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Interviewee: Wirsching, Paul Hugh
Interview Date: September 21, 2002

OFFSHORE ENERGY CENTER

ORAL HISTORY PROJECT

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Place: Houston, TX

Interviewer: Dr. Joseph Pratt

Side A

JP: This is an interview with Paul Hugh Wirsching for the OEC Hall of Fame. The date is September 21, 2002. The interviewer is Joe Pratt. Is it Professor Wirsching?

PHW: Professor Emeritus now.

JP: That is even better. We will start as we start most of these interviews, with a basic question about your background and how you came to work in the oil industry.

PHW: Well, I will give you a little personal history. I grew up in the oil patch. I grew up in Tulsa, Oklahoma, the oil capital of the world; that is before Houston stole that title! I went to st. Louis University and majored in civil engineering, entering st. Louis U. in 1953.

In 1956, I got a summer job as a clerk at Carter Oil Research Laboratory in Tulsa which is part of the Standard Oil of New Jersey Company. I worked there the summers of 1957, 1958, and 1960. They changed the name first to Jersey Production Research, then to Esso Production Research, and then about five years later they were adsorbed into Exxon Production Research in Houston and they closed down the lab.

During that time, I went to Notre Dame and got a master's degree in engineering science. After that I joined the mechanical engineering faculty at Loyola University of Los Angeles in 1959 and stayed until 1968. During that time, I worked exclusively in aerospace and had some very interesting experiences.

I went to the University of New Mexico in 1968 and completed my Ph.D. in 1970. I joined the University of Arizona's aerospace and mechanical engineering department in 1970. For 30 years, I was on the faculty there participating in our reliability engineering program, which is a totally unique program.

After I had been there a couple of years, I met a recruiter from Exxon Production Research and he arranged to make me a summer fellow at Exxon Production Research. I spent two summers there. I do not know what they called it at the time; it was basically the offshore structural department. That is where I really got into offshore structural engineering. In 1972, I did supporting analysis of Exxon's guide tower project. In 1973, I worked on and introduced structural reliability methods to Exxon.

Later I met Bernie Stahl, another one of the inductees

from the Amoco Research Laboratories in Tulsa, and I worked with him in 1974 and 1975 on reliability research and fatigue reliability problems. Bernie subsequently arranged an API-sponsored research contract on fatigue that lasted four years; that really got me started.

The first thing we looked at was the problem of trying to predict fatigue under what we call wide band stresses. A narrow band stress is a stress imagine a sign wave with a random amplitude. For fatigue purposes, you can clearly identify all of the stress cycles in the process. But in a wide band stress, which is what we see on these offshore platforms, you see a lot of low frequency stuff, high frequency stuff. You cannot look at the record and really identify the stress cycles. It turns out that in 1979, this was a really hot topic in the fatigue community. So, it was a very timely project.

I think we worked on that for about two years and we made what I thought was a significant contribution. The paper that we published was on the approximation to the rain float method, which is the numerical technique for calculating fatigue damage. The paper that we published has got, I think, far more attention than anything else I have published. And the thing is, I do not think that

this contribution is terribly significant. What is really significant in fatigue is the enormous uncertainty that we see in all the fatigue design factors. And, as we continued the project, we addressed that issue specifically.

Fatigue design factors are subject to enormous variability and uncertainty; the question is, how do you manage that? Well, probabilistic methods provide the answer to that. There are two fundamental issues in reliability analysis: trying to make an estimate of the probability of failure or the index of a structure, and also the flip side of that is the development of probability-based design criteria. So, we addressed both of those issues and that led to quite a number of publications. But, I do not think anything received as much interest as the rain flow approximation. I still occasionally get questions from students and practicing engineers on that!

In the early 1980s, Pete Marshall recommended me to serve on the committee of the National Research Council; namely, a committee called the committee on marine structures which serves as an advisor to the interagency ship structure committee. While on that committee, we wrote prospectuses. We evaluated proposals and then

monitored the research. My big contribution during that period was the development of what we called the reliability thrust area. The ship structures committee decided that they were going to put all of their resources into reliability projects for a three year period. The ship structures committee is composed of about 6 or 8 agencies including the Coast Guard, the U.S. Navy Sea Systems Command, the Maritime Administration, and a couple of others. Did I mention ABS?

JP: MMS at all?

PHW: Oh, yes. MMS. There were about 6 or 7 projects in the reliability thrust area over something like a three year period that were all funded. I eventually served on that committee for a period of 12 years and wrote 12 or 13 prospectuses that were funded. I think in the history of this committee, that was far more than anybody else had proposed or been able to execute. That was something I was particularly proud of.

In the 1990s, at the University of Arizona, the grad students and I developed an efficient method for performing fatigue reliability and maintenance with specific application to the tendons of tension leg platforms. My big project at the time was the analysis

of the tendon system of the Hydrin platform, a huge platform that is about 90 kilometers offshore of mid Norway. It is a huge structure. I think its displacement was about 300,000 tons. This project, which lasted about one year, was probably the most interesting project of my whole career. And so, that was another thing that I was particularly proud of.

For the last 10 years, I have been working with Ala Monsoor at the University of California at Berkeley on several projects related to the development of probability-based design criteria, mostly for ships. Now, realize that an awful lot of work that we do for a ship structure applies to offshore as well. In fact, ships or ship-like structures are now being used in offshore oil production.

Currently, my work continues. I became Professor Emeritus four years ago; but I continue to work mostly with Ala Mansoor and also with the American Bureau of shipping. I have got a current project to develop basic guidance notes for fatigue, specifically for offshore structures. What the project will amount to is a small textbook on fatigue and welded joints for offshore application.

