SHELL OIL COMPANY

ORAL HISTORY PROJECT

Interviewee: Lee Brasted

Date: December 19, 1997

Place: One Shell Plaza, Houston, Texas

Interviewers: Bruce Beauboeuf
Dr. Joseph Pratt

Code: SOC006

Keywords: exp, Shell, Eng

Bio

Mr. Brasted went got his B.S. in Civil Engineering from Bucknell University in 1964. He joined Shell in 1965 and soon began to work on developing offshore structures for the company. He worked on such projects as Cognac, Bullwinkle and numerous other offshore structures. In 1987, Shell made him Floating Systems General Manager. He retired in 1996.

Summary

Interview covers various platforms and their design. Extended discussion on the evolution of platform technology including with an emphasis on computers and undersea hammers. Useful information on TLPs as most of the interview discusses that technology.

Side A

BB: This is an interview with Lee Brasted. The interviewers are Bruce Beauboeuf and Joseph Pratt. This is December 19, 1997. We are at One Shell Plaza, the 41st Room Conference Floor. Mr. Brasted, how did you come to work for Shell, and what have been your positions and your responsibilities?

LB: I joined Shell in August 1965 in Midland, Texas. I was out there for about four months and then moved very quickly over to the construction design group, as it was called in those days, in New Orleans, which was charged with designing offshore structures. Prior to joining Shell, I had gotten my bachelor of civil engineering degree from Bucknell University, and then I had a National Science fellowship at the University of Illinois for 12 months. Immediately after finishing that, I interviewed at Shell during the time I was at Illinois.

When I first started working with Shell in New Orleans in the offshore in January 1966, I think the industry was in about 250 feet of water. One of the first recollections I have way back then was working on the Mohole Project, a very small piece of that, with John Lacey. He was my immediate supervisor. Later on, he left Shell and was with Fluor for a number of years, I believe now retired. We were assisting Brown & Root with trying to understand the dynamics of the marine riser for that project. A fellow from Shell Bellaire Labs named Ron Murdon -- I think he is currently at Rice -- had developed a dynamic analysis program. Of course, this was back in the days of keypunched cards. To make a single analysis of that marine riser required two or three boxes of cards to be punched. My assignment was to develop a data generator program where we could maybe put in a half box of cards to generate the other three. Using mathematical formulas, everything had been generated by Mr. Murdon.

I designed the platform in 159 feet of water - 159C. It was the first platform that I actually got involved in the detailed design of. That was installed in 1968. I believe it is still in place. I don't think it is any longer owned by Shell. And I had some other developing jobs from that.

From 1972-1976 primarily, I worked for a long time on the Gulf of Mexico. I was still here but our group then did a big design project for Shell UK. I headed up the design team to do the design for the Brunei platform. It was intended to be the first steel platform, but the fabrication problems allowed the concrete platform or the concrete structures to be in place.

After we installed that in mid-1976, I did some other things for a short while for the company. Then I was involved with Cognac in the project management area for about six months or nine months. I guess it was from the middle of 1977 until the end. Then, for a long period of time, I worked on a platform for the West Coast called "Eureka," which was the first self-bending structure that had been done after a launch. That was in 700 feet of water. We installed that in 1984.

Then I took over the supervision of the engineering for the Bullwinkle platform, which was installed in 1988. I followed that job through November 1987. We had the design all done. Actually, the platform was fabricated, except installation systems and things like that had to be completed.

In November 1987, I became manager of Floating Systems Group for Shell here in Houston, which had been, under one name or another, working for a number of years, probably a decade, on the development of tension leg platform designs. At the time I moved into that position, we had a preliminary design, cost estimate and everything for the platform, which, ultimately, with some variations, turned out a few years later to be Auger. We followed that with Ram-Powell. We were just into the design of the Ursa platform, 50 percent or so, when I retired in early 1996.

BB: Working designs on TLPs began in 1976?

LB: Probably. I would think the mid-1970s. There was a lot of TLP work going on before I knew what a TLP was because, in the mid-1970s, I was actually not too much aware of what was going on with Shell in the offshore or even the Gulf of Mexico. We were very intensively involved with that Shell UK project from 1972-1976. But I know there was a lot of R&D going on in the mid-1970s. I think there was an installation in the harbors out by San Francisco by the DOT, or a precursor to the current DOT that was a tripod platform. It was a one-third scale, or something like that. I think it was the mid-1970s.

BB: Shell was obviously a leader in the Gulf of Mexico deep water. To what extent were you involved and to what extent was Shell leader in the development of tension leg platforms?

LB: I think we were pretty much in the forefront all along. Of course, there were a number of industry projects, some of them led by Brown & Root actually. There was a major TLP project. I think that was the late 1970s, and Brown & Root was the prime contractor for them.

JP: Was that the Conoco?

LB: No, it was a general project that looked at a number of different TLP concepts that would be available to be installed off the west coast. The North Sea and the Gulf of Mexico were a pretty far-reaching study: looking at three-legged TLPs, four-legged TLPs and a variety of different configurations and arrangements of drilling systems as well as the structure itself. I think there were other projects led by Fluor. There were a host of them, and I am not familiar with them all. By the time I came along in 1987, they got out of fixed platforms and moved over into floaters. Most of that was ancient history. Actually, we had come so far along within our own company. A lot of the work that Shell was doing at that time, I think, drew from and was built upon those early R&D projects that had a dozen or more companies developed.

By 1987, we were, in terms of going for the deep water TLPs, fairly well going on our own for the purposes of conceptual designs and knowing how to do things. Of course, we were never really on our own; there were always a lot of outside people involved in a lot of different disciplines, tendon development, casing, connectors, just a host of bits and pieces, if you like, that we would work out the general engineering requirements for. Then we started working with a number of different companies, usually, often more than one, to try and develop them into something economically as well as technically feasible.

