I'll Drink to those Legs

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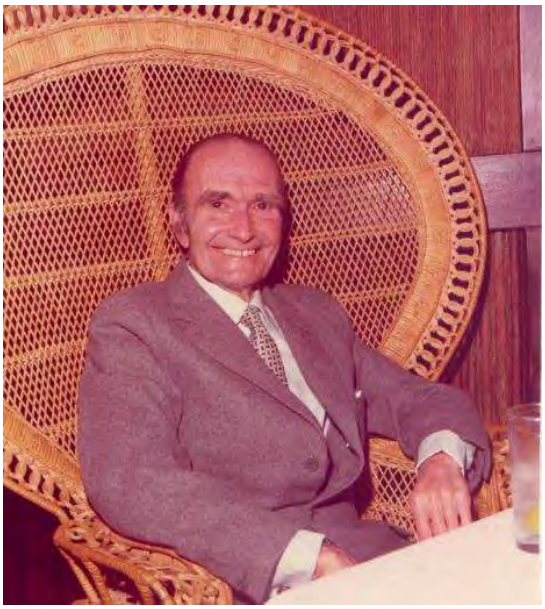
Introduction

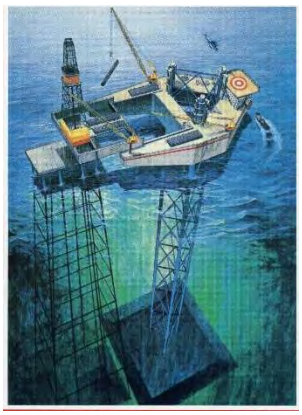
Captain W.D. Noble, who along with Dr Tony Denton, founded Noble Denton and Associates, was an extremely charismatic Master Mariner who could consume not insignificant quantities of alcohol, or more specifically, Gins and Tonic. He was born 21st May 1911 and died 16th July 1980 (69 years old - probably 120 of anybody else's years the way he lived it!) He used to have a drinking game. While one of the authors (John Stiff) doesn't ever remember participating in the game with the Good Captain, the other (Malcolm Sharples) said he used to do it quite often. The game was to drink a toast to the "Rig with 'X' many legs" where 'X' went from one to – well, we are not sure anybody is certain. The list of the rigs that were drunk to is relatively well established, but since this paper is being presented at a jack-up conference, it was decided to modify it a bit to fit the subject matter. This has meant that certain liberties have been taken, and in some cases, have had to stretch the credulity and imagination of the reader and conference participants – how many two legged jack-ups are there?



As a note, the stories relating to the units itemized below are correct to best of the authors' knowledge, but it is possible that some of the stories could be apocryphal and marginally fictitious.

