How to Build an Industry’s Future

One of the great concerns echoing across the maritime world is an anxiety over the industry’s future voiced as a variation of “how can society get its capable young people interested in a maritime sector career.”

In many countries, those seeking an answer often recount a litany of frustrating obstacles to the goal, generally ranging from weak Administration-level attitudes to poor industry-level responses. During the past decade a solution to the problem has emerged in Singapore, where the issue is being tackled through an ongoing public awareness campaign supported by the combined willpower, manpower and financial commitment of concerned parties in both industry and government. Led by the Singapore Maritime Foundation (SMF), this campaign has included television dramas and documentaries that have brought maritime vocations into the light and, most importantly, scholarship programs and youth outreach efforts that highlight young people who have found rewarding and successful maritime sector careers at sea and on land.

The SMF selected two of ABS’ young Singaporean staff for inclusion in that special group, surveyor Sukumaran Praveen, featured in an article in the New Waves career magazine, and engineer Jia Lin Goh, featured in the lower of the two ads pictured above. They have lived up to the honor of being examples for their generation: Jia Lin was promoted in 2011 to Manager, Project Management for the ABS Pacific Division, and Praveen is building a proud record stationed in the Keppel FELS shipyard.
COVER:

The structural realities recorded in the log book of the classification society surveyor began as lines on a naval architect’s drawing board – part of an unending cycle in which today’s experimental concepts become tomorrow’s standard technologies. At this moment, collaboration between industry, academia and the ABS Singapore Offshore Technology Center is bringing such new concepts to life, which is the subject of an article beginning on page 16 of this issue.

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Singapore has two important celebrations coming up this decade: the 50th anniversary of full nationhood in 2015 and the 200th anniversary of its founding as a British trading post in 2019. The island nation has been a valued port in world trade almost since its first day in business, well-known for having both excellent harbors and a pro-business administration with a strong backbone for law and order – factors still vital in the country’s growth.

At the start of Singapore’s first century, founder, Sir Thomas Stamford Raffles wrote that the settlement “continues to thrive most wonderfully; it is all and everything I could wish and, if no untimely fate awaits it, promises to become the emporium and pride of the East.” His wish came true with remarkable speed. In its second year of operation, the port posted trade figures exceeding $8 million (about $164 million in purchasing power today) and by 1831 had progressed from a wild jungle with a handful of clearings and a few hundred residents to an established city with paved and lamplit streets, fine homes, a thriving business community and a population of over 30,000 – progress that continued right up to its invasion during World War II. Today, if the board members of the Singapore Maritime Foundation realize their wish, Singapore will start its third century as the maritime hub of Asia.

“Singapore’s maritime industry is a never-say-die industry, always reinventing itself, adapting to new challenges and coming up stronger,” says Michael Chia, Chairman of the Singapore Maritime Foundation (SMF). “Maritime has been a core industry in Singapore since its very foundation. One very important part of our work is to find ways to help Singapore’s maritime industry continue to grow and develop.”

The SMF was incorporated in 2004 as a privately led, government-funded organization dedicated to helping the country become an international maritime center. Currently, Singapore is already home to more than 5,000 international maritime companies, including some 200 major shipping lines and the world’s top two offshore rig builders, its top bunkering port, one of its top ten ship registries and the world’s largest container transshipment hub.
The idea behind forming the SMF was to bring together the minds and philosophies responsible for these individual successes and direct them towards pushing forth new ideas, driving initiatives that benefit the local maritime fraternity, raising the profile of the maritime industry and nurturing talents. The SMF would then be a government partner in the long-range project of building a full-fledged international hub that would connect not only East with West, but also East with East.

“By 2004, Singapore had become quite a significant player in the maritime world, but we wanted to go further, to be more than we had ever been,” Chia recalls. “While some sectors of the maritime industry are independent, many are interlinked,” he explains. “We saw a need to form an overall industry organization that could represent all its diverse sectors together.”

The SMF divides Singapore’s maritime cluster into four main categories: marine and offshore engineering; the ports; shipping; and ancillary services – a catch-all category that includes such sectors as bunkering, insurance, shipbroking, law and education. The SMF provides a forum in which representatives from these diverse spheres of activity can exchange ideas on how to better their individual sectors while also accomplishing the overarching goal of turning Singapore into a leading IMC.

“The SMF was created as a vehicle for drawing together these sectors and their sub-sectors in ways that could increase their value to the maritime community at large,” says David Chin, Executive Director of the SMF. “The government is very pro-business and has a hand in encouraging overseas companies to come to Singapore. To do this effectively there has to be a partnership between the government and the private sector – the bridge between those two worlds is the SMF.”

