]

It was a tough battle. Adversaries were not easily converted. Oil company representatives struggled to convince people of the industry's renewed commitment to safety and environmental protection. Shirley had been a founder of the Clean Gulf Associates (CGA), an industry organization formed in 1972 to upgrade oil-spill-handling capabilities in the Gulf. As lease sales were scheduled in the mid-Atlantic, some of the same companies organized a new group, called the Clean Atlantic Associates (CAA), with Shirley as its first chairman. The CAA compiled an oil spill contingency manual, identified areas of particular sensitivity to oil spills, and planned to stockpile oil spill equipment for the North Atlantic, Mid-Atlantic, and South Atlantic regions.[23] The CAA sought to puncture the stereotype of offshore oilmen as insensitive to the environment and demonstrated the industry's willingness to abide by rigorous environmental protection standards. "Through strong personal contact, one-on-one discussions, and actual friendships, we formed relationships with the environmental community," said Shirley.

These efforts helped break down public resistance, but obtaining leases and permits to drill still entailed protracted legal struggles. "It looked like, sometimes, that we were never going to get there," said Shirley, "but, looking back, we gained access to almost every area that we wanted to drill offshore." One promising area was the Baltimore Canyon trench off the coasts of Delaware and New Jersey. In a 1976 federal sale, Shell and partners obtained twelve tracts in relatively shallow waters of the Baltimore Canyon. The sale was contested in court, and not until March 1978, when the Supreme Court refused to hear an appeal of a lower court decision validating the sale, was drilling allowed to proceed.[24] A string of dry holes from the 1976 sale, however, including several by Shell Oil, dampened enthusiasm for a second sale held in 1979. Shell had been hoping for a bonanza, "one or more giant fields the size of Mexico's Golden Lane," said Jack Threet.

There had been geological reason to hope for such fields. "We knew we had reservoirs and we were almost certain we had traps," he explained. "But we think there was probably not enough oil generated in the Atlantic Basin to migrate into those traps."[25]

As companies began to write off the Baltimore Canyon, attention shifted to another promising area—the Georges Bank trough southeast of Cape Cod, Massachusetts. But drilling there encountered even greater opposition. In 1976 the Conservation Law Foundation and the State of Massachusetts filed suit to block sales in Georges Bank. After two years of legal wrangling, the Supreme Court refused to grant a final request to cancel the Georges Bank sale, which was finally held in December 1979. Shell and its bidding partners won three tracts for a price of $86 million. Obtaining permits to drill, however, dragged on for many months. In 1978, Congress passed the Outer Continental Shelf Land Act Amendments (OCSLAA), which opened up the offshore leasing process to wider public participation, involving more government agencies, with the intention of building public confidence in this activity. At least in New England, however, this act further delayed drilling. The permits issued by the U.S. Geological Survey and Environmental Protection Agency and approved by state agencies in Connecticut, Massachusetts, Rhode Island, and Maine—pertaining to mud discharge, spill equipment, and protection of fisheries—were among the most stringent ever applied to offshore drilling.[26]

In 1981, once all the appropriate permits had been obtained, Shell finally drilled its first exploratory well in the Georges Bank. But, alas, this and subsequent wells turned up dry. It was a good gamble against long odds, because even with high costs the rewards looked rich enough to justify the search. But after years of fighting the modern-day "Battle of the Atlantic" for access to the eastern continental shelf, the industry found little tangible reward, except for a better geological understanding of this offshore basin and a better appreciation of the political dimensions of offshore development outside the Gulf of Mexico.

Californians put up even fiercer resistance to offshore drilling than easterners. Offshore development was not new to California, but it had proceeded along a different and stranger trajectory than in the Gulf. Beginning in the 1930s, drilling platforms built from piers had been erected from Santa Barbara down the coast to Long Beach. Because the ocean floor of the Pacific sloped off sharply from the shore, companies could not move

deeper gradually as they could in the Gulf. Large structures that would have been placed far beyond view in the Gulf, therefore, were clearly visible from California beaches. In the late 1950s, to appease residents who did not want their scenic ocean view spoiled by drilling rigs, artificial islands made of sand and rock were introduced to house and beautify them. In the 1960s, the THUMS Group—Texaco, Humble, Union, Mobil, and Shell—extended this artificial island concept by building four 10-acre islands off Long Beach. Each had elaborate façades to camouflage rigs and equipment and give the impression of real estate developments rather than offshore facilities.[27] Leasing off California came to sudden halt, nevertheless, after the 1969 Santa Barbara oil spill, which galvanized local groups statewide to agitate for restrictions on offshore development.

Despite early setbacks, the movement gained political strength. In 1974, after the moratorium on drilling was lifted, the State of California unsuccessfully tried to block the first federal lease sale, maintaining that it did not meet the requirements of the National Environmental Policy Act. In the December 1975 sale, held in Los Angeles, Shell Oil and its partners spent $123 million, most of this for two 5,700-acre leases on a prospect called Beta, in water ranging from 220 to 1,000 feet in San Pedro Bay off Long Beach. The sale bolstered anti-industry forces, however, creating enough pressure to cancel the two federal sales proposed for 1976 and 1978. A suit brought by the County of Santa Barbara postponed the next sale, originally scheduled for 1977, until 1979. Meanwhile, the California Coastal Commission (CCC), backed by Governor Edmund G. Brown, issued ever more stringent requirements for federal leasing to ensure that it was consistent with the state's federally authorized coastal management program. Subsequent lease sales became so embroiled in lawsuits and subject to the withdrawal of the most attractive tracts due to environmental concerns that development of offshore California screeched to a halt. Beginning in 1982, Congress inserted prohibitions into the Department of Interior's appropriation that effectively shut down leasing on the OCS of both the east and west coasts.[28]

Within this antagonistic political climate, Shell Oil pressed forward with the development of its Beta prospect. Of all the tracts leased in the 1975 sale, Beta yielded the only commercial discovery, in July and August 1976. Exploratory drilling revealed an estimated 150 million-barrel field, and Shell badly needed this oil to supply its West Coast refineries, which had been forced to purchase increasing amounts of crude from other companies. But bringing the field into production would prove to be neither simple nor inexpensive. Platform designs had to account for the possible impact of shock waves generated from earthquakes. Although the advent of powerful computers had improved the seismic analysis of offshore structures, knowledge of earthquake design was still not that developed, even by the early 1970s. Ensuring that a platform had enough structural resilience to absorb the energy of severe earth tremors, therefore, required conservative and thus costly designs. Development strategy also had to take into consideration the fact that the reservoir contained heavy oil and low natural pressures. Water injection and downhole electrical pumps would be needed to produce the oil. Shell used sophisticated computer simulation techniques to predict reservoir performance, studied various alternate development plans, and eventually decided to build two offshore structures instead of a combined drilling/production platform. The two-platform complex allowed for the most efficient development of the Beta field and provided the large amounts of space needed to support the processing equipment.