The One Legged Rig

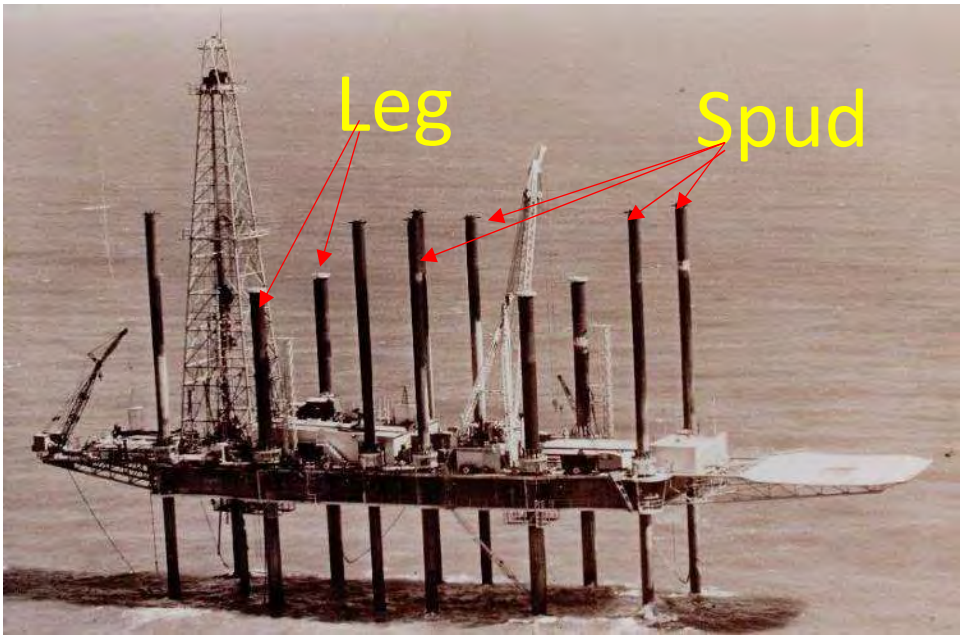
Captain Noble's original "One Legged Rig", was the Elf Oscillating Tower, an articulated tower anchored by a swivel plate to the seabed. Since this does not fit the jack-up theme, the authors have replaced it with the Bethlehem 600. This is not an ideal substitution as the unit was never built, but the authors were asked to review a set of hand calculations performed by Jim Steele. And what a set of calculations. Here, in a three-ring binder, was the complete design of a novel 600 feet water depth jack-up, including calculations of the structure, ballast, soils, preload, etc. You may not have been able to take the folder to a shipyard and come back later to pick up the keys of the completed rig, but they showed what can be done with an imagination and a solid understanding of engineering.



There is an alternative one legged rig, the Arup Concept Elevator (ACE) Platform. The first ACE platform, the Hang Tuah , was installed in West Natuna Sea in 2001. One of the authors did reach out to Arup to determine if they would like their unit included in such a prestigious list as Captain Noble's Drinks list, but no response was received.

The Two Legged Rig

The original two legged rig was the McAlpine Brent C Sea Tank, built on the west coast of Scotland in 1976 and towed around the north of the Orkney Islands to the Brent field in the North Sea. But, again, this is not a jack-up. This posed a problem for the authors; how many two legged jack-up were even considered, let alone built. But our intrepid authors found a solution – Mr. Gus, the Bethlehem unit built in 1955. Indeed, it was the first unit designed to operate in over 100 feet of water. Now, a brief look at the unit would suggest that it in fact has 12 legs. But that would be (marginally) misleading. The unit was originally built as two barges, each equipped with four spuds and two legs. The hull of the platform wasn't buoyant, so it was towed to location on the buoyancy of the lower barge, or mat. Once on location, the four spuds were



lowered to the seabed and jacked down to create a "solid" foundation. These spuds supported the upper hull while the mat was lowered, on its two legs, to the seabed to complete the installation, and help stabilize the unit[1].

Unfortunately, on its first location, one of the spuds broke during the installation (while the unit was still floating on the buoyancy of the mat) and another spud broke while it was being recovered. The problem was that the method of gripping the leg was akin to the slips used on a drill floor, and they did massive damage to the legs resulting in them breaking. It was also realized that four spuds and two legs were not really going to give a solid foundation, so the two halves, the drilling and tender platform were welded together to form a single unit, albeit awkwardly configured as the pipe rack could not be located directly adjacent to the derrick.

So, maybe it is a bit of a cheat, but there you have our version of a two legged rig, even if it was also designed to have four additional spuds.

The Two Legged Rig - Alternative

The "Hughes Glomar Explorer" was quite an oddity, and a huge "scam". It was purportedly built for Howard Hughes to mine manganese nodules from the seafloor. Indeed, it was highly publicized for that purpose; there was even a Nova TV program on the "whole" process. The unit was actually built, as we all now know, to salvage the Russian K-129 diesel-electric submarine that sank in 1968. The Russians did not know where their submarine had sunk, but the US had pinpointed the site through an array of hydrophones and satellite observations. It was located in 16,000 feet of water about 1,000 miles NW of Hawaii.