The structure of the organization reflects this philosophy. Seven of the eight Board members are leading executives in Singapore’s maritime industry, who donate their time and effort to the SMF. Two come from shipbuilding, two from shipping (one of which is also president of the Singapore Shipping Association (SSA)), and three represent the ancillary services – legal, banking and shipbroking. The representative from the Maritime and Port Authority of Singapore (MPA) is the only government person among them. The Board is supported in its work by ten advisory panel members from various sectors of the industry.

“The members develop ideas about what needs to be done, and our job is to make them happen,” says Chin. “Our organization acts as a catalyst for industry-wide cooperation in turning their ideas into initiatives.”

Through the MPA, the SMF has a role as the government’s partner in channeling the existing local talent and cultivating the coming generations of manpower that will turn those initiatives into a long-term reality.

**Promotion is Key**

The SMF’s main lines of action are promotional and awareness-raising programs designed to focus attention on Singapore’s maritime clusters – a wide-ranging remit requiring efforts directed towards both the international community and the local populace.
Possibly its most successful international initiative is the biennial Sea Asia maritime conference and exhibition, which, not coincidentally, runs concurrent with Singapore Maritime Week (the next is set for 9-11 April 2013). The event debuted in 2007 and quickly grew into the maritime world’s fifth largest exhibition, in terms of global participation. In addition, the SMF partners with the Association of Singapore Maritime Industries (ASMI) in bringing the Singapore Pavilion to international trade shows, namely Posidonia in Greece and Nor-Shipping in Norway.

Chin says that one of the strengths setting the SMF apart from other industry associations is its ability to undertake projects that have rather long gestation periods and require constant cultivation. One example of such an ongoing business development project is the SMF’s work with the Singapore Chamber of Maritime Arbitration (SCMA) in promoting the country as an Asian center for maritime arbitration. The eight-year effort is beginning to yield fruit, aided by the success of the 20-plus international law arbitration firms represented in Singapore, the increasing number of corporate and individual memberships in the SCMA (which currently stands at 155 members) and the no-nonsense reputation of the Singaporean legal system.

“Singapore has a very strong legal fabric: uncorrupt, unbiased and secure,” says Chia. “When we set up the SCMA in 2004 – one of the SMF’s very first projects – we knew we had a good foundation to build upon. In fact, we are now on the way to becoming a seat of arbitration for the region.”

“We have been working quite well with BIMCO in this regard – in fact, they have decided to list Singapore as another arbitration center after London and New York,” Chin adds.

Another activity of the SMF is to foster connections between sectors of the maritime industry that, although neighbors, are often strangers to one another. One such effort has been the collaboration with the General Insurance Association of Singapore (GIA) in organizing Maritime Knowledge Shipping Sessions, a series of themed seminars aimed at heightening marine insurance and maritime professionals’ awareness of important maritime issues that are intertwined with marine insurance. First conducted in 2007, the sessions have brought in speakers on a wide range of topics, among them port and terminal operations, ship finance, risk assessment and piracy.

**Building Human Capital**

Even the most successful business promotion agenda would be only a job half done for the SMF. The other half of its responsibility is to promote the maritime industry to Singaporeans, to raise their awareness of its possibilities for meaningful employment. Among its highest-profile efforts in this regard is a group of three successful television programs: Making Waves (2005), a documentary profiling successful people in the maritime sphere; The Peak (2007), a dramatic series set in a shipyard; and Sea of Opportunities (2008), a documentary series exploring the variety of interesting careers the maritime world has to offer. The ongoing challenge for the SMF is that, despite the successes, new efforts are always needed to attract and nurture the young talent that will carry its maritime industry into the future.

“One way to get young people interested in the maritime industry is by organizing talks, such as the MaritimeONE Leaders’ Speaker Series. Because Singapore is a developed country, many young people see other professions, particularly in technology, as preferable to a maritime career,” says Chia. “This makes one of our biggest challenges how to interest them, and keep them interested, in a maritime career – onshore as well as at sea. One way we do this is by organizing talks, such as the MaritimeONE Leaders’ Speaker Series (MLSS) and NetworkONE Reception, whereby industry leaders and young people who have carved a niche for themselves in the industry are invited to
share with undergraduates interesting facets of their maritime careers, and the exciting career prospects the industry offers; there’s also a new pictorial magazine, New Waves, that features young people who have found good jobs in the maritime industry.”