Political and regulatory obstacles, driven by growing opposition to offshore oil in California, hindered the project more than design considerations. But Shell was determined to see the project through by meeting or exceeding all state and federal safety requirements and environmental standards. Early on, Shell teams spelled out detailed development plans in face-to-face meetings with numerous community and civic groups, as well as with the appropriate local, state, and federal officials. They covered all the major impacts of the Beta project, including safety, air and water quality, marine traffic, oil spill prevention, and onshore activities. "The path that we adopted was to be completely open with them," said Phil Carroll, division production manager for Shell Western E&P at the time. "No surprises or attempts to sneak something by. We did everything we could to accommodate them."[29]

Still, the permitting process dragged on for two years. Of the eleven different local, state, and federal agencies from which Shell had to obtain permits, the California Air Resources Board (CARB) threw up the most difficult roadblocks. Shell Western E&P managers took a calculated risk, ordering fabrication of the components just as they began applying for permits. Brown & Root constructed the two platform jackets for Shell in Labuan, East Malaysia; the deck sections, pilings, and conductors were made in Japan. "I was frequently asked," remembered Carroll, "'My God, why don't you stop building those things until you are sure you can get the permits?'"

But because the field required two major platforms in 260 feet of water, Shell compressed the construction schedule, contracting for components from multiple international contractors to speed up fabrication. In late 1979 the jacket for the drilling platform called Ellen was literally being towed by barge across the Pacific Ocean before Shell had obtained all the permits. Carroll planned to tow the jackets right out to location in San Pedro Bay and invite television crews out to see a major new source of energy desperately needed by the nation, but which was being held up by regulatory red tape. Fortunately, the permits came through in time to avoid a showdown.

Gaining permission to develop the Beta field was an impressive feat. Shell's frank and open discussions with government officials and community leaders cleared up many misconceptions about the impact of the project and paved the way through the permitting process. In early 1980, Shell installed the production platform Elly, linked by a 200-foot bridge to its sister drilling platform Ellen. Four years later, as the development drilling program on Ellen drew to a close, Shell installed a mammoth 700-foot drilling platform called Eureka to develop the much deeper southern portion of the field. Built by Kaiser Steel at Vallejo, near San Francisco, Eureka was the largest single-piece jacket installed up to that point on the West Coast and the sixth-largest overall in the world. All told, the Beta project cost $700 million and touched nearly ever organization in the company over the course of a decade. By the late 1980s, Beta had hit peak production of about 20,000 barrels per day, the industry's only commercial success from the 1975 lease sale in Los Angeles.[30]

In Alaska, the last frontier area off U.S. coasts, Shell was not so fortunate. The first stumble came in the Cook Inlet, where Shell had enjoyed previous success in the Middle Ground Shoal Field. In a December 1973 state lease sale, the company tried to expand on that success by acquiring five tracts in the Kachemak Bay area of Cook Inlet. As Shell prepared to develop the leases, however, the coastal communities rose up against offshore operations in the bay, a pristine, picturesque setting. In June 1976, after a protracted series of hearings, the state imposed a one-year moratorium on drilling in the bay. A year later, state legislation authorizing condemnation of leases in the Kachemak Bay forced Shell to sell the leases back to the state.

Undaunted, Shell remained faithful to Alaska's oil potential and optimistic about the industry's chances at getting access to it. In the mid-1970s, Shell and other oil companies believed that federal territory in the Gulf of Alaska might have the same kind of big, concentrated oil deposits that were found at

Prudhoe Bay. Sales of Gulf of Alaska leases by the federal government were supposed to follow the state sales at Prudhoe Bay, but the Santa Barbara blowout incurred the wrath of environmentalists and held up sales for years as research was done on the hazards of drilling there.[31] Finally, in April 1976, the federal government put the acreage up for lease, after failed attempts by the State of Alaska to block it. This sale, *Business Week* announced at the time, "may very well hold the last hope for an oilfield big enough to reverse the nation's four-year decline in oil production."[32] The sale also offered Shell exploration managers a chance to redeem the company in Alaska after their failure at Prudhoe Bay.

The Gulf of Alaska was Shell's top candidate among the seventeen potential OCS oil and gas provinces listed by the Bureau of Land Management (BLM) in 1974. It was also a forbidding frontier region, one of the most hostile in the world. Its fierce, chilling winds drove waves cresting at 100 feet. Fog often made helicopter transport impossible. Moreover, it was a seismically active area that would require earthquake-resistant platforms. "The Gulf of Alaska," said John Swearingen, chairman of Standard Oil of Indiana (Amoco), "will make the North Sea look like a kiddie pool."[33] Shell estimated that a production platform in 300 feet of water in the Gulf of Alaska would cost as much as one in 1,000 feet of water in the Gulf of Mexico. Unfortunately, the techniques Shell had laboriously developed for evaluating leases in the Gulf of Mexico were not applicable there. "There was no information other than seismic," remembered Marlan Downey, exploration manager for the Alaska division. "There wasn't a history of production. There wasn't anything that told you whether or not there would really be commercial oil there."[34] Nonetheless, Shell was anxious to find out. In preparing for the sale, its Alaska division geophysicists identified several major structures. Although they did not find any verifiable bright spots on the seismic data, they saw hints of an unusual type of undersaturated oil that did not have gas. So they decided to bid aggressively, taking on ARCO as a partner, though, to spread the risk. The Shell-ARCO partners were the high bidders in the sale, together spending $276 million (Shell's share being $148 million) out of an industry total of $572 million, according to Shell's 1976 annual report. They won twenty-nine tracts totaling 165,000 acres (nine of eleven prospects on which Shell bid).