The CIA recovery project was given the codename "Project Azoria" and is well documented elsewhere, but its relevance to this paper is that the "Hughes Glomar Explorer" was a ship shaped vessel equipped with two "Docking Legs" that were used to raise the recovered submarine above the water. The legs were LeTourneau manufactured modified jack-up legs with two powered chords. The jacks were standard LeTourneau electric motor based systems. It was semi-successful in the submarine recovery in 1974. It was later stripped of its legs and converted to a DP drillship.

[1] It should be noted that the terminology of "spud" and "leg" is ENTIRELY the authors'. But we had to get the terminology to fit the requirement for a two legged rig! It is also of note that the above narrative is a compilation from conversations with Jim Steele and Ralph Scales (both of Bethlehem Steel) and the recollections of Emile Brinkmann. Additional material came from the book Brantly's *"History of Oil Well Drilling"* (1971)

The Two-and-half Legged Rig

On 23rd June 1988 the ship "Irving Forest" was travelling through the North Sea, with good visibility, but with an unmanned wheelhouse, when it collided with the Glomar Labrador 1, knocking out half of one leg. Fortunately, the rig survived and there were no injuries. The wheelhouse was unmanned because the relief officer was always late, so the officer being relieved decided to show him what for, and leave the wheelhouse unattended.

The Three Legged Rig

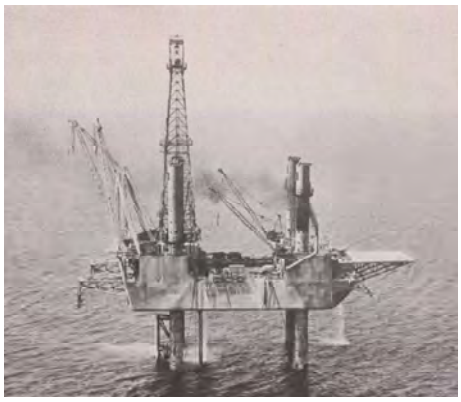
Clearly there are masses of three legged rigs to choose from, but the absolutely obvious choice is the LeTourneau jack-up Scorpion. While nowhere near the first jack-up, or even the first mobile offshore drilling jack-up, it was the first MODERN jack-up. It used electric motors and a rack and pinion jacking system and had only three legs. Up until that point, in order to get any sort of reasonable hull weight out of the water, you needed loads of legs because there wasn't a suitable jacking system that had a suitably large jacking capacity. Basically, most units used the DeLong pneumatic jacking system on a 6 feet diameter leg.
The unit was delivered in November 1955 to Zapata. In 2005, the fiftieth anniversary of the unit, George H W Bush made a short speech about the unit, and how it was an absolutely "no risk" venture for Zapata – if it didn't work, they could return it to LeTourneau for a full refund.

The Four Legged Rig

Again, there are plenty of four legged rigs, but the authors decide that the choice had to go to the four jack-ups built to lay the foundations of the Tay Bridge in 1884. The original Tay Bridge (a railway bridge over the River Tay in east Scotland) collapsed on 28th December 1879 with catastrophic consequences to the train, and all its passengers, crossing it at the time. There were many causes for the collapse, but basically it came down to lousy design, insufficient weight on the foundation, compounded by lousy casting of components all subjected to high winds. Anyway, it was decided to build a replacement bridge adjacent to the old one and these four construction jack-

ups[2] were built to help lay the foundations. It is believed that these are the first real jack-ups ever built; they have their own power supply and a real hydraulic pin jacking system.

The Four Legged Rig – an Honourable Mention



While nothing like as important as the Tay Bridge construction jack-up, the authors would like to acknowledge the Bethlehem Steel jack-up Mr. Gus II. This was the first of the "conventional" Bethlehem mat supported jack-ups using their standard hydraulic pin/pin hole jacking system. The rig was delivered in 1957 and was in operation after the turn of the 21st Century, albeit coming to a somewhat ignominious end when local resident complained about it cluttering their Gulf of Mexico coast skyline. But the real importance of this unit is the SNAME paper published on the design of the unit. This paper sets out a basic roadmap to the design of a jack-up and covers pretty much every topic. Anyone interested in the design of jack-ups is strongly encouraged to read it – and also look at the list of industry pioneers who asked questions at the end[3].