JP: I want to be sure before we quit that you talk about the key bits and pieces, and maybe help us understand where we could go to find out in more detail about that broad evolution of the OTC proceedings and those things. I want to ask you a historical question before you do that and that: Was there any feedback between Shell's early leadership and the semi-submersible drilling vessels and the TLPs, or is that just a separate technology evolving? It seemed like there would be a lot of the same problem.

LB: No, there was a lot of feedback. I think Bruce mentioned you talked to Bruce Collipp. He was in this floating systems group. Actually, he retired along with a couple of other folks the same month I came in to manage that organization. But a lot of input that came from Bruce Collipp, who had been labeled as the father of the semi-submersibles. It was reflected in the design of the Auger platform, in that it had a fixed drilling rig like an exploratory platform does, as opposed to a platform on a fixed platform on a rig. The fixed platform moves the rig over wells. The Auger rig is fixed and does not move; it is permanent on the structure, and had a lateral mooring system in addition to the tendons. The purpose of the lateral mooring system was to index the rig over the pattern of wells which was kind of an ovular pattern -- maybe 200 feet on major diameter and 100 feet or so on the line of your axis - to index the drilling rig over a particular well and hold it in position during the drilling process.

JP: Did any of that, from your point of view, flow in ways that historians would see from the Mohole project?

LB: Yes, a little bit, probably. I am not really sure, but I think a lot of the riser dynamics analysis tools, for one, and probably the mathematical concepts that are used to analyze a floating structure with the various kinds of configurations that you have, starting with a flexible mooring system to a taut, tendon-linked system, built on, or emanated from the early work that was done on that project.

JP: We will need to understand the TLP evolution in order to write this book well and have a good historical antecedent. But particularly, I am very interested in those nuts and bolts you are talking about -- the little parts of the system that Shell had to develop in order to have a successful platform. In your memory, what are the most important parts of it that you worked on, or that you supervised the work on?

LB: Some of the guys who worked with me in the development of Auger might put different priorities on different areas, depending on what they were involved in. But I think a key element in the whole thing was the tendon system, the design of the connectors themselves between individual segments of tendons. In the case of Auger, we used tendon elements that were about 220 or 236 feet long. That is a detail you can find in the records somewhere. And you are trying to install these platforms in a relatively short period of time, so you reduce your exposure to bad weather. Ideally, you'd like to have a continuous welded tendon from top to bottom.

But it would take an inordinate amount of time to fabricate that offshore. There were concepts that looked at welding tendons together in long strings, then pulling them out horizontally and upending them. Actually, we did a lot of work looking at that. A lot of tests were done at different wave tanks in the country to actually test that concept. If there were all these problems that we felt were difficult to overcome, the development of reliable connectors that could be made up fast -- and also disconnected if need be -- I think was very important.

Another key element was the latching mechanism at the base of the tendon that connected to whatever receptacle you had down at the foundation. We worked with a couple of different concepts for both connectors and latching devices. A lot of that work was going on throughout the mid-1980s. I suppose, to some extent, they still are being looked at today, to try to get improvements in those kinds of things. I know riser technology for the production risers, the connectors there, was another key area where we developed our own design of a threaded connection. Again, you don't have the time constraint there that you do when you are making up tendons, because the platform is already secured. But the off-the-shelf connectors were available, a typical casing connector, and that appears to have the integrity to maintain internal or external pressure in addition to the relatively high tension loads you would have to put on them. And so, we developed our own design, from fabricator to manufacturer. I think this is something that has helped make TLPs economic.

For a while, I thought we had something that was proprietary there, but it probably is nothing. Other people have gotten TLPs and they all have got connectors, so there are other ways of skinning that cat but followed by a number of different companies about the same period of time.

JP: I am really interested in those parallel paths; the way this technology evolves is stunning. Can you help us point out some of those parallel paths and how other companies get these things slightly differently from Shell? The process of sharing notes at OTC would seem to serve some of that purpose, the technical papers. It does look like, in this area of oil, there are fewer patent suits and those kinds of things. It seems like a little more of a cooperative effort. I was thinking that might be why the technology evolved so quickly.

LB: Yes, you've got to be really careful with that. I think one of the things that we got involved in, in early 1987 and 1988, when we were trying to finalize the details for Auger, was having our patents and licensing group do a detailed review of all the technology we were doing to make sure that we were adequately covering ourselves in terms of applying for patents that we thought we needed or should have on different ideas that people have; and equally important, to make sure that the technology we were using wasn't infringing on somebody else's. If it was, it appeared to be that we got proper arrangements made with whoever it might be, and that covered a whole host of areas for structural things of systems on the drilling units. There were probably scores of different issues that were looked at like that. And most things worked out quite satisfactorily. I think there were some cases, and there may still be some litigation going on, or maybe it has been settled by now.

BB: We talked with Grif Lee, who was involved with Humble in the very beginning. He was saying that companies looking for oil were secretive, but there was a lot of trading of notes as far as structures. But I talked with Carl Wickizer, and he seemed to give a different tack. He seemed to say that in terms of structures and production structures, Shell often considered that kind of information proprietary.

LB: I think I would have to agree with Carl on that. There was always an effort to try and keep what we were doing either covered by patents, or by a secret if something was different. We got up there with Auger in 2,863 feet of water, well in advance of anybody else in that depth of water in the Gulf of Mexico or anywhere else. The company had a real leg up on the competition in deep water for a number of years, and I think probably still does. From the standpoint of both the technical aspects of it, as well as the project management organization, how do you get a million parts all together at the right time and the right place and make it work? That was a major feat also. It involved slews of people doing that.