And they drilled nothing but dry holes. There was no source rock. It appeared that temperatures never got high enough in the formation to cook up the oil. "Everything looked good and the structures were there," said Nanz. "Except oil was not generated in the particular ones we sampled."[35] These dry holes were also expensive. Stormy weather and high formation pressures made drilling from semisubmersible rigs difficult, resulting in drilling costs from $10 million to $23 million per well, according to the company's 1977 annual report. Shell's Gulf of Alaska venture was a complete failure, a miserable disappointment. When a second lease sale in the eastern Gulf of Alaska came up a few years later, Nanz resisted any temptation to place another bet. "I feel like that monkey they put on the sled down there at NASA in the acceleration chamber," Nanz told his geologists. "He did not want to get back on that sled again and that is how I feel about this sale."

Shell went to the sale but acquired only five tracts for $1.4 million. It was saving its money for other sales in Alaska's western and northern waters. Despite a string of controversies, delays, and failures in other frontier areas, Shell's exploration leaders still believed in the potential of offshore Alaska. In 1978 the company announced that it expected Alaska to provide 58 percent of the country's future crude and condensate discoveries. There were some very large structures off the Alaska shore. If oil and gas had migrated out there, these structures could be "company makers." As one executive described Shell's thinking, "There was a huge, world-class field up there onshore. So there just had to be something, right, in the offshore?"[36]

New Urgency

During the 1970s, offshore oil in the United States became the subject of rising political controversy. Environmental opposition and the "not-in-my-backyard" syndrome thwarted the industry's efforts to explore many frontier areas of the OCS. As the oil industry also came under intense scrutiny for alleged profiteering after the Arab embargo, questions about the competitiveness of offshore leasing increasingly entered the discussion. Critics charged that the bidding system based on cash bonuses with fixed royalties did not always give the federal government a "fair value" on leases and that joint bidding by the major oil companies kept the smaller independents from operating in deeper waters.

Oilmen scoffed at the suggestion that lease sales were not competitive. They argued that, even though smaller companies did not have the capital to develop leases on their own, many of them were often included in successful offers. Oil companies emphasized that skyrocketing lease prices were ample evidence that the system was highly competitive. In 1977, Nanz pointed out that, of the average winning bids in the previous twenty OCS sales, 45 percent of the bonus was "left on the table"—it was not needed to get the lease. "It's been more than competitive," he commented. "More like frantic."[37]

With OCSLAA, Congress attempted to reform the bidding process to make it even more competitive. The amendments required the Department of Interior, during a five-year experimental period beginning in September 1978, to try new bidding systems that reduced the amount of front-end money needed to obtain leases and thereby, in theory, enable more companies to purchase leases. The traditional format consisted of a cash bonus bid for a given tract with a fixed percentage royalty on what was produced, whereas the alternative systems included those that derived income for the federal government largely through variable royalties bids or net profit sharing rather than through cash bonus bids. Shell, like other companies, did not like rising cash bonuses but still favored the traditional system over most of the alternatives, which company officials argued would only encourage speculation, impose new administrative burdens, and delay exploration.[38]

With the deepening of the energy crisis in the United States, the last thing the Department of Interior wanted to do was delay or impede domestic exploration. The December 1978 overthrow of the shah of Iran by Shiite Muslim revolutionaries cut off petroleum exports from Iran, lifting world crude oil prices from $13 per barrel to $34 per barrel and precipitating a full-blown panic at the pump. In March 1979, U.S. Secretary of the Interior Cecil Andrus, as directed by the OCS amendments, announced a five-year offshore leasing schedule aimed at expediting exploration and development. The program would average five sales a year with emphasis on the Gulf of Mexico and Alaska. Faced with new urgency to develop domestic oil deposits, over the next several years the Department of the Interior continued to rely on the tried-and-true system of cash-bonus leasing and experimented with the different systems only in a limited way. After studying the comparisons, Interior found that these systems produced no statistically meaningful differences in industry competition, a view that the Supreme Court upheld in 1981.[39]

As Interior expanded its leasing program, Shell Oil geared up for the biggest push the company had ever made into the offshore United States. Company officials had often criticized Interior's leasing timetable in the past and thus were exhilarated by the promise of new areas being opened for exploration. Over the years, Shell had placed bigger and bigger bets on offshore development. Now, Bookout and his lieutenants were prepared to stake the whole company's future on it. In their minds there was really no alternative for a company whose central realm of business was in the United States. They could not see any more major finds onshore. Nanz estimated that nearly 60 percent of the oil yet to be found in the United States was offshore, most of it under federal control.[40] The risks of pushing into the offshore frontier were staggering—huge bonuses, expensive drilling, and if all went well up to that point the monumental costs of development. But they had to be taken for Shell to have a future as a major oil producer. The exploration department was looking for large-scope projects; these would involve higher risks, but if they came about they would remake the company. "We worked so hard," remembered Mike Forrest. "Shell needed to find 200 million barrels of oil a year just to stay even, to replace production."[41]

By the mid-1980s, roughly 60 percent of Shell's exploration dollars went to the offshore effort in the United States. "Exploration has been called a poker game," Jack Threet mused in 1984. "But there's more to it than that. In this game, we don't have chips or coins or dollar bills that can change hands over and over again. We're dealing with a declining resource base, and every barrel we find is never going to be found again."[42] Two places Shell believed in were Alaska and deepwater Gulf of Mexico. Environmental opposition had basically shut down leasing off California and Florida. Drilling in the North Atlantic and eastern Gulf of Mexico (the MAFLA region) had found little. There were really no other virgin areas in the United States to explore for large oil accumulations. Shell believed that large oil fields would be discovered in Alaska and included the risked reserves there in the company's ten-year long-term plan in the late 1970s and early 1980s. Shell's exploration leaders still held the Gulf of Mexico in high regard, but the economics of so-called deep water was still controversial (see below), so the deepwater Gulf of Mexico did not really make it into Shell's long-term plan until the mid-1980s.

