DISCUSSION

OFFSHORE AND COASTAL FLOATING HOTELS: FLOTELS

M Lamas and **L Carral,** University of Coruna, Spain

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COMMENT

R Reeves, Marine Asset Corporation, UK

I should like to describe the Compact Semi-Submersible (CSS) vessel which was conceived as a vessel with the scope and capabilities of much larger vessels at half the cost.

Concieved, developed and managed by a team of international experts, the CSS offers a safe, stable, offshore environment, working platform and accommodation for the personnel onboard. It boasts a safe means of access to connect to an offshore structure and enable the timely and safe transfer of personnel between the vessel and the worksite, despite adverse weather conditions.

The technology is not new and has been commonly used in Semi Submersible Drilling units.. However, the utilisation of semi-submersible technology compacted into a vessel specification with attributes and facilities enabling an extended 'on location' duration in support of an offshore structure, is new.

The CSS is essentially a self proppelled mobile offshore work platform with life support facilities for accommodation, messing, recreation and the like, a helideck for crew changes and a telescopic hydraulic gangway installed to safely transfer personnel to the offshore worksite.

Having a deadweight of some 3800tonnes, installed power of 16800kW, propulsion of 4 x 3000kW and controlled by a DPS-3 system, the CSS will be able to stay on location in up to 6m seas and winds in excess of 40 mph. The duel engines rooms will enable the CSS to stay on location and safely retrieve personnel in the unlikely event of a single engine room fire or flood.

The detail has been concentrated into the hull and seakeeping characteristics to effectively produce a stable platform. The first variant will be produced as an accomodation support vessel but other variants include:

- Sub Sea engineering vessel with Saturation dive spread;
- Well head maintenance vessel;
- Heavy lift vessel;
- Wind Farm mothership; and
- Helicopter support vessel for national navy use.

The CSS concept evolved over a five year period of study, design, testing and marketing. The first CSS vessel is now under construction and due to be delivered toward the end of 2012.

The views below show the DP-3 accommodation vessel version. It is 84 m long, 32 m beam, has a speed of 14.5 knots and has 500 beds.

Figure 25. DP-3 accommodation version of CCS

D Roddier, Marine Innovation & Technology, USA.

This paper about offshore flotels shows the designs that have been already built with traditional concepts such as mono-hull ships, semisubmersible barges or jack ups. But there a number of new proposals for offshore flotels that for sure will appear in the market in the next years. *Marine Innovation & Technology* has recently designed two innovate semisubmersible structures that could be used as offshore flotels: the *Clubstead* and the *Minifloat.* They are presented in following pages, together with a curiosity about an accommodation barge used by Ecuadorian navy.

We also would like to make some comments on the particulars mentioned about semi-submersibles that appear in section 6.1.

Section 6.1. Paragraph 3: *Semi-submersibles have much greater response to externally applied loads such as weights, loads, and ballast. Another way of stating this is to say that its righting moment and metacentric height are much lower than those of a standard mono-hull barge.*

This comment should be clarified as response in generic terms refers to motion response. The roll response of a semi is much better than the one of a mono-hull. The comment on the metacentric height is also slightly inadequate or at least not defined well enough. GM = KB –KG + BM, where K is the keel, B the centre of Buoyancy, G the centre of gravity and BM the ratio of the waterplane inertia/displaced volume. In most cases the BM of a semi is larger than a mono-hull, so semi is better for larger GM. KB is half the draft for wall sided floaters so it depends on the design, but semis are usually deeper so yes you want for stability a higher B so mono-hull are better. You also want a low G and again, if you can put more stuff near the keel (and not on the top side) the mono-hull is better, so it's not very clear and you have to run the numbers for different designs...However this is only for static stability. Motion in waves has to do with the wave exiting forces and the platform natural frequencies. Usually a semi have longer natural periods so are not exited as much by the waves, hence a better motion performance.

Section 6.1. Paragraph 4: *The semi-submersible has seriously reduced topside cargo capacity. It relies on a low centre of gravity to maintain stability.*

This should also be clarified, as you can put a lot of cargo in the columns. Most of the drill rigs have fuel and water ballast tanks there, keeping the CG low.

Section 6.1. Paragraph 5: *The semi-submersible costs more to build and to operate. Ballast controls are similar to those for a submarine.*

The point here is that it is easier to retrofit an existing ship because of availability that a semi. For a payload to payload ratio, I am not sure if the cost is that different. You also have to take into consideration that most semis are build according to offshore rules from classification societies, while most barges according to ship rules, which are not as stringent. This is because a ship dry-docks every 5 years for major repairs, while the semi is usually in place for 20 years. Also stronger lighter steel 50 KSI instead of 36, etc.