He is quick to add that their presentations don’t try to sugar-coat the risks of life at sea, but only to tell their side of the story. While young people tend to be well informed about seafaring’s potential risks, he says, they often know less about its potential benefits.

“We try to give them a balanced view of the industry – it’s not just the troubles you read about; there are other things about a maritime career that are absolutely great” Chia explains. “At the end of the day, it’s up to them to decide, but it’s also our duty to tell them the good points about a sea career, the exciting parts, what the many personal and professional benefits are, and all the things a maritime career can do for them.”

One of the SMF’s first education-oriented initiatives involved a 2005 partnering with the Universities of Glasgow and Strathclyde to bring to Singapore their Bachelor of Engineering courses in naval architecture and marine engineering, followed by a similar arrangement with Newcastle University in 2007.

Among the organization’s most important educational outreach efforts to Singaporean youth is its MaritimeONE (for Maritime Outreach Network) scholarship program, begun in 2007 as a joint effort between the SMF, the MPA, ASMI and SSA. Sponsored by local companies, MaritimeONE scholarships help students pursue advanced marine-related studies, after which the SMF tracks the scholars and helps them find work after graduation. Since the inaugural Scholarship Awards Ceremony in 2007, a total of 118 scholarships, worth more than $3.2 million, have been awarded to outstanding and deserving students to pursue maritime-related courses in Singapore and overseas.

The program has garnered praise from the start, receiving encouragement and support from many industry luminaries; in 2008, for example, the venerable Tan Sri Frank W.K. Tsao, Senior Chairman of the IMC Group and a grand seigneur of modern Asian shipping, said of the MaritimeONE effort that it “represents a significant milestone in the collaboration between the public and private sectors in Singapore – as nurturing young minds through education is a great way to build human capital for the industry.”

While assisting the formation of Singapore’s maritime future, the SMF is also looking to its own evolution. One of its hopes in the regard is to develop into the voice of maritime Asia. “More than 50 percent of the world’s ships are owned by Asians, but as a group we have a relatively small voice in world shipping forums,” Chin says. “We are in a perfect position to help articulate the needs of the Asian shipping community, particularly during development of international maritime regulations.”

When the SMF was formed in 2004, the Singapore Government committed funds to support it for five years. At the end of 2008, the organization produced the booklet Steering the Maritime Industry to tell its backers what it had accomplished, and the government responded with another five years’ support. SMF is currently producing its second quinquennial report with an eye to justifying another round of funding. “Our hard work has brought us many successes, and the MPA has recognized this with continued support. You have to show you’re worth your salt,” says Chin.

“It is important to carry on our heritage, to develop the maritime industry and to ensure that it remains a cornerstone of our national economy,” says Chia. “We have to help it grow and thrive so that it can contribute even more to the well-being of the country.”

New Waves is a new pictorial magazine that features young people who have found good jobs in the maritime industry.
Priming the Pump for Water Independence

A decades-long drive for water self-sufficiency has made Singapore a world leader in water reclamation and management technologies.

The island nation of Singapore packs more than five million inhabitants into an overall area of some 272 square miles, making it the country with the world’s densest population over one million (over 19,000 people per square mile). With few natural freshwater sources, the island has been challenged by the water needs of its residents almost since its founding as a British settlement in 1819. More than 40 years ago the country embarked on a quest for water self-sufficiency, mapping its route there through science, construction and public support. Today, decades of effort in technology development and infrastructure investment have turned a once-impossible dream into a reality ready to be grasped. As it nears its goal, Singapore has managed to forge strength from disadvantage and become a world leader in water management, conservation and recycling.

Water self-sufficiency was made a national objective by Singapore’s first post-independence Prime Minister, Lee Kuan Yew, who has cited two historical lessons among the inspirations for that vision. The first lesson came from an incident during the Battle of Singapore in World War II, when the causeway linking Singapore and Malaya was dynamited to stave off invading Japanese troops and inadvertently took with it the island’s water pipeline, leaving the people with about two weeks of fresh water reserves. The second lesson came shortly after Singapore left the Federation of Malaysia in 1965 for full nationhood, when Malaysia’s first post-independence Prime Minister, Tunku Abdul Rahman, remarked that “If Singapore’s foreign policy is prejudicial to Malaysia’s interests, we could always bring pressure to bear on them by threatening to turn off the water in Johor.”