Despite the Gulf of Alaska bust, Interior and oil company officials considered other parts of offshore Alaska to have the highest resource potential anywhere in the United States. It was big-structure country. For years, Nanz had led the charge in lobbying the Interior Department to accelerate leasing in Alaskan waters—particularly the Bering Sea and Beaufort Sea basins. After the second oil shock, his words finally appeared to carry more weight. In June 1979, Secretary Andrus revised the leasing schedule announced in March to give earlier consideration to the Alaskan sales. Although not entirely satisfied with the proposed pace of leasing, Nanz was encouraged by the announcement. He asserted that the technology was available for exploring most Alaskan offshore basins. But extreme weather would make it difficult. Ice prevented seismic boats from even getting into Alaska's northern waters, except for maybe one year out of every five. Drilling crews would have to cope with minus-60 degree temperatures and 24-hour darkness in the winter. Furthermore, there was no clear-cut method for producing oil from such an ice-ridden environment. Yet Shell's credo held that, if the fields could be found and the economic conditions were favorable, the technology would arrive to bring them into production. In 1979, with the price of crude soaring near $40 per barrel and the phasing out of price controls in the United States, almost any project seemed possible.

Shell Oil believed as fervently as anyone that Alaska might be the savior of the U.S. oil industry. Shell Western E&P performed exhaustive geophysical work on all of Alaska's offshore basins and, with Amoco as a key bidding partner, forked out millions of dollars in a succession of lease sales held between 1979 and 1985. In 1979, Shell spent $69 million in partnership with Amoco on leases in the first sale in the Diapir basin of the Beaufort Sea, north of Prudhoe Bay. In October 1982 the company joined Amoco, Union Oil, and Koch Oil in purchasing leases in another part of the Diapir basin, mostly on parcels that covered a huge structure called Mukluk. In April 1983, Shell Oil spent $78 million in a joint venture with Amoco and Marathon to acquire leases in the St. George and Norton basins of the Bering Sea. A year later a Shell-Amoco combine dominated a sale of tracts in the Navarin basin, with Shell putting up $175 million of the winning bids. The last major area was the Chukchi Sea, for which, in lease sales held in 1985 and 1988, Shell outspent the competition for large tracts. In the final analysis, Shell spent more money and acquired more acreage than any other company in offshore Alaska lease sales.

All areas held tremendous promise. The Beaufort Sea possessed giant structures, Mukluk in particular. It looked much like the neighboring

Prudhoe Bay field, with the same reservoir rock, source rock, and geological history. Even though Mukluk was only a 1–2 billion barrel prospect, the industry—led by British Petroleum and its U.S. affiliate Sohio—had high hopes for it, spending nearly $1.5 billion on Mukluk leases. Most of the tracts were in 40–100 feet of water covered with ice as thick as ten feet for eight months of the year. Shell and other companies turned to building artificial islands out of gravel to drill their exploration wells. Tragically, though, Mukluk turned out to be the most expensive dry hole in history.[43] Oil stains in the rocks indicated that it had once been a giant oil field. But some time in geological history the structure had been breeched, allowing oil to leak to the surface, or regional tilting had caused the oil to migrate elsewhere. "We drilled in the right place," said Richard Bray, the president of Sohio's production company. "We were simply 30 million years too late." Although Shell geologists had not assigned as high a probability of finding oil at Mukluk as some other companies, and thus did not bet as heavily on it (the company spent $162 million on leases), Shell Oil shared in the costly disappointment.[44]

Shell and the industry did not fare any better in the other basins off Alaska. Either they found no source rocks or the deposits they did find were not large enough to be commercially viable. The company collected massive amounts of data on every prospect, drilled in every basin, and came up empty. The last gasp was in the remote, hostile waters of the Chukchi Sea. Shell had obtained acreage on several sizeable structures and, after struggling to satisfy environmental concerns in gaining a federal drilling permit, discovered oil. The federal drilling permit was approved none too soon, on March 23, 1989, literally one day before the *Exxon Valdez* oil tanker rammed into a reef in Alaska's Prince William Sound and spilled 240,000 barrels of petroleum into those pristine waters. Even then, Shell had to jump through many hoops to prove it had the capability to drill in the tempestuous Arctic waters, building a $15 million oil spill barge with state-of-the-art cleanup equipment.[45]

The Chukchi deposits were too expensive to develop. The technological challenges were supreme, even for Shell. Because enormous sheets of floating ice would demolish conventional drilling and production platforms, the company looked at installing big ice-breaker platforms and pipelines that could resist ice scouring. Even if the technology could have been found, however, the falling price of oil by the late 1980s made the development of the Chukchi deposits out of the question. "It may have been a blessing in disguise that we didn't find commercial quantities," admitted Jack Little, the head of Shell Western E&P at the time. "We probably would have found the technological problems to be almost insurmountable."[46] During the 1980s, Shell spent an estimated $2 billion on leases and drilling offshore Alaska and came away with nothing to show for it.[47] So ended, for the time being, Shell's arduous, thirty-year quest to find bonanza reserves in Alaska.