CLUBSTEAD

This is the first proposal of *The Seasteading Institute*[1] for a seastead[2]. The base floater draws from traditional oil platform designs such as pillar platforms and semisubmersibles, but with the addition of a deck suspended from steel cables, inspired by *Tensegrity* concepts, which are commonly used on bridges. Cable stays are tensioned at the top of towers to support the weight of both light and cantilevered top-sides.

A feasibility study was performed for the design of the Clubstead based off the coast of California. The platform is dynamically positioned and can house up to 270 people. Due to its primary function, as a floating living facility, the architectural design and the engineering studies are intertwined. The feasibility study focused on survivability and passenger comfort to assess the novel design. The survivability analysis was based on structural strength and motion predictions in a 100-year storm. Passenger comfort was evaluated in operational conditions.

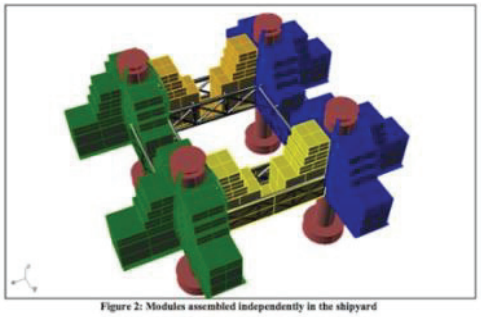

Figure 2: Modules assembled independently in the shipyard

Figure 26: Clubstead: virtual picture and structural model

The upper part was designed under the rules included *in API RP 2A-WSD Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms - Working Stress Design* from the American Petroleum Institute.

[1] a think tank from Sunnyvale (California) with the aim of establishment autonomous ocean communities, enabling innovation with new political and social systems

[2] The term *seastead* refers to any structure used for ocean colonization

The submerged columns and footings, which provide the hydrodynamic stability to the structure, are designed according to the American Bureau of Shipping (ABS) rules: *Rules for Building and Classing Mobile Offshore Drilling Units.*

MINIFLOAT

The MiniFloat is a small semisubmersible platform fitted with heave plates at the base of each column. While exhibiting similar motions to traditional semis, the platform is significantly smaller, enabling cost savings across the board. It is an alternative to provide temporary offshore accommodations of up to 192 beds. With a 3 azimuth thruster DP-3 system and a 6-point mooring system, it can be safely berthed next to a fixed or floating platform.

Figure 27: Minifloat: virtual picture.

EGM-1

The *EGM-1* or *Estación Guardacostas Móvil 1* (Mobile Coastguard Station) is a non self-propelled concrete barge used by the Ecuadorian coastguard as floating base of high speed crafts for fast response against drug dealers. This base consists of a floating building that has a media centre specialist, two generators, a desalination plant, a wastewater treatment plant, water and a fuel storage facility, kitchen, dining room and bedrooms for a total of 13 crew. The Ecuadorian navy has three similar units.

Particulars:

Length	15,5 m
Wide	13 m
High	3 m
Free board	1 m
Draft	2 m
Building	10 m x 10 m (base) x 8 m (height)
Cost	$500,000

Figure 28: EGM-1.

M Laranjinha, Grenland Group, Norway

From Grenland Group we would like to congratulate the author for this exhaustive study on all floating accommodation units existing today in the market. We also would like to show our *GG4-A Lightweight Semisubmersible DP Class 3 Accommodation Vessel* as a "state of the art" offshore flotel.

The GG4-A is an advanced, compact and low cost Accommodation Unit with some features incorporated to prepare the vessel for possible other services in the future. The GG4-A is arranged to accommodate 440 persons in single cabins and up to 600 persons using Pullman berths. 200 of the single cabins are located in two temporary quarter's modules on the Upper Deck.

The total steel weight of the vessel is about 5,500 tonnes. The GG4 design is characterized by low drag, hydrodynamically favourable pontoons and columns, and a minimum of bracings. This sophisticated structural and hydrodynamic design gives the GG4 extremely low fuel consumption associated with dynamic position keeping in harsh environmental areas.

Grenland Group undertakes projects within design and engineering of new drill ships and semisubmersibles, as well as modification and conversions of older semisubmersibles, FSOs & FPSOs, shuttle tankers and other offshore and marine floaters. Visit us at www.grenladgroup.com.