Auger was a 100% Shell project. Mars is Shell and British Petroleum. And Ram-Powell was Shell, Conoco and Amoco. And Ursa got a number of other partners. When Mars was coming along, the decision was made to bring the engineers from BP into our offices and work side-by-side as one team. There was a lot of concern in the company that they were opening up a Pandora's box of secrets. Are these people going to walk away with a lot more than they are putting in? It may have happened, maybe not. I know we did get a lot of excellent engineering and good input from those people as far as relationships, and still are. So it is a two-way street. And Shell was the operator in all those cases, so I am sure we gave away some technology and some know-how, but benefited some, too. Being out there first in the deep water, with all the background that Shell had, going back to whenever it was, the mid-1970s probably, put them in a position where they didn't have to worry too much about being overtaken. Plus, they had a tremendous lease position that was far and away, beyond what most of the competition was near to.

BB: Just one other thing about the trading notes issue. When I was talking with Ron Geer last week, he was saying, I think this was in the early 1960s, that Shell bid on some fairly deep water leases. Because Shell was so much the leader, they were the only one who bid. The federal government turned them down because they didn't want Shell to be the only one. So in the early 1960s, Shell went on this education effort in Washington, D.C. which he and Bruce Collipp, were a part of, to educate other members of the industry so they could bring on some competition. So it strikes me that there are at least, was a case of Shell openly trying to educate, and maybe not give away too much but.

JP: When they had that million dollar school . . .

BB: Right, the million dollar school.

LB: That was the fixed platform. I think Lowell Johnson and others were involved in that. That was actually before my time.

JP: 1962 or 1963.

LB: That was two years before I came. But then there was another educational process relating to floating systems and everything we knew. There were a number of companies -- I think Exxon was one of them -- that paid something like $100,000, from what I recall, for attendance at a floating technology discussion. That also must have been in the 1970s. Geer would have probably given you more information on that, or maybe Carl Wickizer could further recollect on that.

BB: I thought that was interesting. In some cases, they are helping to educate the industry, and maybe other cases, more . . .

LB: It was a two-pronged thing: one was to help educate the other companies so that they can get out there without being fearful; the other thing was who is going to build the TLP for you? Are you going to have your own fabrication yard? In order to develop the infrastructure of the Brown & Roots, the McDermotts, and the other companies that feed into that construction process, you've got to have more than one buyer for those companies.

BB: Carl Wickizer said that Shell eventually realized that they had to bring in some other people and then, of course, educate contractors as well. The price collapse of the 1980s, I think he mentioned, also necessitated bringing in more partners. Maybe that was when Shell went more towards joint ventures.

Would you talk about your work on the fixed structures and some of the challenges there.

JP: . . . When you started it and how it evolved up to Bullwinkle. That is good information.

LB: I think the most fascinating part of it is the size of the structures involved and the equipment that we built them with. I remember the first time I went offshore to watch a launch of a platform, probably 1967 or somewhere in that time frame for the installation of that Eugene Island structure that I developed the design for. It was probably a McDermott derrick barge -- it might have been a Brown & Root, I don't remember -- with a 250-ton crane. For a country boy growing up, that was a huge crane! And a few years later in 1987, I was in Trieste, Italy, with Gordon Sterling and Jimmy Mayfield. We were looking over the Italian semi-submersible crane vessel, which was under construction at that period in time. It is called Saipam now, but it was a different company in those days. And that has two 7,000 metric-ton revolving cranes on the back. Hereema's vessels, with the 3,000, 4,000-ton cranes. And there happened to be a vessel called the *Coral Sea* or something. It was a crane ship with a 3,000-ton crane that was there beside this huge semi the day we were on it. We were getting ready to lift one of the crane booms into place for the big vessel. I remember standing up on the control cab for this semi-submersible. You look way down there and here's this little boat down there with a 3,000 ton crane on it. This was only 20 years after I had looked at a 250-ton crane. I thought, you know, what are we standing on here? This thing, once they get it all together, could literally reach over the edge and take that thing up out of the water.

JP: I do that with my slide show on the offshore industry . . . to show the first purpose-built derrick barge. I tell them that by the early 1980s, there were derrick barges that could have lifted it and placed it on a deck.

LB: Right.

JP: Humble had the first derrick barge.

LB: I gave some talks on offshore industry at the school I went to in New York State last spring. A slide that I had borrowed from Hereema that showed their *BV102* vessel, which is almost comparable to that Italian vessel. And you tell people that here you've got something that can pick up 15,000 tons. What does that mean to them? What is 15,000 tons? It is equal to 15,000 Toyotas. It is mind-boggling what we do. Then you come along with Bullwinkle, and you've got a 50,000 ton structure built on land, on its side, loaded onto the world's biggest barge (still is). You take the thing out, tilt the barge a little bit, give it a small push and it slides into the water. Most people in the world think you are out of your mind doing something like that. But as an engineering manager involved in that, myself and other folks down there, we didn't have any concerns at all that it was going to come up top end first. It looked just right.

JP: That is a curious little trivia fact I'm interested in. When you first started, were they already barge launching, or were they lifting?

LB: No, they were barge launching.

JP: I wonder when the first barge launch was. That must have been the most trying time for an engineer.

LB: I don't know. I know they had a lot of interesting things happen with them back in the early days. Perhaps some of your friends at McDermott can clue you in on a lot of that because they were there. This is a McDermott story, so I probably shouldn't be telling it. They were out in the Santa Barbara channel. It was after Union had a fire back in 1969, and then there was a ban for X number of years. They came back, were installing the first platform. I think it was a 12-legged structure, and they are cube shaped. You never know how they are going to float. National TV was out there - Walter Cronkite or somebody - watching this thing. It went off the barge upside down. So what do you do next?

BB: There had been some cases where it hadn't gone well.