Deepwater Vistas

As the failures followed one upon another in Alaska and other frontier areas, Shell started to shift the exploration spotlight back on the Gulf of Mexico, a proven oil province that in the late 1970s showed renewed signs of life with rising oil and gas prices. During 1975–77, Shell had actually deemphasized the "Cenozoic play" in the Gulf in favor of exploration elsewhere. In 1970–74, Shell bid on 64 percent of the volumes discovered by the industry in the Gulf but on only 22 percent during the next three years. The company focused on geopressured natural gas prospects in the ultra-deep producing horizons of the Texas Miocene. Discoveries in 1975 at Prospects Manifold (Eugene Island 136) and Calcite (East Cameron 57) encouraged this search, and Shell subsequently dominated the Corsair sandstone trend with discoveries at Picaroon (Brazos A19, A20) and Doubloon (Brazos A23) in the June 1977 and May 1978 sales.[48]

The June 1977 Gulf of Mexico lease sale surprised industry observers by taking in $1.17 billion in high bids. Shell placed second in the bidding, with $100 million in winning bonuses. Anticipated higher natural gas prices from the staged decontrol of gas, observers presumed, spurred on the bidding. Indeed, most of the discoveries on these leases—including significant ones by Shell on the Brazos and Matagora Island tracts—were made in gas-rich areas stretching from the mouth of the Mississippi River westward to the Mustang Island area near Corpus Christi, Texas. Over the next several years, lease acreage in the Gulf continued to draw spirited bidding. In the December 1978 sale, Shell outspent all others, laying out $184 million for ten tracts, again in natural gas–producing areas. Two years later, Shell and its leasing partners announced a $1.2 billion program for developing fourteen central and western Gulf of Mexico gas fields discovered on these leases.[49]

Despite success discovering natural gas in the West Louisiana and Texas Miocene, Shell managers felt they could have done better. The company still led the industry in Gulf of Mexico discoveries in the mid-1970s with an ultimate estimated volume (in 1987) of 349 million barrels, compared to 229 million for its closest competitor, Gulf Oil. But these results did not meet the extremely high standards that Shell explorationists set for themselves in the Gulf. As the 1987 lookback study concluded, Shell had "lost a good opportunity to add volumes mostly by Bright Spot discoveries," and "a lot of smaller companies did well on the 78 percent of the volume SOI [Shell Offshore, Inc.] did not bid."[50]

Beginning in 1979, motivated by the sense of missed opportunity in previous years and dimmed prospects in other offshore areas, Shell Oil expanded exploration in the Gulf. Meanwhile, BLM accelerated its lease sales. In 1981 there were a record seven offshore sales held in the United States. "We had a lot of lease sales. We went through a lot of lease sale reviews," remembered Charlie Blackburn. Competition for leases in the Gulf became fiercer than ever. The oil price shock of 1979 and the perception that offshore prospects were declining created a feeding frenzy for what was left. Bonus bids skyrocketed in the Gulf, shattering all previous records. "The bidding just got ridiculous," said Blackburn. "The whole business got ridiculous!" The September 1980 sale in New Orleans brought in $2.8 billion; Shell Oil purchased sixteen tracts for a whopping $316 million, second-highest in the sale. "I got a three-letter description: W-O-W!" said John Rankin, manager of the BLM's New Orleans offshore office, after the sale.[51]

Shell's exploration managers became increasingly dissatisfied with the direction of BLM's leasing program in the Gulf. First, there was the question of steeply increasing costs, as Blackburn indicated. Bonus bids, even those by Shell Oil, the most accurate and cost-efficient explorer in the industry, were too high for the potential volume available. During 1979–82 the company's bonus per barrel of oil discovered soared to $3.94, from well under $1 for the previous eight years, while the ratio for the top companies in the industry increased by a factor of at least four or five. Shell tried to maintain its advantage by bidding on deeper, more subtle traps rather than compete only on the few bright spots nominated, yet most discoveries were on bright spot prospects such as Roberto, Hornet, Cougar, Boxer, Glenda, Wasp, Peccary, Hobbit, and Cheetah. And the company made only two geopressured discoveries at Onyx and Persian.

Although all nice discoveries, these were still predominantly gas deposits containing lower average volumes than those discovered by Shell Oil in the preceding years.[52]

In Shell's view, the second problem, which contributed to escalating costs, was the federal government's method of rationing leases through the nominating process. The relatively small amount of nominated acreage actually offered in sales was creating an artificial shortage of exploration opportunities. "Tract selection," as the BLM method was called, offered tracts or blocks in a piecemeal fashion, which hindered more efficient exploration strategies involving basin-wide assessments or the pursuit of structural trends that transcended tract boundaries. The Department of Interior's policy of stipulating a two-year time limit before the release of well logs compounded the problem. Often, when a company had a discovery on a given tract, it would fail to get a promising offset tract nominated before having to surrender its well logs on the discovery. This policy both increased the cost and inhibited the development of prospects that spanned multiple blocks. Billy Flowers remembered Picaroon and Cougar as two important discoveries with open offset tracts that were not being followed up in 1980.[53]

Cougar was particularly important in that it held clues to finding petroleum in deep water—depths beyond the record 1,000 feet set by Cognac. At Cougar, Shell had found hydrocarbons in the "turbidite sands" associated with deepwater geology. The company had been focused on so-called deep water since the late 1950s. But the definition of the concept had changed over time—first deeper than 60 feet, then deeper than 200 feet, deeper than 600 feet, deeper than 1,000 feet. The only constant definition of deep water over time has been "the depth of the water just past the deepest platform." The modern concept, in use since about the early 1980s, refers to depths deeper than 1,000–1,500 feet, the maximum depth for a conventional six-leg platform, although every company has had their own definition.

The deepwater realm was still largely uncharted territory in 1980. The soaring price of bonuses, the small amount of acreage offered in the sales, and the short time horizon of leases stipulated by BLM prevented pioneering moves into these depths. But Shell geologists believed such depths held interesting possibilities. Combining information from deep-water cores drilled by the *Eureka* drillship in the mid-1960s with a 1977

regional seismic survey that probed the edge of the continental shelf and down the slope, Shell geoscientists detected some huge structures, salt pillars that were different from the conventional Gulf Coast salt dome. These pillars had squeezed up from the mother layer of salt, called the Louann sheet, 165 million years ago when cycles of seawater had rushed in and evaporated as the Gulf of Mexico was slowly forming.

