# Deep Stability

## Researchers from USP develop an unprecedented project for a platform to extract oil on the high seas

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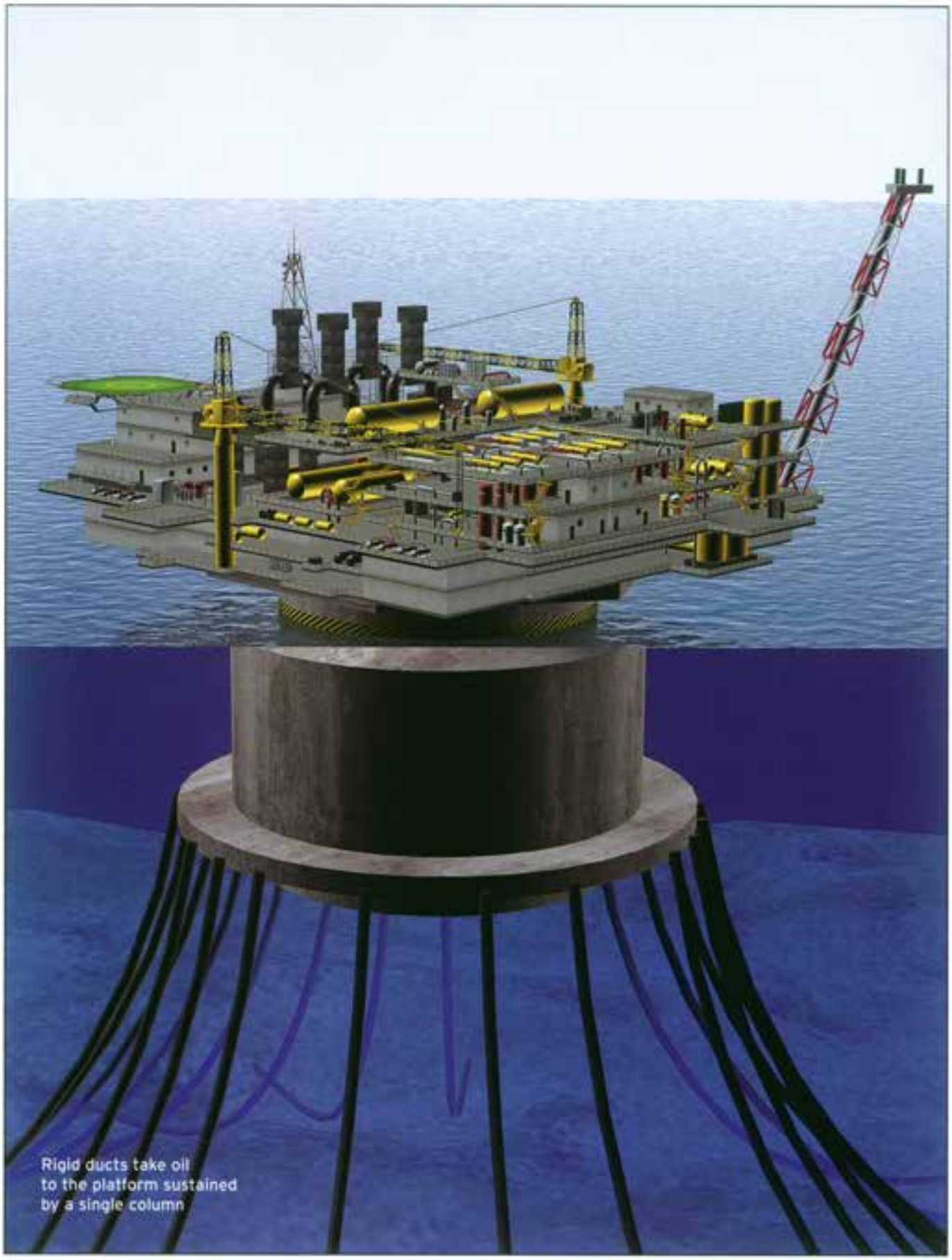
On the high seas, the movements caused by the action of the waves can become one of the great enemies of the platforms that extract oil at a depth of thousands of meters, in deep and ultradeep waters. This phenomenon can be seen in the Campos basin, Brazil's largest oilfield, where the waves of the Atlantic Ocean are sufficient to rock the oil platforms, however large they are. This rocking movement is disagreeable, both for the stability of the system and for the safety of the workers who live on the high seas. The oceanographic peculiarities of the waters off the Brazilian coast, where some of the world's largest oilfields at great depths lie, led the researchers from the Oceanic and Naval Engineering Department of the Polytechnic School (Poli) of the University of São Paulo (USP) to a project for an innovative platform. The surprising new design for sustaining an oil production plant is made up of a single column, and not by several, as in the semisubmersible platforms.

