Since the beginning of the offshore industry MARIN's research, tool development and Joint Industry Projects, have initiated and followed the trends in offshore hydrodynamics. On our 75th anniversary, MARIN takes a look at the past and asks where the industry is heading in the future.

Complex couplings and interactions in deep water exploration and production.

Courtesy HESS/MODEC

Offshore

Where do we go from here?

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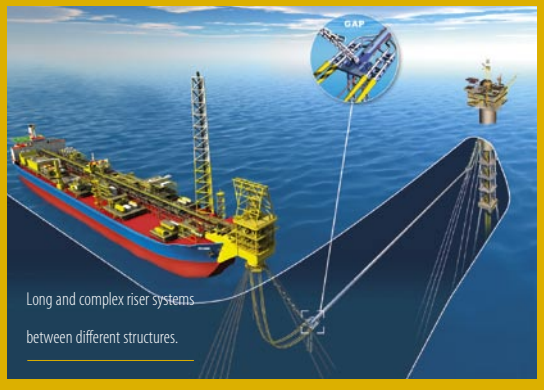
When the first floating offshore structures were tested the background of the observed wave and low-frequency motions was not directly clear. This initiated research that still is the basis for today's analysis techniques. Pioneers in this field such as former MARIN president, George Remery and Aad Hermans of TU Delft, linked experimental observations to mathematical insight.

Through the seventies the focus was on the prediction of the wave frequency motions with the linear diffraction theory and the understanding of low frequency drift forces. Landmark research included the PhD thesis of Gerard van Oortmerssen (1973) on diffraction theory and Jo Pinkster's on wave drift forces (1980). One of the first JIPs in this field was initiated during this time – the Wave Drift Research. Alongside this, Jan Hooft's work provided important insight into the specific behaviour of semi-submersibles (1972).

In the eighties the next step was made as there was now a focus on the time domain simulation of the motions. Insight into the damping of low frequency motions as a result of viscosity and wave drift damping was provided by the important work of Johan Wichers in 1988. Rene Huijsmans worked on the effect of the current on wave drift forces. This combined insight in excitation and damping resulted in a string of famous MARIN programs such as MOORSIM/TERMSIM, LIFSIM, SEMISUB and DPSIM.

In LIFSIM, multiple body problems related to heavy-lift operations could be handled just in time to support important offshore lifting projects in these years. DPSIM allowed the analysis of Dynamically Positioned (DP) vessels – another important development. Work on the analysis of risers was also initiated as the behaviour of flexible risers became a pressing issue for the feasibility of offshore structures. Lead by Henk van den Boom, the DYNFLX Code was developed for riser analysis.

In the early nineties the combined insight of vessel motions, mooring and riser dynamics, led to the development of coupled mooring analysis tools. The DYNFLOAT program was developed,



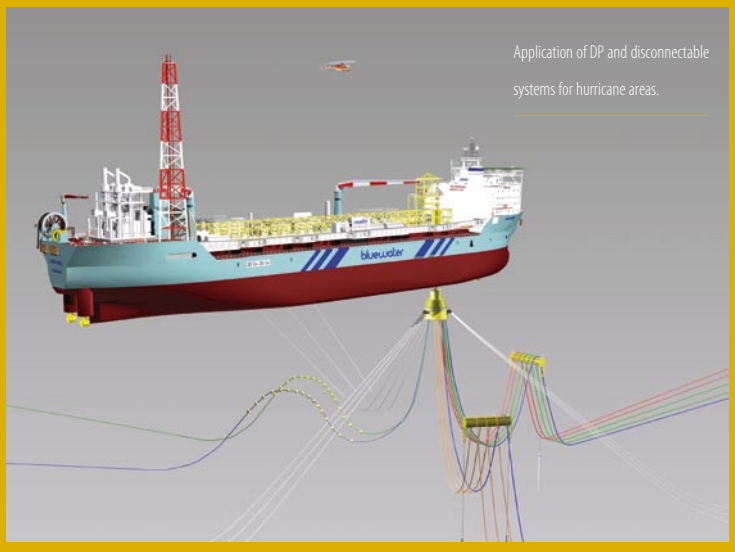
Long and complex riser systems between different structures.

Courtesy SBM Offshore

supporting the first steps of the offshore industry into really deep water.

In these years floating offshore structures were also being used in harsher environments. Thise move resulted in the JIP "FPSO Green water loading" in 1996 and later, to Bas Buchner's PhD thesis on this challenging issue. Initially, the green water and slamming research was mainly based on experimental work. But in 1998, through co-operation with Professor Arthur Veldman of the University of Groningen, the first steps were made with the numerical simulation of wave impact loads. Promising results led to the use of the improved Volume of Fluid method in the SAFE-FLOW and ComFLOW-2 JIPs.

The improvement of the behaviour of floating offshore structures remained the focus of MARIN in the new millennium. The "DPJIP" initiated by Albert Aalbers introduced the concept of wave

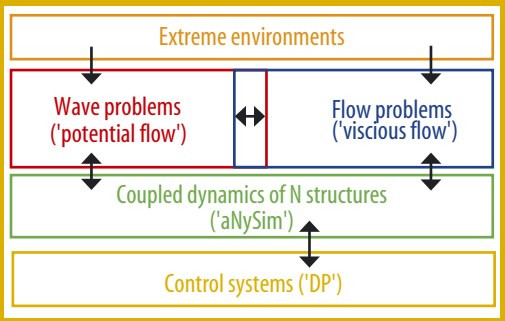


Application of DP and disconnectable systems for hurricane areas.

Courtesy Bluewater Energy Services

feed forward into the application of DP. The FPSO Roll project gave more insight into roll motions of FPSOs and the Offloading Operability JIP provided the "SHUTTLE" tool to both engineers and operational people.

MARIN sees its role in linking the newest research techniques with the future challenges of the offshore industry of which there are several. Large floating structures for deep water and LNG production, different offshore structures in close proximity, complex couplings, long and complex riser systems in deep water in current and waves, increased use of



control systems such as DP and controlled winches and extreme environmental conditions, are just a few challenges! This certainly means an increased complexity of simulations, model tests and full-scale measurements. Our insight into subjects such as extreme environments, wave problems, viscous flows, analysis of coupled dynamics of different structures and control systems, needs to be extended step by step.

Future offshore problems also require the integration of these subjects. Wave related problems are not just "potential flow" problems, viscosity needs to be taken into account. Viscous and free surface CFD will consequently be more important. On the other hand, wave effects will need to be considered in problems such as Vortex Induced Motions. Linear motion calculations will remain very important but are not enough to evaluate behaviour in the highest seas. Other CFD and test techniques for extreme conditions need to be developed. Interaction between different structures is so complex that it requires special approaches and tools. MARIN's present aNySim program is undoubtedly an important step.

So to get back to the question where we go from here? It is clear future research can be based on the strong foundation that has been developed. This, combined with new ideas, will allow us to tackle future problems. The strong relationship with the offshore industry needs to continue as well as the fruitful co-operation with universities.