The Four Legged Rig Honourable Oddities

There are two rigs included in this category, the Transworld 61 (1970) and the Transworld Rig 60 (1971). The Transworld Rig 60 is a jack-up submersible. Makes sense; why not extend the water depth range of the submersible type rig by sticking a modified jack-up on top of it?

The other rig, the Transworld 61 was a jack-up semi-submersible drillship. There were two of this design built (the other being the Transocean 3). They were an attempt to improve the speed and ease of moving a semi-submersible from location to location by using a (vaguely) ship-shaped hull, but gaining the motion response advantage of semi-submersible. Once on location, the "legs" were jacked down and the pontoons deballasted so the hull was elevated above the water level thereby resulting in a four-column semi-submersible. It sort of worked, but the Transocean 3 is reputed to have had a dedicated welding crew onboard just to cope with the cracks in the outriggers, and the unit eventually capsized and sank in the North Sea. The Transworld 61 went on to operate off Brazil and was eventually scuttled in the mid 1980s.

[2] The authors are much indebted to Dr. Richard Stonor for drawing our attention to this jack-up, and the Institution of Civil Engineers paper on the replacement bridge construction.

[3] "Engineering Problems related to the Design of Offshore Mobile Platforms" by Rechtin, Steele, and Scale, SNAME 1957

The Four Legged Rig – Honourable Heartfelt

There have been a number of jack-ups included on currency and postage stamps, but probably the most locally iconic was the Sagar Samrat depicted on the Indian 1 Rupee note. The story goes that there had been quite a lot of drilling on Bombay High, but only dry holes found. Then the Sagar Samrat, the first rig owned by ONGC[4], drilled its first well and hit oil – the first to be found offshore India. This made the unit a national hero and it was placed on the 1 Rupee note. Interestingly, in the mid-1990, one of the authors (John Stiff) was tasked by ONGC with determining if certain changes could be made to the rig, and if they would affect its operation. One specific change was the removal of the "King Posts" that were installed on the unit so that it could add or remove sections of leg, by itself, for ocean transportations/tows (the unit was self- propelled and had a full marine crew on board). Given that the King Posts were rusted beyond belief, and the unit was never going on another ocean transportation, John made the unthinkable error of saying "Yes, they are worthless; cut them off.". What he didn't know was that the King Posts were an iconic part of this iconic rig, easily visible on the 1 Rupee note and he had been asked his opinion as part of a purely political brouhaha over reducing the weight of the grossly overloaded jack-up[5] so that it could operate more safely when afloat.

The Five Legged Rig

The only five legged jack-up known to the authors (apart maybe from the occasional 6 legged jack-up that had lost a leg) was the Isle de France, an IHC Gusto designed unit. It was built in 1965 and scrapped in 1989. The main item of note about this rig is that it wasn't dry; there was wine onboard to be happily consumed at mealtimes.

There is a story – probably apocryphal, that RG LeTourneau was approached to build a jack-up for Elf. Part of the design was for two large capacity stainless steel tanks. The good RG questioned the necessity for stainless steel as it was going to increase the costs significantly, and may have even made his bid uncompetitive. Well, said the prospective buyer, you have to store wine in stainless steel. "WINE!" Mr. LeTourneau said. "You can't store wine on one of my jack-ups". And that, so the story goes, was the end of that.

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[4] The Sagar Samrat was an Offshore Mercury design jack-up, designed by the Offshore Company. I have been told, on good authority, that the Offshore Company never did receive one penny of royalty for the rig from ONGC.

[5] You never wanted to move the Sagar Samrat in dead calm conditions if you ever hoped to see the loadline. It had one, but it was pretty much subsurface during every rig move.