"All the simulations done with the unprecedented monocolumn system showed that there are great gains in movement, stability and safety", explains naval engineer Daniel Cueva, from the team of Professor Kazuo Nishimoto, of the Poli, the coordinator of the research carried out in partnership with Petrobras, in the ambit of the Naval and Oceanic Engineering Center of Excellence, made up by USP, the Technological Research Institute (IPT), the Federal University of Rio de Janeiro (UFRJ) and Petrobras's Research and Development Center (Cenpes). According to the researcher, the project for building the platform with a single column has now resulted in a patent request, on the part of Petrobras, in the United States. In two years, the company invested R$ 1.2 million in the project.

The technological development consists of the creation of a platform of the floating kind, without compartments for storing the oil. It is an option to the semisubmersible platforms, much used all over the world. In the category of floating units, Petrobras also has FPSO (floating, production, storage and offloading) ships. In another family, there are the so-called jacket platforms, fixed directly on the ocean bed.

"The MonoBR (as the new platform project is being called) goes in the direction of Petrobras's objectives of investing in consistent alternatives to large scale production floating hull units that have as their premiss greater safety and better operational characteristics",



Rigid ducts take oil to the platform sustained by a single column

explains Isaías Quaresma Masetti, an engineer from Cenpes who is responsible for the project. According to the technical team, the monocolumn platform has now undergone all the rigorous preliminary tests of technical and economic viability to which a project like this is submitted in Petrobras's internal ambit. One of the fundamental problems that the MonoBR has managed to solve was lessening the breadth of the movements of the unit due to the action of the waves, which brings about a greater operational flexibility for the system.

After all the assessments carried out during the development period, the new concept was validated, and is now on the list of available alternatives. When the new tender process is started, and the choices of the units determined on the basis of the needs for safety, operation, and costs, the monocolumn may now be one of those chosen. The winner of the tender does not have the power to veto or to alter the technological choice previously made by the company. "Extracting oil at a depth of 3,000 meters of water, is, in all its aspects, an innovative activity and one that calls for much technical boldness, as well as responsibility", Masetti explains.

The scientific line of thought for the monocolumn project arose from discussions that involved basic concepts of naval engineering, aligned with a few adaptations of structures used with frequency in the world oil industry, but in a different function. According to the engineers involved with the project, the location of these oilfields in the Atlantic Ocean, at a depth of over 1,500 meters, is one of the great difficulties in prospecting for oil. The impact of oscillations is not felt only at the level of the surface, but also in the ducts that carry the oil from the wellhead to the unit. "Today, for great depths, the use of rigid steel ducts, called steel catenary risers (SCRs), has come to be one of the great objectives", explains Marcos Cueva, a cousin of Daniel, and also studying for a doctorate under Nishimoto. According to the engineer, flexible risers are being supplanted, due to some technological limitations for depths of more than 1,500 meters and to their higher cost, compared with the rigid ones.

"The great problem with the rigid ducts is that they are subject not only to the effects of the currents on the bottom of the sea, but also to the oscillations of the floating unit. If the platform up there is swaying a lot, we begin to have problems related to the fatigue of the ducts, something that does not appear in the flexible ones, due to the nature of the materials used", Daniel Cueva explains. To allow the system to stay within acceptable levels of movement, the designers decided to adapt a system known to the designers from the sector, but which had never been used for this purpose. "The 'moon pool', a sort of opening installed in the hull of the platform, is much used in vessels to allow drilling equipment to access the sea bottom", Marcos explains. "We decided to use is as a way of reducing the amplitude of the vertical movements."