Principal Dimensions	m
Length of Pontoons (Loa)	79.26
Elevation of Lower Deck from Base Line	22.00
Breadth of Deck Box	59.72

Key Features & Capacities:

Total Installed Power	20,000 HP (14,720 kW)

Engine Room	Four (4)
Max. Operating Displacement	circa 16,500 tonnes @ 16 m draught
Lightship Weight	About 10,900 tonnes

Class: DNV ✠ 1A1 Column Stabilized Accommodation Unit (N), Heldk, E0, Dynpos Autr

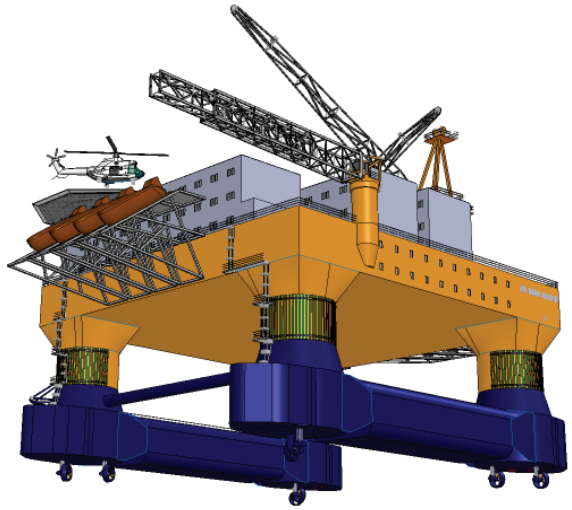

Figure 29. GG4-A Lightweight semisubmersible

J Black, Equinox Offshore Engineering, Singapore

The paper explains quite well this new market of offshore accommodation ships, or flotel ships, where our company operates. But there is a small mistake, as the author classified the ARV2 as DP offshore accommodation vessel, when it is mainly focused in shallow water operations, and therefore moored.

Our company targets two markets:

- Deep waters, with the DP2 accommodation vessel ARV1.
- Shallow waters, with the moored accommodation vessel ARV2.

DEEP WATERS

The Equinox Offshore Deepwater fleet, commencing with ARV1, provides a DP accommodation, logistics, works scope and safety hub to support deepwater operations across the field spectrum.

The DP2 (+) ARVs combine safe personnel transfer via dynamic gangway, high quality offshore accommodation, project management facilities and extensive onboard operational support. The vast storage and workshop capacity allows the vessel to be configured to suit project requirements for laydown, prefabrication, hot work, assembly, organization of work packages and other required work scopes.

SHALLOW WATERS:

The Equinox Offshore Shallow water fleet, commencing with ARV2, provides a moored accommodation, logistics, works scope and safety hub to support shallow water, coastal and land based operations for oil and gas, windfarm, mining, emergency relief and onshore construction operations.

As well as providing an accommodation and works hub in shallow water, the vessels acts as a safety hub proving hospital and treatment facilities, evacuation via helideck and general field evacuation as a self mobile, rapid transit asset. The vessels also come equipped with FiFi to support in field emergency procedures. The vessel can be provided to accommodate 1100+ POB.

CLASSIFICATION

Regarding the comment about classifying an offshore accommodation vessel, from our experience with ARV1 we are agreed that these vessels should be classed as *Passenger Ships*, and not as *Special Purpose Ships*. It should be clarified that ARV1 is a fully certified SOLAS Passenger Vessel with the following Class notation:

Bureau Veritas, ✠ Hull ✠ Mach, Ro-ro passenger ship, Unrestricted navigation, ALM, DYNAPOS AM-R, INWATERSURVEY

ARV2 is also a passenger ship.

DP CAPABILITY AND COMFORT

As explained in the paper, DP is the key to the provision of offshore accommodation, ARV1 have been also measured in relation to the DP capability and passenger comfort:

- DP Capability: the accommodation repair vessel hull has been sought for its specific motion characteristics to make it suitable for the majority of worldwide offshore operations locations.
- Passenger comfort: motion analysis studies carried out show very good results from Motion Illness point of view.