LB: It's not a big deal. They usually have harnesses and things to turn them over. It was upright and in place in short order a day or two later, but it certainly didn't look good . . .

JP: . . . on TV! It doesn't look like you know what you are doing.

LB: Look at these people. They don't know what they are doing. It's upside down.

BB: Where did you look for information or models in designing offshore structures? Was that all pretty much set in place when you came to Shell? Was your academic background helpful in that regard?

LB: Actually, no. Academic background really doesn't do too much for you at all except for whether you know about P over A plus M over S, in terms of very simple structural formulas and even more complicated ones. But when you get involved in the design analysis of a structure for offshore, there are so many other disciplines involved. You've got geotechnical people that discipline all their own people on the foundations aspect of the thing.

Then you've got the oceanographers and meteorologists who are determining what the wave and wind forces actually are. Then, at the same time those and other groups of people determine the probability of getting hit with different magnitudes of those. And there are so many areas that could come together, just taken from the structural aspects, before you get together and start thinking about what size the members are going to be, and things like that. Then the approach during the time-frame that I was involved up to and including Bullwinkle, was always how to make it as economical as possible, recognizing the fact that you are going to have a large amount of steel and a launch structure. I have forgotten the number of Bullwinkle but it was something like 50,000 tons. There was probably 10,000 tons of steel in there that would get highly stressed at one time in its life for a grand total of maybe one minute during a launching process. And there are other bits and pieces in there that, as it is laying on its side being supported in the fab yard are stressed to their design nominal. Once erect, there are all kinds of numbers you could cut out and never miss. So the challenge is to try and make all that work together as economically as possible so you have as little redundancy as possible. And you always look down the road with the contractor to see what kind of equipment they've got in making your structure as big as possible.

We did Cognac in three pieces in 1977 because the biggest barge available was then *Oceanic 93*, which launched those three pieces. That was a key in figuring out how to do that for McDermott and Shell together. When Bullwinkle came along in 1984, we designed that structure both as a single-piece structure and as a multi-piece structure. And when we went out for the first phase of bids on that, we said we wanted a turnkey fabrication, transportation and installation bid from the contractors who can decide whether it is going to be a single-piece or a multi-piece. When we got those bids back, both Brown & Root and Bullwinkle Constructors, another organization which was the dark horse, had opted for single-piece designs, which would have required fabrication of the launch barge, which was all worked into their bid. McDermott, which dropped out earlier in the first round of bidding, was looking at -- I'm stretching my memory back there -- a two-piece structure. They also had a concept for a single-piece structure that would require tandem launch barges. They did a lot of work on the development of that.

JP: Fill us in on the multi-piece. That is an interesting part of the history. Hondo is two pieces connected horizontally, and Cognac is three pieces connected vertically.

LB: Yes.

JP: Structurally, what is the difference when you are doing it in pieces? How does that calculation go in that bid? I know you couldn't do one-piece because of the equipment, but what are the changes when you have to put them together into one?

LB: Like the Bullwinkle, you are sitting there, you've got a 50,000-ton structure and you are going to launch that. So at some point in time during the launch process, you've got that weight minus whatever points you've got, which is substantial pivoting on the rocker arms. In the case of Cognac, which was a substantially lighter structure in 1,000 feet of water, each of those pieces is independent. So you have three launch systems, and the stresses are not going to be nearly as tiring. I know when Hereema was designing their *H851*, they started out with a 200-foot long rocker beam. And that came from input from us. They were also talking with Exxon at the time, because at one time, they were letting them build a two-launch barge because Exxon was building two platforms in Korea for the West Coast. We were doing Bullwinkle. And it looked like we were all going to come off at the same time. They were actually going to build a barge for each one of them. But we said we needed a 200-foot long rocker beam. As we got farther into the launch design, we saw that even with a 200-foot long rocker beam, that was like a 200-foot long barge. When you are going off the end of that, you still had troubles with loads. So we had to put a rocker beam on a rocker beam. Actually, the rocker beam split. There is a hinge on the middle of the big rocker beam that allows the outer 400 feet pivot also, which saved us a few thousand tons of steel in the structure.

JP: I imagine that the rocker beam is as long as the platform you started with?

LB: Yes, that is part of this growth in size of things.

JP: Help me with this evolution through these pieces. Obviously, it is easy to launch, but it must have been outweighed by the difficulty and the structural implications of putting them together if people would have kept doing them that way.

LB: Yes, I think it is the structural implications. With Cognac, we installed the base section in 1977, and piles were installed with an underwater hammer, so the foundation was all in place. In 1978, the midsection and the top section were installed in two pieces up on top of that, and that is all connected together by a big pin that ran all the way through the legs from top to bottom with grout. That was done because of the long time for installing the foundation and getting it grounded and secured. There was the concern about having a single structure piercing the water line if you got hit by a hurricane. You'd have a lot of exposure problems. With Bullwinkle, we came past that issue. For one thing, underwater hammers had come a long way. We had the technology for stabbing piles. It had been demonstrated on Cognac and other platforms within 10 years.

JP: Who was pushing that change? Who were the leaders for those underwater hammers?

LB: There were a couple of companies. There was Menk and Hydroblock.

JP: Menk, from the North Sea, and Hydroblock?

LB: Yes. Menk and Hydroblock were the two prime ones, both German companies helping a Dutch company. When you look back at Cognac, the installation cost of that platform was probably half of the total bill. On the Bullwinkle platform, the installation was still a large number but it wasn't that big of a percentage of the total structure. We had more confidence in the hammer operation. We knew we could get the platform set up, get a pile in each of the four corners very quickly, and then we would essentially be storm secure. Even with Bullwinkle, we did get run off by a couple of hurricanes for all the piles and conductors were installed.