Geologists speculated that ancient "turbidity currents"—underwater rivers formed by suspended sediment—might have carried significant amounts of sand out into deeper water, forming reservoirs to trap oil against the salt pillars. Whereas reservoirs on the shelf were highly faulted and required numerous wells to develop, deepwater reservoirs, if they were there beyond the edge of the shelf, might be large and continuous. In the 1979 and 1980 Gulf lease sales, Billy Flowers and Bill Broman, exploration manager for the Offshore Division, nominated some of these prospects, which ranged out beyond 1,300-foot depths. But because the industry as a whole was not yet concerned about those depths, the Department of Interior would not put them up for sale. Large areas had no calls for nominations, and some were not even blocked out yet.

Shell exploration managers decided that they needed more wide-open lease sales with longer lease terms to bring those areas into play. They put together a traveling road show of talks and presentations to high-level Department of Interior and U.S. Geological Survey officials to persuade them to open up deepwater areas for leasing. Instead of maximizing bonus bids in small sales, they argued, the government could take in more aggregate revenue in the form of royalties through larger, broad-area sales. But lease terms would have to be revised to provide incentive to the companies. They told the officials that the standard five-year leases and one-sixth royalty would not promote deepwater development. Something on the order of ten-year leases and one-eighth royalty would provide more incentive. They also pointed out the need for a safe supply for the country and the effect it would have on the U.S. balance-of-payments situation. "And we did something we had never done before," remembered Flowers. "We showed them prospects." Flowers and Broman were careful not to give away crucial information or overstate the potential, but they wanted to let government officials know that there *was* potential out there. They presented seismic data on some of these deepwater structures that made shallower water tracts, which had been put up for sale, pale by comparison.

One prospect in particular, codenamed "Bullwinkle," showed three likely oil pays.[54]

Lobbying by Shell and other companies planted a seed with Interior officials that grew after the 1980 election of Ronald Reagan as president. Shell officials found a much more receptive audience in the new administration. Reagan's secretary of the interior, James Watt, believed fervently in letting the market determine energy outcomes and in releasing federal lands for exploration. Executives from other oil firms also lobbied for reforms to the leasing program, but according to J. Robin West, assistant secretary of the interior for policy, budget, and administration under Watt, none were as effective or forthright as representatives from Shell Oil. "Charlie Blackburn was the one who tried to really work with us and help us understand what were the pros and cons, what was reasonable, what was not reasonable," remembered West. "Some of the other guys . . . would come in like potentates with vast entourages and they would lecture us about what they wanted and leave." Lloyd Otteman remembered making a presentation with Flowers to the undersecretary of the interior, Don Hodel, laying out their proposal for broad-area leasing with a slew of maps and view graphs. In the middle of the meeting, Hodel received a call from Secretary Watt. "He said he needed to go see Jim and he said he needed what we got," said Otteman. "And he just gathered everything up and went off! Later, he came back, and it wasn't too long after that they came out with 'area-wide leasing.'"[55]

Area-wide leasing, which was part of a new five-year leasing program announced by Watt in May 1981, opened up the bidding on any unleased tracts in an entire planning area (e.g., the western, central, or eastern Gulf of Mexico). Millions of acres would be placed on the auction block at one time. For tracts in waters deeper than 900 meters (about 2,950 feet), the program also offered ten-year leases and one-eighth royalty. Watt's area-wide leasing plan aimed to allow oil companies to explore areas they believed to be most favorable rather than areas selected by the government through the nominating process. Area-wide leasing promised to reduce some of the competition and thus lower the costs of bidding; companies with independent data could submit smaller bids on deepwater tracts because the probability of another bid on a given tract was relatively low. It was the most effective way, on the other hand, of accelerating the pace of exploration in federal offshore waters. After years of vocally advocating such a leasing program, Shell Oil could take some credit for helping bring about this major policy change.

The new policy and outspoken and confrontational style of Secretary Watt were not, however, universally popular. They drew protest from small oil firms and renewed political opposition at both the state and federal levels. Critics complained that the new system would give the majors, who had superior capital and technological capabilities for plying deepwater environments, a substantial edge over the independents. Environmentalists worried about a new wave of environmentally risky offshore development. The Pacific coast states, Florida, and several environmental groups went to court to block Watt's program. While the process was under litigation, Watt combined all offshore leasing, regulation, and royalty management functions in the new Minerals Management Service (MMS) within the Department of Interior, streamlining the leasing process and concentrating the growing pressure against the OCS leasing program in one agency. Legal and legislative challenges to the program failed in the U.S. Court of Appeals, and in May 1983 the MMS held the first big area-wide sale in the Gulf of Mexico, opening up over 37 million acres to bids, more than ten times what had normally been offered previously.[56]

To prepare the company for the new, big deepwater play, Shell had already embarked on a program to establish the viability and safety of deepwater drilling. Up to that point, nobody had drilled deeper than 1,500 feet in the Gulf of Mexico, and there were only a handful of wells in the world deeper than 3,000 feet, none of them in the United States. In 1981, after Watt's announcement of the new leasing program and as Shell exploration managers geared up for the play, Bookout had gathered top management together and recalls telling them: "I cannot in good conscience fund and launch this kind of program unless we can develop it. You've got to give me confidence you can get to 3,000 feet, and I want something on the drawing board saying you can get to 6,000 feet." The head office then assigned Carl Wickizer, manager of Production Operations Research, to conduct a feasibility study of "ultra deepwater" drilling and development in water depths beyond 6,000 feet in the Atlantic Ocean. After earlier exploration failures in the shallow waters of the Baltimore Canyon, Shell decided to see what the different geology of the deeper water in that area held. In the December 1981 lease sale, Shell obtained tracts in water extending to 7,500-foot depths in the Baltimore Canyon and Wilmington Canyon areas.[57]

Many critics of deepwater offshore leasing claimed that a technology barrier existed at 6,000 feet. Shell was determined to prove them wrong. In 1982 the company contracted with SONAT for the dynamically positioned drillship *Discoverer Seven Seas*, one of four vessels in the world rated for 6,000 feet of water. Shell then spent over $40 million extending the ship's depth capability to over 7,500 feet, adding a new large marine riser, a new long baseline dynamic positioning system with enhanced software and hardware, a new remote-operated vehicle designed for greater depths, and other modifications. Before the *Seven Seas* could begin drilling, however, Shell had to disprove the previous conclusion of the U.S. Geological Survey that the ocean floor in the area was too unstable for safe drilling.[58]