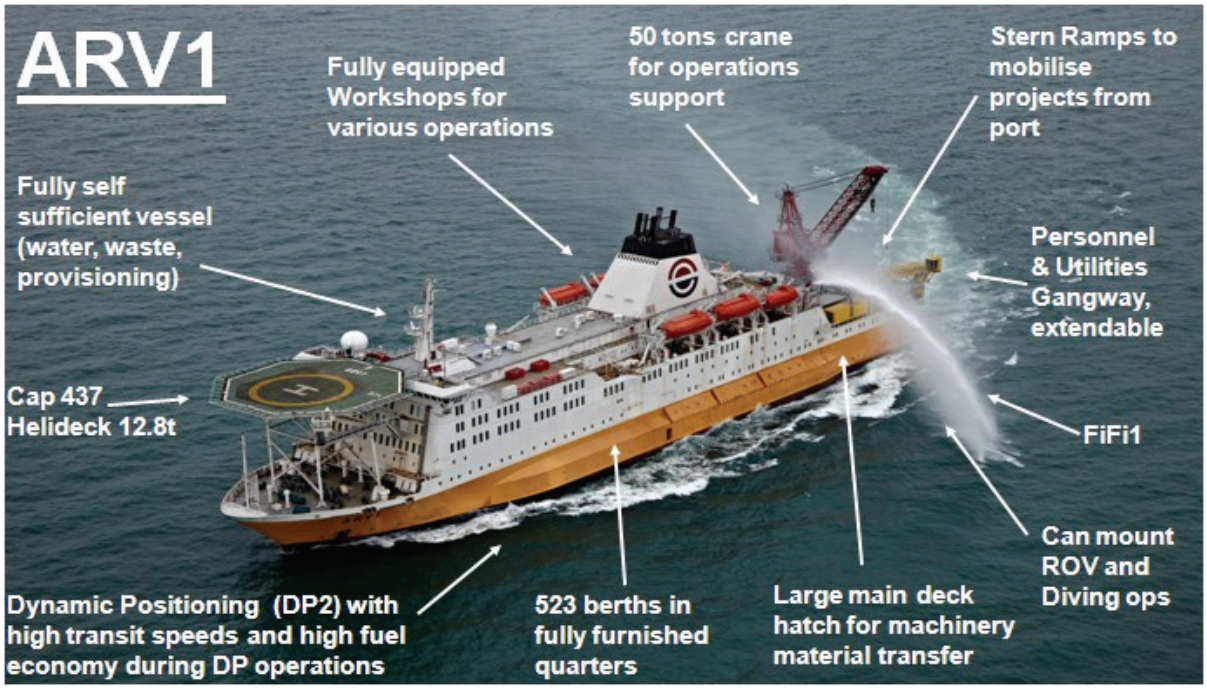

Figure 30. Equinox Offshore Deepwater ARV1 Design

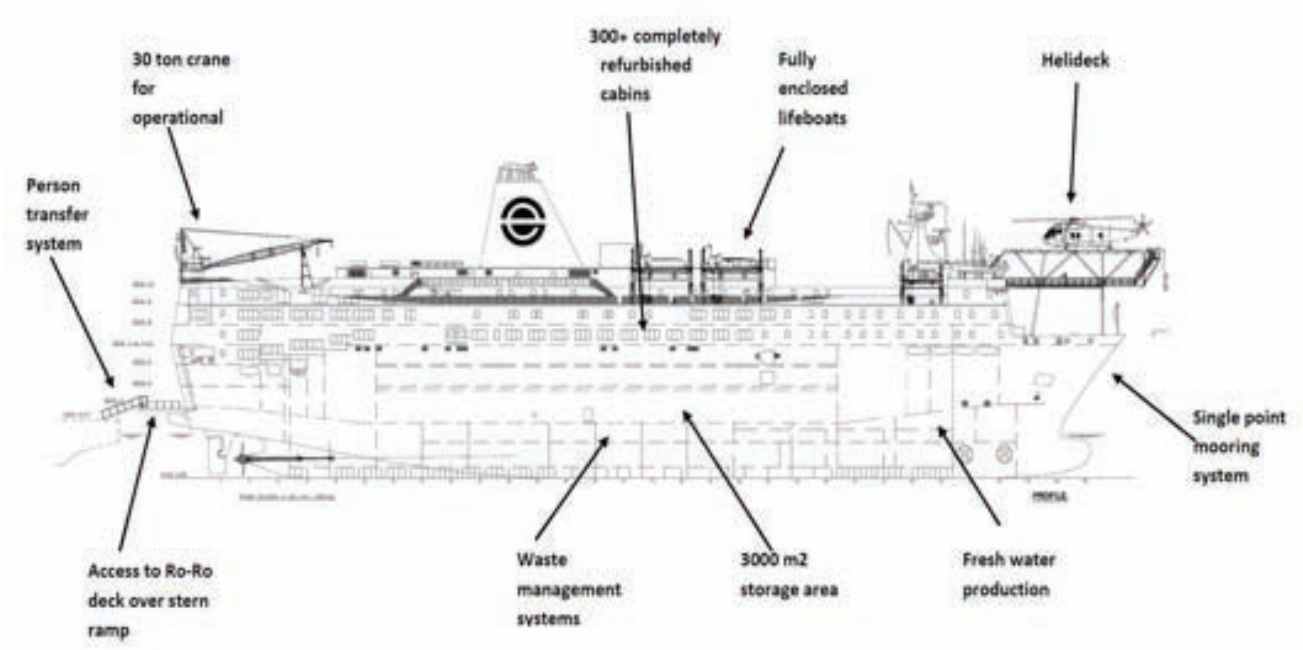

Figure 31. ARV2 design for shallow waters

F de Bartolomé, Former Astano Technical Manager, Spain

This is an interesting and complete report about the state of the art of Floating hotels.

I would like to highlight the importance of these offshore facilities and the opportunities that this market offers to the shipbuilding industry.

In my opinion, the main technical issues to be addressed are those entire relative to the safety, comfort, and security of the people and facilities.

In fact, issues like good seakeeping and manoeuvring, fire fighting, damaged stability, noise & vibrations, and the possibility to be able to make a rapid disconnection and escape in case of big storms, hurricanes etc, are absolutely critical.

The possibility of terrorist or pirates attacks to industrial and tourist offshore facilities must not be ignored, especially in some dangerous areas of the planet. Security measures to detect menaces with time enough to be safe, is also critical.

In case of flotels for offshore workers, may be that the facility is connected to production platform by bridges or articulates arms which serve as personnel access and umbilical gangways. In this case, a specific design of the bridges connections to the flotels structure by means of articulated spring arms, must ensure the structural resistance, and that the necessary degrees of freedom are released by means of hinged joints, and only tension-compression capabilities are adjusted according to the motions between the two units.

As the authors has indicated in his paper, Astano (later Izar Fene), designed 30 years ago a front end engineering for a floating hotel, the Flotel 92. But more recently, several accommodation modules for FPSO, Drillships, Semisubmersible units, and a floating commercial centre including a parking for 500 vehicles (shown in Figure 31) were also designed.

Nevertheless, during the 2000 years, we made the project of several offshore units for Aquaculture, based on the oil & gas technology, trying to put the aquaculture industry in a superior level of technology and market.

One of those projects was the Restocking Ship. Its main target was to preserve and restock fish species which were in danger of disappearance. This facility was provided with accommodation areas, laboratories, offices, fish hatcheries, etc.