JP: That is one of the costs of being out there first, though it seems historically, everyone has overdesigned the first ones just because you have to be afraid. You've got to be sure they are secure. You spend the money to be sure you know what you are doing and then you take money out, it looked like. We kept reading about the Cerveza platform that came after Cognac, which was a lot less expensive. Then you could look at what you did.

LB:T hat was all when it was launched in one piece. That made a big difference. It was just about the same water depth but not quite. I've forgotten what it was . . . 925 or something. Cognac was 100 feet more than that.

JP: But that is a fascinating process of technological change, where you are dependent on the equipment of different companies to stay up with them, to guess where you are going to be or meet you at the pass. I am curious about this also, and you are the perfect person to ask: how much feedback are we going to find from the North Sea into the deeper water Gulf? There are the hammer companies. There is some TLP operation in the North Sea earlier than in the Gulf of Mexico. Are those harsh waters of the North Sea teaching lessons that can then be brought back in the late 1970s and early 1980s and applied them to the Gulf of Mexico in a big way, or is there not going to be much of that?

LB: I don't know. I think historically, most of the technology went from the Gulf of Mexico to the North Sea. But there were other things about the North Sea, maybe even shorter installation of windows and things you had there, big hammer technology, because of big platforms. In the North Sea, you get a 100-feet design wave for the 100-year storm as opposed to 70-72 in the Gulf of Mexico. So piling was bigger on Auger. When we did the Brecht platform, we had 72-inch diameter piles. At the time, that was the biggest piling that we had driven anywhere. Cognac came along a year later which had 84-inch diameter piles. We didn't have an underwater hammer at that time either, so the other thing was done from the top, even though Brecht was an all skirt pile type thing.

When you start out in looking at fixed platforms, one of the things you try and do to minimize cost is minimize the number of piles. If you can get away with two piles in a corner instead of four, that saves you a lot of installation time. That means your piles are going to be bigger. When guys were looking at concepts for Bullwinkle back in the early 1980s, they asked hammer companies, "Are you going to be able to make a hammer with whatever it is we need, a million-and-a-half per pound or something, of energy?"

JP: I think you have just helped me start thinking about this better. The support companies did take giant strides in the North Sea, Hereema in particular.

LB: Absolutely.

JP: And that does transfer because then you have the equipment to do those designs? In the Gulf of Mexico, it didn't have to because it was tamer, you had more time to install and all kinds of other things. But the semi-submersible derrick barges . . .

<u>End of Side A</u>

Side B

LB: . . . so I wouldn't say any particular area of expertise. We were working with Furrow and Wright on the Brunei platform back in the 1970s, particularly on upending systems and that kind of thing. They were doing fixed platforms, primarily for the North Sea and a lot of Gulf of Mexico stuff also. But they had more specialists. It was an engineering consulting company that did platforms, whatever anybody wanted. I don't know whether Brown & Root or McDermott operated the same way at that time.

JP: You were doing the kind of things Jay Weidler was doing for Brown & Root, with the computer modeling and testing.

LB: However, don't get the idea an engineer was a total lone ranger on a job because we weren't. We relied on a lot of input from a lot of people. But we were pretty much responsible for the thing from A to Z.

JP: Over these eras, one of the dynamic aspects here has been the change in robo computers. Could you explain how that changed your job over time? You were talking about when you entered the industry and you were using the punch cards, up to now. On the other end, you get the 3-D seismic use the computer. But in the design of platforms, that would seem to be an awfully good advantage as far as getting more and more computing done.

LB: It is. When I started on that first platform, Eugene Island, our office was in New Orleans. I lived in New Orleans until 1974. The way we analyzed the platform, I created about three boxes of cards that would be analyzed -- a dozen or so wave force directions. Then you'd get on the airplane to come over to Houston where Shell's computing center was in the Prudential Building down near Holcombe. You would take the cards over there, submit them, go across the street to a hotel whose name I've forgotten, and about midnight or one o'clock in the morning, the phone would ring. It was the computer operator over there saying, "Hey Lee, this thing hasn't come out yet." I didn't know anything about computers. "Well, are the lights all still twinkling?" "Yes." "Well, just leave it alone." In another few hours, that thing would find a solution. Now you could literally do it on a Hewlett-Packard calculator. On a desktop PC, it might take all of five or ten minutes to do that complete analysis.

We used Cray computers for doing some of the analyses on Bullwinkle. We had 170 or 200 different load cases that we looked at, including different directions of wave approach, with different varieties of top-side loads with a rig over it, as one extreme or as another area all the way through load-out. Fabrication stresses. Load-out. Transportation, launch, and in place. Then you would combine those things all together and you've got roughly 250 independent load analyses that are being done. Then you had 4,000 members and 1,500 joints to platform. You've got to sort through all that to figure out who governs what, when. So you really get your finger on the key. Without a computer, you'd get a rough design, suspension, purchase. That was 80 years ago. But it takes a lot of time. Certainly, computers are what has made a structure like a TLP viable.

Midway through the design of Bullwinkle, which would have been probably about 1984 or 1985, we were developing CADD systems in our drafting department. We started out on the design of Bullwinkle with draftsmen at their tables with T-squares and all that kind of thing. And we ended up with Bullwinkle transformed in the middle, with everything being done on the computer. Of course, now our company is like all others. Draftsmen these days don't have a board, probably?

JP: Would we find that Shell takes the lead in developing computers modeling programs for offshore, or are most of the company borrowers from the specialized companies?

LB: In terms of Shell, most of the technology that we used in terms of analyses and modeling structures was developed, for the most part, in-house. We even had our own structural analysis program called "Stress." That was developed by the folks at Bellaire Research Center, and we used that for the design of Bullwinkle. As far as I know, it may still be being used. About the time I retired, we were seriously looking at using commercial three-dimensional space-frame programs because the support of our in-house proprietary system was out of hand. We couldn't keep up with advances. But we had a lot of bells and whistles tied onto that. I think before commercial programs were available, the way the wind forces tied it all in, I think we were ahead of the game a little bit.