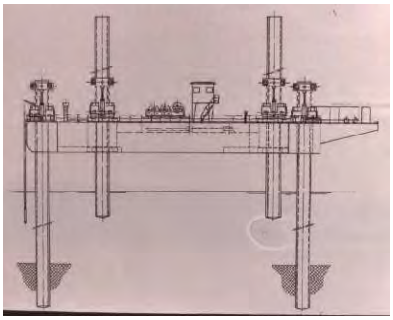
The Six Legged Rig

The Transocean 1, built in Germany in 1965 is reportedly the first jack-up designed specifically to operate in the North Sea. It had six tubular legs, each fitted with one rack forward and one rack aft. After its North Sea life it was converted to a production facility in the Arabian Gulf called the Deutag 1.
One of the authors (Malcolm) stated that it could jack-up in significantly larger waves than most units at that time, and could "preload" (pre-drive) exceptionally quickly because of its six legs.

The Seven Legged Rig

Are you still standing after drinking to (at least) six previous rigs? If so, maybe you can count the legs on that chair over their – it has seven legs.

The Eight Legged Rig



The Avala 1 was a unique design of walking jack-up built by IHC Gusto in 1978 for pier construction.

The 10 Legged Rig

The Offshore Rig 51 is generally accepted as the first mobile offshore drilling jack-up and was delivered in 1954. It had 10 legs, each of 6 feet in diameter, and used the Delong type pneumatic jacking system.

The Twelve Legged Rig

The best known twelve legged jack-up has to have been the Mr. Louie, designed by Emile Brinkmann and delivered in 1959[6]. The Mr. Louie drilled the first well in the North Sea, offshore Germany, in 1964. (The first well drilled in the UK sector was by the Mr. Cap.) It later, in 1968, went on to drill the discovery well for the major UK gas field "Indefatigable".

There is a story from Emile Brinkmann about the leg footings[7]. Mr. Louie Russel, who financed the construction of the Mr. Louie, had very firm ideas about what a leg footing should be like. He wanted a pad at the base of each leg; BUT he wanted it to have a slip fit so it could slide a limited distance up or down the leg. Emile Brinkmann said that this arrangement wouldn't work, and an argument ensued.

Construction proceeded and when it came time to fit the footings, Emile got to the welders first; he got them to weld them on solidly – well, most of them, because as they were about to start on the 9th footing, along comes a Cadillac, and out steps Louie Russel. Plans changed and the last 4 footings were fitted to slide. And that's how the unit went into operation.

But that's not the end of the story. Years later, the unit was sold to Reading and Bates and was towed to the North Sea (in 1964). It was a rough tow, so when it arrived in Germany, Emile had it towed up a river to protected waters to inspect the footing. All the welded fast footing were in good condition, but all four of the slip footings had fallen off. When they were replaced, they were welded on solidly.

The Eleven Legged Rig

OK, this is a bit of a cheat, and out of order, but the Mr. Louie was notorious for losing legs, so the authors believe it deserves the distinction of also being an eleven legged jack-up.

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[6] Emile Brinkmann was the father of Carl Brinkmann, a longtime member of the jack-up working group that developed SNAME Bulletin 5-5A, the basis for ISO 19905-1 and 19905-2.

[7] The story is indirectly taken from a video interview with Emile Brinkmann, conducted by Malcolm Sharples in about 2014 for the Offshore Energy Center in Galveston (as it was know at the time). It is possible that some minor details have been misquoted in the transcription. Sadly, Emile died on 3rd December 2018 aged 95.

The Fourteen Legged Rig

The Offshore Rig 52, built in 1955 had fourteen legs and was retired in 1980. The unit was comprised of two jack-ups that were welded together.

More Than Fourteen Legged Rig

There may be many, but the best example of a jack-up with more than fourteen legs must be the San Marco, a twenty two legged jack-up that was built in 1957 and was converted to a rocket launch platform, operating off Malindi, Kenya for the Italian Space Agency. It is accompanied by the Santa Rita, an old LeTourneau rig built as the Scarabeo in 1959, as the rocket control platform. It was responsible for 27 launches between 1964 and 1988. It is understood that the platforms are still on location, but are not currently in use. There was some talk of them being used by the Russians.