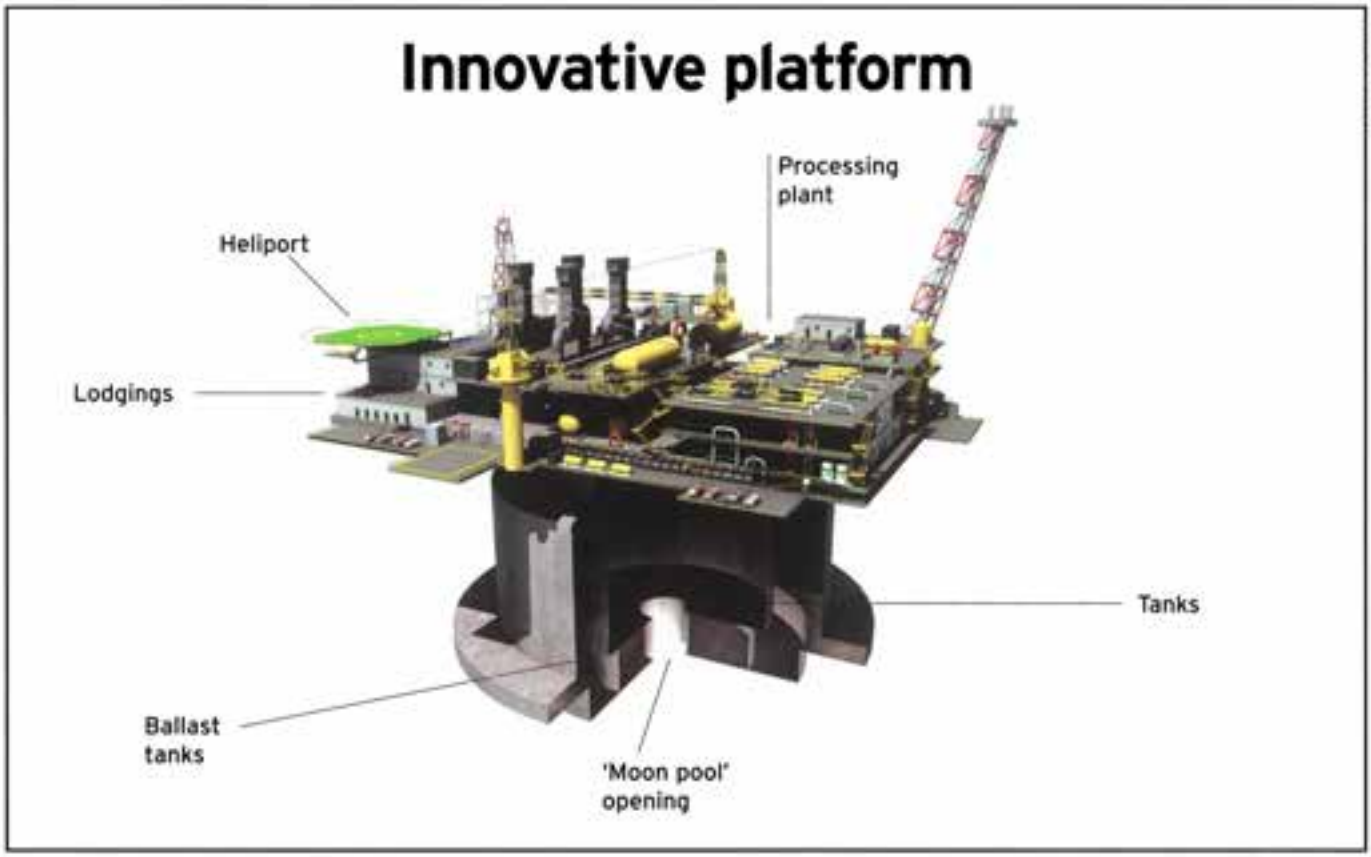
IMAGE BY POLI/USP

**Monocolumn keeps the platform stable**

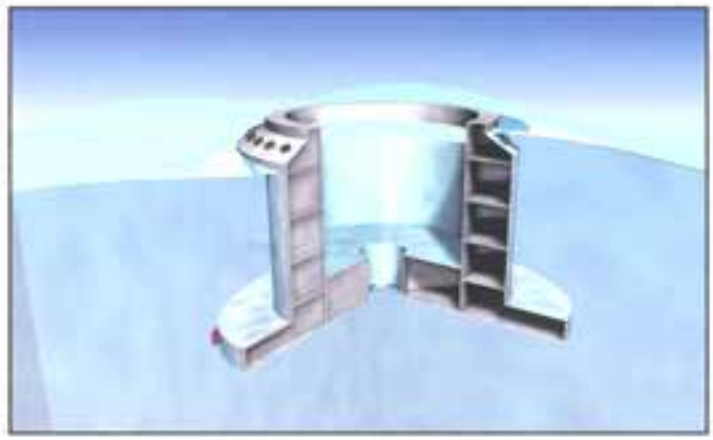
The work of researching and simulating projects like the one for this platform has come closer to reality since the so-called numerical test tank (NTT) was inaugurated at USP (*see* Pesquisa FAPESP *73*). Besides the physical tanks, which is the case of those existing at the IPT and the Coordination of the Engineering Postgraduate and Research Programs (Coppe), in Rio de Janeiro, a set of 120 computers and a three-dimensional projection screen operate in fine tuning, to offer the scientists conditions very close to reality. The simulation done on the NTT allows the engineers to make observations of the platform from all angles. And even to descend to a depth of over 1,500 meters, to analyze whether the SCRs are swaying, or not, more than they are allowed to. "Fatigue in these materials is always a concern", Daniel advises. Based on this and on other exclusive computer tools, developed as a result of the needs of the project for developing the platform, the scientists can say that the MonoBR, for example, has high levels of safety. "We did tests in which up to one quarter of the volume of the unit was flooded, and the platform did not sink", Marcos said.

The MonoBR was not born just from virtual tests. The prototype has already been in the IPT's tank in São Paulo, and this June will make its debut in Coppe's tank, in Rio de Janeiro. There will be four weeks of tests in which the MonoBR will be observed in Coppe's tank, which is one of the largest in operation in the world. It measures 40 meters in length by 30 meters in width, and is 15 meters in depth. "If we use a prototype on the scale of 1/100, for example, we are going to be able to observe it at a depth of 1,500 meters", Daniel explains.

According to the researchers, the development process has great academic importance, for the manner it has evolved within the university, integrated with platform design companies. "We did something that can be called an advanced conceptual project", Daniel explains. Academic projects like this usually stay merely at the conceptual stage. "They do not enter the so-called basic project stage, and much less get into the detailing, which only occurs close to the tender process."