BB: You talked about some work on the West Coast where you've got a very sharply declining shelf. To what extent did work on the west coast inform the move out into the deep water Gulf of Mexico in terms of TLPs or other structures?

LB: Probably not a whole lot, other than when we started the design of the Eureka platform on the West Coast in 1977. We installed that in 1984. There were a lot of political waves and one thing or another. That was down off Long Beach. I think we went into that knowing we were going to have the single-piece structure. There was just myself and one other engineer named Bill Lootes who worked on that thing for a long period of time. I was assigned as the engineering supervisor and Bill was working with me on it. We'd get a stab plan ready to have this thing installed by 1979 or so but there would be a delay. Instead of stabbing up, we kept working on it. That happened a half dozen times. Before you knew it, it was 1982 and we were ready to bid the thing. We essentially had the design done and went and got it built. I don't think there was a whole lot that came . . .

The West Coast is quite a bit different because there are a lot of other things you've got to consider out there. The wind and wave environment is a lot more benign than most of the areas because of the shielding of channel islands. But then you've got earthquakes. So you had the seismic criteria on the *Eureka* platform, which had 60 wells. We made it substantially heavier than a comparable platform might have been in the Gulf of Mexico.

BB: Can you talk about fixed structures and when you and perhaps others at Shell began to think about the limits of fixed structures? And what were some of the limits? You often hear about towing them out and installing them. Were those the main limits?

LB: I think the main limits on the depth of a structure all comes down to economics. On Auger, we had this group developing TLP technology. And then the decision was made, by the time Auger came along, that that was the way we were going to go. And Mars came along behind that in a little bit deeper water but not a whole lot. Within the company, there were a lot of questions about whether we should be putting in the fixed platforms or put TLP. Actually, we spent a lot of time engineering bottom-supported platforms for Mars. In the long and short of it, we could do it. It would have been a two-piece platform at least, in that water depth maybe three. But we basically developed quite detailed, completed designs for bottom-supported structures and did the installation, engineering, and everything. I think there were some preliminary bids, at least, from people like Gulf Marine Fabricators, McDermott, Brown & Root on those platforms. It was a matter of economics. The costs of fabricating and installing it just didn't compare it with what we could do with TLPs always having to back that up to around 1,500 feet of water. Bullwinkle is 1,353 feet, somewhere in that range. The time we were working on that problem is probably where I can see a trade off going from fixed to a floating type platform. And it may even go back farther.

Atlantis is that organization here in Houston that's got a mini TLP concept being built for British Borneo, BP or somebody else. Shell is a very small non-operator player in that, near 5% interest or something. That was being done for a tiny fraction of the cost of Auger, Mars or Ram-Powell. You know, it's got a lot fewer wells and a lot fewer facilities on it. Most of the technology and things that have been developed and learned on those platforms, is a benefit because now, there are a lot of marshes and fields out there that could be developed. If you tried to do it with a fixed platform, just by the very nature of things, you've got to stand out on the bottom of the stuff and you've still got that tremendous weight force that's going to be propagated all the way down through it. And we won't be economically competitive. Technically, you can do it. It is reasonable.

JP: Economics.

LB: It's economics.

JP: Has there been much effort to imagine TLPs as truly mobile, to be able to go somewhere else 10 years later? In the small ones, that would seem to be a necessary part of that, to make money.

LB: Yes, that is always there. You float this thing away and use it somewhere else but so far, at least the fields that Shell is involved in -- the Mars and the Auger and the Ram-Powell, they are so big that those platforms are going to be producing for 20 years or more. The technology associated with the reservoirs is not going to just sit there and stagnate. I don't know what the numbers are in terms of the amount of oil you recover out of a given reservoir, but historically, it is probably between 25-40%. So if you've got an Auger sitting there, you know when you get done with it in today's concept, that there is still a tremendous amount of oil down there. There is the guarantee that scientists all over the world are working on that problem.

JP: They're already into 4-D seismic now watching reservoirs, seeing how to do it for 20 years down the line.

LB: I think all those kinds of things are going to prolong the lives of the Auger's, Mars's, and Ram-Powells. One of the things that we think about seriously is cathodic protection of those systems -- both the stuff that is way down 3000 feet below the water and the hulls themselves. In 20 years from now, it has had its theoretical reservoir completion but then somebody is going to come along and say, we want another 10 years out of this thing, maybe 20. So how do you take care of keeping the structure intact? There is not a whole lot you can do. You can bank a little bit on those guys 20 years down the line. Then 15 years down the line, you start worrying about that.

JP: They're retired and you're worrying about it! [Laughter]

LB: Not entirely but all phases of that technology are moving along. So we can have our OPs.

JP: That's right. It's like thinking you're going to keep your old Datsun running for 30 years and realize it is cheaper to buy a new one down the line when they make better and better cars.

LB: Yes.

BB: In terms of that work on TLP at the beginning and mid-1970s, we've talked with Pat Dunn last year. You mentioned one of the bold moves that Shell made was -- I think Mr. Bookout was the president -- to gather a lot of deepwater leases even before the technology was there or they knew what was in those fields. I am guessing that this gathering up of deepwater leases is 1983, which was when the government began to offer area-wide leasing. When Shell made the move to gather up all that deepwater acreage, was the TLP concept already there, or did they gather up all that acreage and not really have the ability to develop it right at that time, just taking a chance?