The company did this in 1981–82 by deploying its proprietary "deep-tow" technology. Deep-tow was a fish containing side-scan sonar that produced high-resolution images of the ocean floor and accurately revealed geological or man-made hazards. The deep-tow survey produced a new perspective on the seafloor geology of the area, showing a generally stable bottom topography and thus paving the way for deepwater drilling on Shell's leases. In late 1983, one hundred miles southeast of Atlantic City, New Jersey, the *Seven Seas* drilled an exploratory well in a world record water depth of 6,448 feet in the Wilmington Canyon. Although the drilling program in the Atlantic, which included two other deepwater wells, did not discover oil, the successful demonstration of drilling at such extreme depths established the industry's capability to drill in water depths beyond 6,000 feet. Just as important for Shell, it inspired confidence in the company's senior management about exploring in any deepwater frontier.[59]

Although the *Seven Seas* did not drill the first ultra-deepwater well until late 1983, Shell Oil was confident enough in the early feasibility study to bid aggressively in the first area-wide lease auction in May 1983. Gulf of Mexico Sale 72 as it was called, shattered all records. The industry leased 656 tracts for $3.47 billion. Under the leadership of Flowers, offshore vice president, and Doug Beckmann, exploration general manager, and with the enthusiastic senior management support from Blackburn and Bookout, Shell Oil put together an ambitious bidding strategy, spending $270 million for sixty blocks.[60] Several of the prospects it bought—Bullwinkle, Tahoe, Popeye—were in 1,300–3,000 feet. In October, Shell made a promising discovery on Bullwinkle, in 1,350-foot waters of the Green Canyon area. Producing from this depth would be a daunting challenge, but Shell's civil engineering

department believed that the fixed-platform concept could be stretched to that limit. As engineers began to design such a structure, exploration managers were already thinking about venturing farther out. In 1984 the *Seven Seas* moved into the Gulf to drill on the deeper leases obtained in the 1983 sale.

As with each historic step into deeper water, production lagged behind exploration. Fixed-platform technology could not be extended much beyond the depth of Bullwinkle. Either subsea wellheads or some kind of floating or compliant structure would be required. Concepts for all kinds of deepwater producing systems were beginning to come on stream. In 1981, Conoco had installed in the Hutton field in the North Sea a tension-leg platform, which was an innovative concept using large steel tendons to tether a floating platform to the seafloor. But the costs of all these concepts presented serious questions. Subsea completions were still expensive and not yet perfected. And Conoco's Hutton platform had experienced giant cost overruns. Shell Oil had to count on significant technological development and favorable economic scenarios to produce oil from 1,500–2,000 feet of water, let alone in anything much deeper.

One of the leading methods Shell's production department considered for those depths was subsea wellheads linked by pipeline back to a fixed platform in shallower water. But offshore pipelining faced distance limitations and economic constraints. Shell's production managers had a rule: the company could explore no farther than fifteen miles past 600 feet of water, the practical depth limit and distance for installing marine pipelines at the time. Because of these concerns, Shell Offshore's exploration managers made only a few bids in the April 1984 sale, the second major area-wide sale in the Gulf. They were caught off guard, however, when other companies, notably Exxon and Placid Oil, acquired acreage in water deeper than Shell had been prepared to go.[61]

The results from this sale prompted a flurry of meetings and discussions at Shell about what its deepwater strategy should be. Exploration managers wanted to eliminate the fifteen-mile rule and probe the extreme depths. Upon transferring from the Alaska Exploration Division in 1984 to become general manager of exploration for Shell Offshore, Mike Forrest told the production managers in New Orleans: "We just spent millions of dollars on prospects in the Bering Sea where there is no infrastructure and there is no proven oil source rock. And yet, in the Gulf of Mexico, we are not willing to take risks going out into deeper water? This is a proven oil province!"

Shell's problem in the other U.S. offshore basins was unfavorable geology. The problem in the Gulf was water depth. The geology problem could not be solved. But the water-depth problem could, as Shell had proved again and again.

Shortly after the April lease sale, Flowers obtained meetings with Threet, Blackburn, and Bookout to make the case for pushing farther into the Gulf. All three appreciated the urgency, given the competition, and they resolved that Shell would drop the fifteen-mile rule and begin gathering seismic data from ultra-deep water, using a $45 million, state-of-the-art seismic vessel, the *Shell America*, which had just been launched and outfitted. "We decided to drop everything we were doing on the shelf and put the *Shell America* to work in deep water," recalled Flowers. As long as a football field and 60 feet wide, the *Shell America* was one of the biggest, fastest, and most sophisticated seismic ships ever built. It housed a massive array of equipment and could deploy eight floats, all by a computerized launching mechanism. It not only could gather more specific data but did so with more speed and precision than ever imagined. It also had the space to accommodate large processing systems, giving Shell the capability to do much faster processing of its offshore seismic data. The *Shell America* virtually revolutionized marine data acquisition.[62]

Time was short before the next Gulf of Mexico area-wide lease sale in July. On the auction block were large tracts in the western Gulf. The *Shell America* immediately set out to gather as much data as possible. Because of the time constraint, however, the vessel had to focus on specific locations. Tom Velleca, general manager of geophysics in Houston, urged the Offshore Division to organize a team to search quickly for prospects in the Garden Banks area. Located in waters ranging from 1,000 to 4,000 feet, the prospects they worked on were considered very speculative. The geophysicists did not have as much seismic coverage as they would have liked. The *Shell America* had time to shoot only one seismic line across some of them. In fact, the areas they prepared bids for were more accurately classified as "leads" rather than "prospects." Previously, Shell had only bid on prospects, for which the company had good data. But the exploration managers thought that now was the time to take calculated risks. The introduction of area-wide sales had opened up huge swaths of virgin territory that could be purchased very cheaply. The lease sale team in New Orleans—Flowers, Beckman, and Don Frederick—poured over the surveys in preparation for the July sale.