The opening installed in the hull of the platform, called a 'moon pool', was used to reduce movements produced by the waves



In the case of the platform designed for Petrobras, the figures to be seen in the studies carried out at USP give the exact dimensions of the challenges of extracting oil from the depths of the ocean. "Our project provides for producing oil at a depth of 1,800 meters. The forecast weight of the MonoBR is 135,000 tons, and the width of the hull, for example, is 95 meters", says Daniel. The estimated price of the monocolumn platform is from US$ 500 million to US$ 700 million, a far lower amount than for those on the market.

Several small technological innovations are being planned for the final design. "For example, this platform has what we can call geometrical symmetries. This makes it much easier to construct and to inspect the critical points of the structure", Marcos reports. The researchers explain that the dimensions of a platform of this size are not just related to the great depths. Because of the characteristics of Brazilian oil, which is highly viscous, the production plant has to be increased, to make room for the robust equipment for extracting and producing the oil. The deck, in this case, always has to withstand heavy loads.

From the conceptual point of view, the hydrodynamic conditions (the movement of the waves and of the maritime currents) of the Brazilian sea can be regarded as having major responsibility for the development of the single column platform capable of supporting these conditions with more flexibility.

The Brazilian researchers, accordingly, chose a unique path, due to the environmental differences of each region. In the North Sea, in Europe, for example, the conditions of the waves, current, wind, and depth are different. According to Daniel, the discussion on the single column is a recent one. "It all started at the beginning of the 1990s. The Japanese, the Norwegians and the Americans are also thinking about it, but the only project really adapted to Brazil is ours." •