A brief description of it, is included in this comment

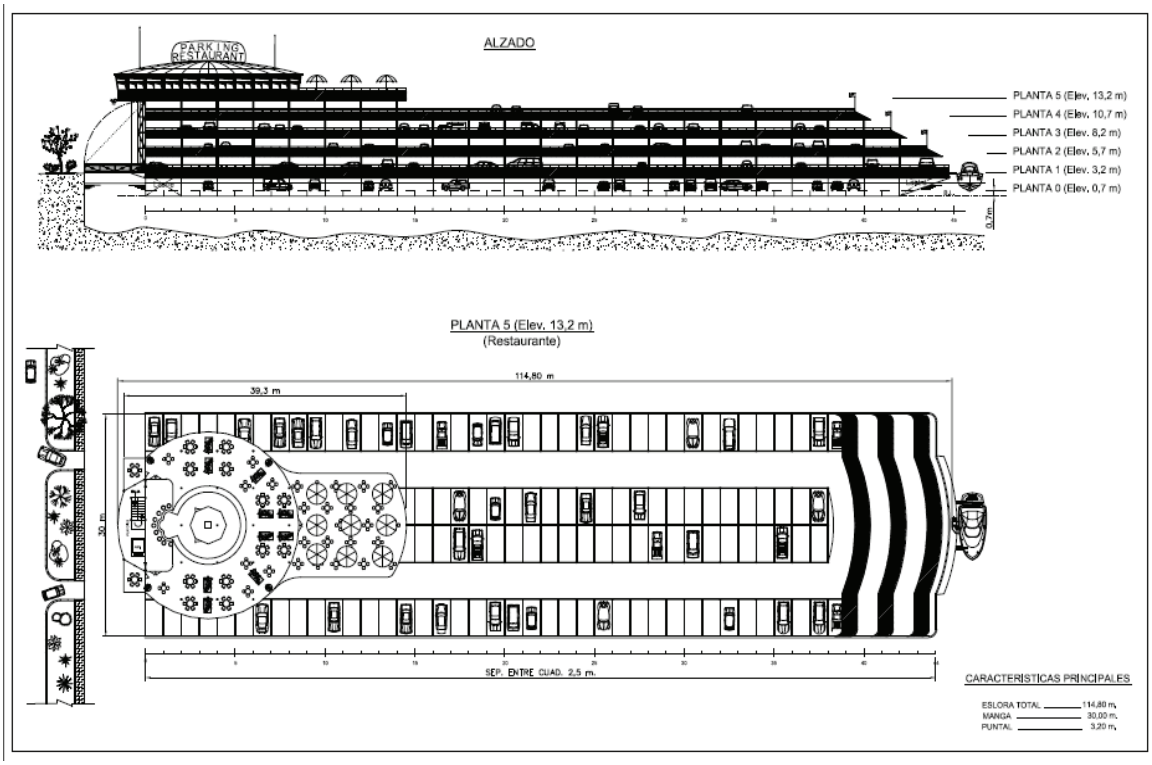

Figure 32. Floating commercial centre including parking for 500 vehicles

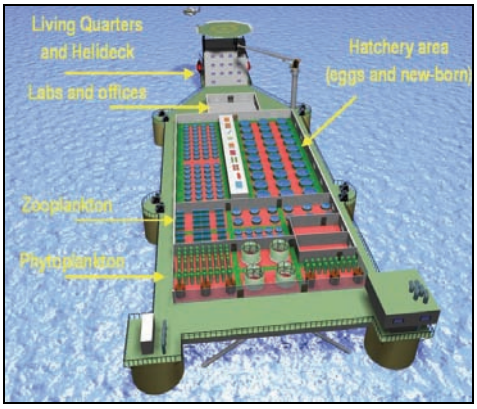

Fig.2a

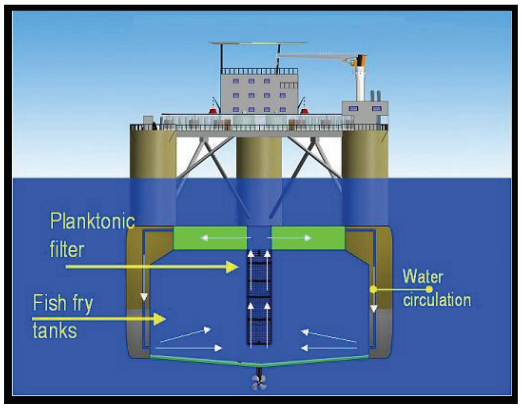

Fig.2b

Figure 33. IZAR "Restocking Ship"

THE RESTOCKING SHIP

It's long been our feeling that the ocean is a vast reserve and that we don't have to worry about things like reductions in numbers of fishes. Archaeological excavations reveal that our ancestors were already putting to sea in boats in order to catch fish.

But the rapid depletion of fish stocks is the inevitable outcome of sophisticated industrial technology being thrown at decreasing marine populations as demand rises, fuelled by growth in human population and incomes.

Aquaculture and stock enhancement programs, could help ameliorate the coming shortfall.

The restocking ship is thought to be one of the most efficient ways to implement stock enhancement programmes.

The IZAR patented vessel (See Figure 2.a and 2.b), resembles an offshore semi-submersible unit, supported by buoyancy columns and three storage tanks placed underwater within the hull structure. Double deck is arranged into the structure to hold additional hatchery and filtering areas, whilst side tanks are used for ballast purposes.

On top of the buoyancy columns, large surface is provided for hatchery of fish fry, laboratories, offices, living quarters, etc. The vessel is outfitted with electric propulsion for transit at 6 knots between fishing grounds to make provision of zooplankton.

The ship would receive fish pumped at sea directly from trawl codends along three metre diameter pipelines. Fish pumped onboard the ship would first be used for scientific stock assessments and, then, their eggs would be released into nets beneath the ship and hatchery area within a double deck.

Fish fry would be on-grown aboard. The unit would act both as hatchery and safe havens for eggs and larvae during their most vulnerable early lifecycles.

Tanks to hold plankton and newly-hatched fish would be sited on the semisubmersible ship's main deck.