Other things that relate to the offshore industry . . . at the University of Arizona I developed a one-week professional short course that I offered yearly for 20 years, the title of which is "Structural and Mechanical Reliability." During that period, it was attended by a number of people from the Marine industry - both from ships and offshore structures.

I also served on committees of the American Society of Civil Engineering. I was on the fatigue and fracture reliability committee for two or three terms; I served as chairman of that committee. I was on a CE committee on reliability of offshore structures. I served as chairman of the administrative committee on structural safety and reliability. I was on the International Ship Structure Committee for two years.

I have a number of grad students - both Ph.D. and masters students - that have worked with reliability problems associated with marine structures. I am proud to say that some of them have continued in reliability!

JP: I am going to ask you a general question and if it is not answerable, then do not answer it. But four our purposes, and I guess for my purposes, it would be useful to have someone who has been in this area for a while to

try to state ion language that people coming to the museum might understand why fatigue reliability, why this issue is of importance to the offshore industry? Also, how has knowledge about it has evolved over your career. A key issues that has changed how we come to know it and do it better.

PHW: Fatigue is the major failure mode in structural and mechanical systems. It does not play as important a role in structural systems as it does in mechanical or aerospace systems, but there are some very troublesome and expensive fatigue failures. For one thing, the tankers are routinely inspected and I think every five years, they bring a tanker in, put it into dry dock, wash it out, go inside and inspect for cracks, and they find hundreds. So, it gets very expensive to maintain a ship's structure.

With regard to the bottom-founded offshore and drilling and production platforms, you also have expensive failures - braces that break. There have been some very disastrous failures in the past. Some are troublesome. Offshore structures are still highly redundant and when a brace breaks, it is very difficult sometimes impossible - to repair and certainly very expensive. Fatigue failures often occur without warning in places

where you have not experienced fatigue before so it is a very important failure mode.

Now, with regard to reliability, one of the problems that we have designing for fatigue is that we find that there is enormous scatter in fatigue data. So, when we try to perform tests to determine how many cycles to failure, we find that when we repeat the experiment it is not repeatable. There is a large amount of scatter in the data and sometimes we see scatter over two orders of magnitude. I have data that is scattered over four orders of magnitude! For the layman, anorder of magnitude is a factor of 10.

JP: It is not an exact science.

PHW: Exactly. We are talking not only about the strength of the material with regard to fatigue but also the loads that members will see. The loads are principally fatigue loads on most structures. You can imagine a structure sitting, for example, in the Gulf of Mexico over a long period of time. You certainly cannot predict exactly what the loads are going to be during the service life, which is typically about 20 years. We use reliability methods, fundamental or basic probability and statistics, in order to try to manage this uncertainty. Our goal in

analysis is trying to predict the probability of failure, or an index of the probability of failure.

Because of all of the uncertainties in the factors - things we can measure - things we can and cannot measure we do not often have much confidence in these probability of failure estimates in an actuarial sense. We use relative sense to help us understand the risks and also as a design tool or as a design aide.

JP: Are most fatigue problems exposed in extreme conditions such as a hurricane or are there whole categories that just bail?

PHW: Most of the fatigue damage that you find in offshore structures is caused by the operational sea state. A hurricane will give you a few cycles of very high stresses, but it is the operational sea state where you get upwards to 10^8 cycles over the service life. It is those lower amplitude large cycles that cause fatigue.

JP: When you say developing a system of safety checks for fatigue for fixed platforms and TLPs? What did you develop?

PHW: A safety check is an equation or an inequality that tells

you whether the design is safe or not. In the most simplest form, you have stress in the member, which you know, strength of the member, which you know, and you divide the strength by a factor of safety. We say the design is safe if the stress is less than the strength divided by the factor of safety; factors of safety are typically less than 1. So, we pretend that the strength is less than it really is to account for all of the uncertainties.

JP: When you entered this field, what were the key questions facing the field and what are they today? Have they changed dramatically?

PHW: No, I do not think so. When I first started working on these fatigue problems, a fundamental issue was basically what is the fatigue strength? We define fatigue strength by what we call an SN curve, where we plot stress on the ordinate cycles to failure on the abscissa. These diagrams clearly show that at higher stresses you get shorter life, which is just what you would expect. When I entered the field, data on tubular welded joints was very primitive. There has been a major improvement in the quality of the data of fatigue strength of not only welded tubulars but welded joints of all types. Most of the work has been done by the Europeans. It turns out

that the American Petroleum Institute, in their requirements, still use what they call the old X curve, based on what was at the time primitive data. But, it has worked well overa period of years and it has withstood the test of time. Most of the new criteria that is being written uses the curves that have been developed principally by the Norwegians.

JP: Is there anything you would like to add for the tape on people you have met or events you have been part of that are particularly memorable?

PHW: Oh, the people have been memorable. Bernie Stahl really got me started in this business. He hired me at Amoco and supported my research. Pete Marshall was an enormous help as well; he introduced me to the Ship Structures Committee. Nick Settlemeyer with Exxon Production Research has also been a mentor of mine and I think that he has made some very significant contributions at Exxon. He is not particularly well-known because some companies do not encourage publication very much, but I consider him to be one of the world's top experts in fatigue. He is in it every day.

JP: I think Exxon figures that if he is known within Exxon, then he is famous! I think that is the way they see

these things!

PHW: Yes!

JP: Is there anything else you would like to add? This is very useful. It is good when you prepare it like that. It makes my job easy.

PHW: No, I think that is about it.

JP: Great. Congratulations.

THE END

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