LB: I think some of those things had 10-year lease terms on them, or maybe you had 10 years before you had to have the structure there, or maybe you could work on it. So I think there was a high degree of confidence within the company at that point in time. Yes, we know we couldn't go out there with a TLP to bid next year, but certainly, two to five years from now, if we pull out all the stops, we can get there. Because of the background that we had, starting from the early 1970s, it was just a matter of gearing up to do that.

I think there were improvements being made in drilling and production technology along that period of time, too. There was a lot of concern about pipelining processes and how the fluids were going to behave in the pipelines. What was that early on floating production system that was put in? A company from Dallas, the Hunt Brothers. It was an engineering success. It was a lateral board thing; it wasn't a

TLP. It had two or three wells. But it all came to a halt because of the problems with the reservoir due to sand build-up in the wells and hydration problems in the deep cold water just solidified the product in the flow lines.

BB: We were looking in the museum downstairs. What was the subsea? It was Ursa? What was that, 3,000 feet of water?

LB: Mensa is 5,400 feet of water for gas subsea. Ursa is a TLP that will be in nearly 4,000 feet of water next year.

BB: Obviously, there are different considerations of whether you go for a TLP or a subsea. Do you see more and more subseas as you get out in 3,000-4,000 feet of water. Of course, what you have plays a role in terms of oil and gas and having wells.

LB: Yes, I think so. As you get out into the deeper water, the technology to install a TLP probably is good out to 7,000-8,000 feet. I have heard some people say maybe 10,000 feet. One of the things that happens is the weight of the tendon systems and all that get so great that the pressures on the risers as you go into the greater depths can be a problem. A lot of times, however, that is balanced because you've got internal fluid as well as external. But Shell and others have been working for at least a decade and a half on carbon fiber technology for both tendons and risers. The technology to make that pipe out of carbon fibers will take the pressures and the tensions exists. The problem is how to connect one section to another because you have to go from a carbon fiber material to a metallic material. But I think I have heard recently that that problem is almost solved. That really holds down the weights and allows it to go farther conventional looking TLP. But there are probably a lot of situations, particularly where gas fields are involved, where you don't need a whole lot of wells. The subsea type technology is moving along at least at a rapid pace, or maybe even more so, than the surface type technology. We will be able to carry on out in those water depths.

JP: In the middle of your career, was there a sense of competition with the subsea people? Was there a sense that you were competing technologies within the same company?

LB: I don't think so. Even when we were talking about the TLPs -- particularly the later ones -- Mars and Ram- Powell, maybe more so than Auger -- we recognized that maybe there is a smaller field over here somewhere that we want to produce to this particular floater. There's a piece in the museum down there, a Molino wellhead from the mid- to late-1960s, off California. Shell had a subsea manifold manned chamber on the Gulf of Mexico floor, in 200-300 feet of water, some time in the mid-1970s. I think there was production there from a couple of wells for a short period of time. But I don't think it has ever been really a competition, but more as an adjunct that will allow you to do things with minimal fields once you've got a big infrastructure there, whether it be a fixed platform or a floater.

JP: I was out on Bullwinkle last summer when they were realigning it so it could serve as a collector for all these outlying fields, that you are tieing the subsea in the fixed platforms.

LB: Yes, I think Bullwinkle may have more production coming to it now from somewhere else than it does from whatever deal it was set out initially to produce.

JP: Yes, I think a lot more. I'm trying to remember the numbers, but I think they were gearing up to 200,000 barrels a day of oil for processing.

LB: Which is another thing, like what I was saying earlier about the life of these structures. How do you design it? Maybe the reservoir that Bullwinkle was put on will be depleted for good in another five years. You know, you've got that issue that you just raised, plus the reservoir guys themselves trying to figure out how to get that other 50% of whatever is down there. Somebody might want Bullwinkle there for another 25 years. And I am sure it is feasible to do that. It will be a lot of hourly work, reinstalling anodes, but maybe they will use other kinds of systems thrust current systems, and things like that, with that technology. It has been tried and had its ups and downs, but when push comes to shove and you've really got to have it to extend the life of an old platform, somebody is going to figure out how to make that work.

JP: Yes, you've got that fixed cost in Bullwinkle, plus the much higher cost to do something like it. So you are saying, "Well, is it going to be worth a hundred million dollars or whatever to save a lot of money?"

LB: Yes. If you look at the North Sea and what they've spent on some of the Forties field platforms, they spent more than the initial cost to refurbish and get the gas off the top of those fields over there. They lost billions of dollars.

BB: You have talked a lot about TLPs. Were you involved in some other floating structures? Is there anything else that might compete with a TLP?

LB: I can't really think of it. There is the floating production system type of structure that is being used off Brazil. It certainly got some application in the Gulf of Mexico. I am not that close to what has been happening the last two years in our own organization, but that is one of the things that we evaluated all along, with tension leg platforms and fixed platforms for moderate stresses. We also looked at an FDS-type system where you've just got the lateral mooring system. There is a lot more motion in the platform, both horizontally as well as vertically as it rides up and down on the waves, and you have to use flexible risers, maybe fewer of them than you do the vertical risers. Again, there are some pluses and minuses when you compare them. An FDS is a little bit cheaper to install because you don't have the expensive foundation system like you do with the TLP. On the other hand, the offsetting factor has always been the cost of the risers. Because it doesn't have any steel riser vertical below your TLP, you've got usually a complex type pipe coming up from a remote wellhead that will not be directly under your floating system. And those are substantially more expensive to have than steel risers.