On board the unit, egg and larvae mortality after two-three months will be reduced dramatically. If the young fish are then released into the sea, the ratio of adult fish surviving after three years compared to wild reproduction is augmented exponentially.

Additionally, this unit could help to cut short fleet scrapping programs and kick-start flagging fisheries for many species around the world.

M Simpson, Hart Fenton & Company, UK

One of the author's conclusions of this paper that reviews the accommodation vessels is referred to the future accommodation requirements of offshore wind industry: "*At the same time that the oil & gas industry is going to deeper and deeper waters, the offshore wind industry seems to be the next one that will require offshore flotels, but certainly with specific requirements different from those in oil and gas; so new concepts of offshore flotels are expected."*

We are agreed with this conclusion as the requirements of Offshore Oil & Gas Industry will be different to Offshore Wind Industry. In fact, an infield windfarm mothership concept has been developed by Houlder's specialist design subsidiary, *Hart Fenton & Company*, to fulfil the accommodation necessities of the people in charge of maintenance of offshore wind farms.

Figure 34. Infield wind farm mothership concept

The concept's key purpose is to act as an Operation & Maintenance (O&M) mothership, with the vessel providing accommodation, workshops, hotel services, storage and a five-tonne lifting capacity to operate in field. The vessel will be designed so that it can remain on station for up to seven years. Current specifications are an LOA of 89.6 metres, a breadth of 20 metres and accommodation for 12 marine crew and 48 workers.

The barge-shaped hull is intended to be moored to a single buoy mooring system down weather of the prevailing wind. This would allow the vessel to "weather vane" and encounter wind and waves on the bow, and effectively remove the roll element from the vessel motions, leaving the vessel to pitch and heave. With relatively short seas, these motions should be acceptable to up to 60 persons living on board.

The hull of the vessel has landing recesses in its side to allow workboats to dock alongside. The vessel would also be fitted with an open safe haven in the stern to

protect workboats, and have a Launch & Recovery system to allow the workboat to be stowed on board during rough weather. The vessel would also be fitted with a small helicopter deck to allow for emergency helicopter landings.

Hart, Fenton & Company believes the concept is ideally placed to provide suitably located offshore accommodation for workboats and technicians. It removes the requirement for the capital investment to a build fixed structure while successfully integrating installation, access and ongoing infield support.

AUTHORS' RESPONSE

First of all, I would like to give thanks to all the participants in this discussion. Their comments prove that this is an interesting subject for the maritime industry all over the world. And it also shows that the market is emerging with new proposals to accommodate the people involved in the exploitation of ocean resources, not only the oil & gas, but lately also in the offshore wind energy.

I have collected all the discussions under similar subjects in the following paragraphs.

1. INNOVATE SEMI-SUBMERSIBLE FLOTELS

The new proposals of semi-submersible flotels focus on lowering the costs offering compact units smaller than similar semi-submersibles used for other purposes like drilling or production. The comments show some of them.

1.1 CSS (COMPACT SEMI-SUBMERGIBLE) DESIGN

The *CSS Accommodator*, described in detail by **Mr Reeves** from *Marine Asset Corporation,* and as explained in the paper, is one of the proposals for the next generation of offshore accommodation vessels. It could not be included in any of the categories in which I classified the flotels as it is a hybrid concept between a semisubmersible and a ship. In fact, it collects the best particulars of each design: the seakeeping capability of semisubmersibles combined with the low resistance of mono-hull ships.

This particular shape of the hull prevent it to be classified as a Ship or as a Column Stabilized Unit, like the offshore flotels of the paper, but it was classified under the MODU Code as a Mobile Offshore Unit: ABS +A1 Mobile Offshore Unit, +AMS (E) 1 x MF/HF-DSC Radio Telephone, DPS-3 UWILD, Helideck.

1.2 MI&T DESIGNS

In the same line of the *CSS* design, **Mr Roddier** from MI&T presents two totally innovate concepts of flotels. In this case they are semi-submersible units of the Column Stabilized type, one with three columns, the *Mini-Float* and one with four columns, the *Clubstead*. The *Mini-Float* is a semi-submersible flotel for low cost optimization. On the other side, the *Clubstead* is a very bold proposal, as combines a marine design in the hull with a bridge engineering design for the upper part. Not only is the design itself bold, but also its purpose: a floating city-resort for 270 persons designed for a think-tank with the purpose of ocean colonization.