Shell bid on ten leads in the sale and won seven of them, and for minuscule bonus prices compared to what the company had been paying prior to the introduction of area-wide sales.[63]

Two blocks acquired in the sale covered a prospect called "Auger," located in 2,900 feet of water. Further exploration identified it as the prospect with the most potential. The outline of the bright spots extended west into two open blocks. In those blocks, Shell geophysicist Mike Dunn mapped an amplitude anomaly at a subsurface depth of 19,000 feet, well beyond the horizon of conventional thinking about bright spots. Dunn and other geophysicists were convinced, however, that the amplitude effects were real. In the next area-wide sale, held in May 1985, Shell leased the two open blocks. "We were so afraid that other companies would go after the blocks," said Forrest, "that we bid $5 million on one and $2 million on the other. It turned out we didn't have any competition at all."[64]

In the May 1985 sale, Shell expanded its deepwater play into water depths of 5,000–6,000 feet. Critical to this play was the need for thick, continuous oil sands that could yield large fields and large reserves per well. Because turbidity currents off the continental shelf dumped such immense quantities of sands in one place, geologists had reason to believe that reservoirs there would tend to be far larger than shelf reservoirs. According to Broman, some of Shell's earlier geological research predicted that, unlike in the deltaic setting, where oil pays were found on the crests of salt dome structures, the turbidite sands deposited beyond the shelf would have largely avoided such crests. The seismic probes, therefore, were shot across the flanks of these structures, "down dip" from the crests. Shell's geoscience team mapped the salt ridges and the regional synclines where turbidite sands might have funneled into deep water. Meantime, Flowers and Forrest pressed the production managers on what size oil fields in water depths between 3,000 and 6,000 feet, using "to be designed" technology, would make deepwater producing operations economic. Gene Voiland and Carl Wickizer, production department managers, finally stated that, if the exploration group discovered fields of at least 100 million barrels, the engineers would find a way to make the discoveries pay.[65]

While these discussions were taking place, Shell drilled an exploration test well in 3,000 feet of water on Prospect Powell that had been leased in the April 1984 sale. Drillers located the well to penetrate a very strong, shallow bright spot anomaly plus a deeper, poor-quality bright spot. Drilling indicated that the shallow anomaly was not associated with oil or gas. However, Frederick excitedly reported the discovery of a 40-foot thick oil pay at the deep level. Further drilling and seismic surveys showed that the trap was entirely stratigraphic, likely to contain huge amounts of oil, certainly enough to meet the economic criteria set by the production department.[66]

Armed with this bit of intelligence, Shell Oil dominated the May 1985 sale. With partners or alone, the company was the high bidder on eighty-six of 108 blocks for which it submitted a bid, in a variety of areas. Its share in the high bids totaled more than $200 million. While most other deepwater lessees did not show interest in acquiring additional deepwater acreage, Shell took a giant plunge. It obtained tracts in the Green Canyon area ranging out to 7,500 feet.[67] It acquired prospects code-named Mensa and Ursa, among others. Combined with the tracts leased in the 1983 and 1984 area-wide sales, Shell now had huge areas of deepwater acreage in the Gulf of Mexico. Although no one at the time knew the extent of what this acreage held, Shell's deepwater play would pioneer the most spectacular new offshore frontier ever encountered.

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According to conventional media accounts, the origin of the deepwater era in the Gulf of Mexico dates to the mid-1990s, when first production at Shell Oil's Auger prospect was achieved.[68] But the path to deep water has a longer history, starting with federal leasing reform dating back to the late 1970s that allowed Shell Oil to implement an aggressive deepwater exploration and production strategy. The area-wide leasing system introduced in 1983, in response to years of lobbying by Shell and other companies, gave oil companies easier and cheaper access to offshore territory, thus helping uncover valuable new domestic sources of oil and gas. The acceleration of deepwater oil development came at a price, however, in the form of declining public revenues from offshore leasing.[69] The 2010 Macondo/*Deepwater Horizon* oil spill also convinced many Americans that the more permissive regulatory approach to deepwater oil development introduced intolerably high safety and environmental risks.

In the three years since the disaster, a host of reforms have been implemented to improve regulatory oversight and ensure safe operating practices.[70] The long-range effects of these reforms remain to be seen. Meanwhile, the leasing system in the Gulf of Mexico created in the early 1980s remains relatively unchanged, and deepwater exploration and development have returned at a vigorous pace. Efforts to open up new offshore territory, such as in the Arctic and along other parts of the U.S. coast, have resumed, leading to a replay of many of the debates from the 1970s and earlier.[71] The story of offshore leasing and development in the Gulf of Mexico in the 1970s and 1980s provides valuable perspective on current debates in the United States over offshore oil, as well as for making international comparisons. The government policies that have opened up the deepwater Gulf may provide a template for reforms to government leasing policies elsewhere. The globalization of oil markets has forced nations and governments to become internationally competitive in attracting oil investments. Further research into the terms of access offered offshore might provide new insight into how different governments value energy security and how different companies calculate the risks of deepwater development.

Before we see a transition to some kind of alternative energy regime, we will experience a relatively lengthy period in which an ever-growing amount of petroleum supply comes from marine environments. For the United States, this transition began in the 1970s. As the U.S. experience during the past thirty years demonstrates, the "end of easy oil" does not mean an abrupt transition away from conventional oil but an initial transition to difficult oil, like that produced from 5,000–10,000 feet of water. Deepwater is an important gauge with which we can measure the ability of global oil supply to keep pace with galloping demand. It is also a good indicator of how government and business negotiate the delicate balance between "energy security" and protecting the health of the marine and coastal environment.

Notes

This essay is adapted from Tyler Priest, *The Offshore Imperative: Shell Oil's Search for Petroleum in Postwar America* (College Station: Texas A&M University Press, 2007), 180–226.

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8. Here and in the following discussion, John Redmond information is from notes on the Cognac project and interview with author, Nov. 12, 1999, Houston, Tex. Most of the oral history interviews cited in this essay are archived at the M. D. Anderson Library Special Collections, University of Houston, Houston, Tex.

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