That was looked at seriously in Mars and Ram-Powell. If you've got 20 wells to develop, the directional drilling gets you in all those spots from one location on a TLP. If you are going to have an FDS, it doesn't have a drilling rig on it. You've got to have another exploratory rig over here drilling a well, and maybe you've got one over there drilling a well because you've got your FDS. Pretty soon, you get a real mangled mess of anchors down there. So the coordination of all that, and then thinking about doing a workover over here at an inopportune time when I am trying to drill over here, are the kinds of considerations that have always been to the detriment of an FDS for the types of fields we have developed so far in the Gulf of Mexico. They have worked quite fine down in Brazil because the reservoirs are different down there. They require fewer wells than their reservoir geology there to get their production up. If you've only got five or six wells to begin with, then you don't have that opportunity to get things in such a mishmash manner as if you were trying to develop 16, 18, 20 wells.

JP: You have a whole other related set of issues with pipelines.

LB: Yes.

JP: Who should we talk to in Shell about pipeline evolution?

LB: That's a good question.

JP: Because that has been almost never brought up.

LB: Yes. The pipeline folks are always there. I'd have to think of the names and get back with you on that.

One of the older fellows, I think he is retired now, is Dean Henfeld. He was involved in developing Shell Technology. There was another fellow whose first name was Don. He just retired a year ago, or maybe earlier this year. His last name has escaped me.

JP: You all were doing your business fairly separately, I would assume?

LB: Yes.

JP: And the project gets put together when the pipeline comes in?

LB: Sometimes more separately than we would like, but we worked together quite closely with them, particularly on the TLPs but not on fixed structures like Bullwinkle. Bullwinkle had a dozen or more pull tubes of varying size, so you could bring a wire down through it, grab hold of the end of the pipeline and pull it in there. There have been a lot of other systems used. Exxon has a technique where they stab it down, get hold of the bottom, and pull it from the platform end away. I don't think we at Shell had ever used that. In fact, there are some structures in the Gulf of Mexico and also in the North Sea we did where we had a big bending shoe around there. We bent a 28-inch diameter gas pipeline around the shoe at the bottom and connected to some fasteners up the legs. So the pipeline technology development of leg techniques and all that has been key to the development of deep water, too. And getting out to develop of J-Lay technique, which allows us to get into deep water. Both McDermott and Hereema were working on that simultaneously and both do it now. But without that technology, tension-leg techniques weren't going to work.

BB: You retired last year?

LB: I retired in 1996.

BB: Do you think companies -- as long as the price still stays $18, $19, $20 a barrel--will keep going deeper, with TLPs and subsea continuing to be the main mode of operation out in the Gulf?

LB: I think so. I think if the price stayed around $20 a barrel, which it is under that right now, a company like Shell would not have a whole lot of problems making some fairly major strides. It has gotten to where it is pretty darned efficient. And, I guess, it is all a learning curve on the TLPs. Auger was $1.1-$1.2 billion. I think we chopped $150 million off the cost of Mars for a larger reservoir, probably two times or three times the size of Auger. And Ram-Powell comes along, with about the same size of reservoir in terms of barrel of oil equivalent as Auger, probably. And we lopped another $50 million or so off the Mars cost, for an almost identical looking platform. It really was a clone from the standpoint of the structure. The topside was a bit different. So everybody involved is continuing to look, learn and do things cheaper so that your production and operating cost is less.

JP: You get it cheaper and you get to go deeper!

LB: Yes, that's right.

BB: Are there any other people or documents that you think I should talk to or look at?

LB: I have brought a bunch of pictures you can look over, if you want to. If there is something there that is helpful, you are certainly welcome to borrow it.

JP: You went to the North Sea in cooperation with Royal Dutch. How much trading of people had been done between you and the parent company?

LB: Quite a bit, actually. In 1972, when we did the design of the Brent A platform, my boss at the time came to me in April or May of that year. We had done a design for a stable island offshore, East Coast of Canada, a year or two earlier, that involved a structure that looked somewhat like Brent A turned out to be. It was a 400- foot water depth structure that had at three giant 24- foot legs that would float the structure so you didn't have to have a launch barge. It was kind of a hybrid, self-upending.

1972 was a time period where things in the Gulf of Mexico were in a little bit of a lull. Our group in New Orleans designed the Auk A platform for Shell UK and that was a 275-foot water depth platform. A couple of engineers worked on it and another guy did the deck. It was built over there. Their people looked after the fabrication and installation of it. But we were sitting there with a bunch of engineers, in the middle of 1972. Shell UK came along with the Bratfield and asked for some input on it. What would we do? We worked up some designs, went over and presented them. They said, "Gee whiz, we'll take that one. Can you do it?" And we did. We had 10 or 12 people involved in the engineering of that for a year-and-a-half, two years maybe, all in New Orleans.

Historically, in the civil engineering group, as well as the whole platform technology -- oceanographers, meteorologists, those kinds of folks -- there's been a fairly lively interchange between our side and Royal Dutch Shell in The Hague. During my career, at any one time, we kept maybe one person over there from our group and I'd have the one person from their group over here for a year or two years.

JP: I got to know some of those guys, Henry and . . .

LB: Don Henry?

JP: Yes. And Tim Warren has given a presentation lately on what his job would be like fifty years in the future.

LB: I don't know him.

JP: Let me be sure I understand this, too. I am assuming that offshore Gulf of Mexico is one of the most significant things within Shell USA. Is that correct?

LB: Yes.

JP :It's the big place . . .

LB: It is <u>the</u> . . .

JP: . . . that you can be left preserved for you underneath?

LB: Right.

JP: Royal Dutch could really work out if only they had the technology and the big fields, and that would help explain why you have been the leader for so long. You have a stronger incentive than Amoco or Exxon to do your very best in the Gulf of Mexico.

LB: Oh, yes. Royal Dutch is just recognizing that. The technology has been developed here certainly has application in other areas of the parent company wherever it is, in Africa, the Far East, and so forth. I am sure it is not going to be lost in the Gulf of Mexico.

JP: This is great material. This is going to be a good book. Even if the Shell book . . .

THE END