1.3 GG4-A DESIGN

More conservative, but also quite interesting, it is the design presented by **Mr Laranjinha** from *Grendland Group*. It is also a compact and a low cost alternative to bigger semi-submersible flotels. The idea with the *GG4-A*, as with the *CSS* and the *Mini-Float* is to optimize the hull to the requirements of a flotel, as most of the semi-submersible flotels are bigger designs adapted from drilling rigs units. This design is able to offer the same capacity and capabilities of bigger and more expensive semi-submersible units.

2. COASTEL DESIGNS

Two coastels have been presented in this collect of comments: a Floating car-parking designed by ASTANO and a Mobile Coastguard Station presented by Mr. Roddier. No one of these purposes had been listed in the article, part 2.1, so we should add them as other possible uses of coastels. With the Coastguard Station, also an important aspect not covered by the article has been raised: the use of concrete in shipbuilding, as it is a concrete barge. But this idea requires a separate paper.

3. CAPABILITIES OF SEMI-SUBMERSIBLES

Mr. Roddier, that is an expert in this field, has clarified some aspects on the behaviour of semi-submersibles compared to mono-hull ships. It is really a valuable contribution to the article. Perhaps a deep study should be done comparing both alternatives for offshore flotels in order to be sure with alternative is better under each specific condition.

4. DYNAMICALLY POSITIONED VERSUS MOORED POSITIONED

Mr. Justin Back from Equinox Offshore has raised this question with his comment. But it is quite obvious, as he demonstrates with his two pair of ARV, that if your target market is shallow waters a moored vessel is quite enough instead of a DP flotel.

5. CLASSIFICATION OF MONOHULL SHIPS

Also the question of classification of mono-hull ships has been raised by Mr Back. He is agreed that the class notation *passenger ship* is the most convenient to these flotel ships.

6. SEAKEEPING

Also the issue of seakeeping associated to comfort has been mentioned both by Mr Back with the motion analysis studies and by **Mr Bartolone**. This is a critical point for any passenger vessel, and of course for a flotel.

7. THE OFFSHORE WIND MARKET: THE WIND FARM MOTHER SHIPS

Mr. Reeves from *Marine Asset Corporation* has also mentioned a new type of floating hotels specifically designed for the offshore wind market: the Wind Farm Mother Ships. In the paper it was already anticipated that this new market would require new type of flotels: "*the offshore wind industry seems to be the next one that will require offshore flotels, but certainly with specific requirements different from those in oil and gas"*. Several designers and operators are launching their proposals of Wind Farm Mother Ships for the new requirements of more and more distant wind farms offshore United Kingdom. In this farms not so close to shore, people dedicated to maintenance of the wind turbines will have to remain offshore as in the O&G fields. The picture send by Mr. Reeves for his *CSS* design illustrated it:

Figure 35 MAC wind farm mother ship

Mike Simpson from *Hart Fenton & Company* has also appointed these special requirements of flotels operating in the wind farms. The proposal introduced by Mr. Simpson is a very interesting design for a low cost mother ship: instead of being spread moored or dynamically positioned, the ship uses a fixed single point mooring system with a non-self propelled barge. This has quite sense as the type of flotels in the offshore wind market will be addressed to a particular wind farm during years, and not only during a few months as in O&G market, so they could not put aside a self propulsion system.

8. THE AQUACULTURE MARKET

Mr. Bartolome, former ASTANO technical manager, has opened a door to the aquaculture market. In principle the design introduced does not need a flotel as it accommodated the people needed in the own structure. But other proposals of offshore fish farms could require it.

9. FINAL CONCLUSIONS

We have seen that the term "flotel" applies to very different vessels and structures. With this article I have tried to classify them and put light over this market. I hope I have been succeeded.

In resume, we can say that an offshore flotel will be required where an ocean resource is being exploited (mainly energy resources) and the structure for exploited it could not accommodate the people in charge of that. Regarding the coastal flotels, coastels, they respond to the needs of expanding the land area to the water for many reasons, already explained in the article.

10. ACKNOWLEDGEMENTS

I would like to give thanks again to all the participants. For me it is an honour to be able to discuss these ideas with the most experience professionals in the sector.

It is also a privilege writing this article in the *IJME*. Therefore, I would like to be grateful for the opportunity to the *RINA*, and especially to Eric Tupper, that has helped me with his advices.

Finally, I give thanks to my PhD supervisor, Mr. Luis Carral, for guiding me in the PhD dissertation.

I would be very pleasant to receive more comments and feedback about this article from IJME readers. I am at their disposal at miguel.lamas@udc.es