While that comment may be tempered by its historical context – Malaysia and Indonesia were in conflict at the time, and it may express a fear of Singapore siding with the latter – it raised anxieties and tensions about the water supply that reappeared over the years and remained a lingering shadow in the relations between the two countries. When negotiations to extend the water contracts stalled over questions of price in the late 1990s, the island nation decided to let the 50-year contract expire in 2011 and embarked on a determined effort to achieve total water self-sufficiency by the time the remaining contract ends in 2062.

In 1963, when Singapore became independent of Great Britain and joined with Malaya, North Borneo and Sarawak to form the Federation of Malaysia, its water was supplied from three old reservoirs and a pipeline from the southern Malaysian state of Johor. Accounting for some 80 percent of the island’s fresh water supply at the time, the pipeline was the product of 50- and 100-year contracts signed with the territorial government of Johor in 1961 and 1962, under which Singapore buys the water, treats it and sells a portion back to the supplier.
In 1998, the government commissioned the Singapore Water Reclamation Study, which led to the conclusion that waste treatment and desalination technologies were at the right combination of capability, reliability and affordability so as to make viable the large-scale water reclamation projects the country needed. To bring that about, Singapore’s Public Utility Board (PUB) was given authority over both water supply and sanitation. In 2001 the PUB announced its Four Taps plan for water independence, identifying the four water sources (taps) that would become the building blocks of Singapore’s future: water from catchment basins and reservoirs was named the ‘first tap’; imported water, the second; water reclaimed from household and industrial waste, the third; and desalinated seawater, the fourth.

The third and fourth taps did not exist in Singapore at the time, so the PUB mapped out a plan to prove the technologies and then develop them such that the three national taps of reservoir, reclamation and desalination would grow to replace the imports and cover the country’s water needs into the future.

So far, the water independence drive has paid off handsomely. In 2011, imported water accounted for only 40 percent of the country’s supply, reduced from the 80 percent of 1965. That achievement is even more impressive when one considers that it was accomplished despite escalating resource consumption from both an industrial revolution – in which Singapore evolved from a poor, low-wage manufacturer to the only Asian nation whose debt is rated triple-A and A-1 by Standard & Poor’s – and a booming population that soared from under two million to 5.2 million during the same period.

**Strengthening the 1st National Tap**

The foundation of the First National Tap is rainwater large-scale capture. The rainwater drainage network, completely separated from the sewer system, consists of about 7,000 km of roadside drains and 1,000 km of canals and waterways that conduct rain and runoff to the country’s 17 reservoirs. Those reservoirs were created through a massive water engineering effort that converted all the country’s rivers and estuaries into fresh water reservoirs (and, in many cases, implanted wetlands to serve as natural filtration systems). The process began in the late 1970s with a cleanup initiative for the Singapore River, which for two centuries had been a main artery of commercial maritime traffic.

“The Singapore River was so filthy that nothing could live in it,” recalls C.H. Tong, CEO of Keppel Offshore & Marine and Chairman of Keppel Integrated Engineering. “Lee Kuan Yew challenged industry to clean up the rivers so fishes could live again. And in ten years, after a whole array of efforts, we did it. Now the whole river system is changing slowly to fresh water and the fishes have returned.”

One of the key steps to cleaning up Singapore was controlling cultural habits that in some cases were older than the country itself. One emblematic sanitation reform was changing the practices of its thousands of street food vendors, or hawkers, by collecting them in central locations called hawker centers. “Cleaning up the hawkers was a tremendous job. They sell food on the street, so the challenge was how to make sure the plates, etc. would be washed and everything kept clean. In the old days, the most popular spot for the hawkers was the Orchard Road Car Park – during the day it was a car park, and at night the hawkers would gather. They would leave rubbish everywhere,” Tong says. “That’s how the concept of hawker centers came about: put them in central locations so that there can be proper control of sanitation, waste discharge and so on.”
Reforming the food vendors was just one part of a broad initiative in which the land, the rivers and societal habits were cleaned up – after all, it would do little good to return the rivers to health if the land runoff would just sicken them again, or if the population engaged in lax practices that spread diseases like malaria. The third piece to Singapore’s cleanup, then, was securing the public health by reforming the public’s habits. The wallet being a driver of much human action, the initiative was backed by a group of very hefty fines on such violations as littering (to promote cleanliness), spitting (for germ control) and leaving standing water (to remove breeding grounds for mosquitoes), which gave rise to the widely-circulated pun “Singapore is a ‘fine’ city.” The strict regimen resulted in a healthy patient; the clean, safe and orderly environment it produced is often credited as the foundation of Singapore’s rapid industrialization, evolution and success.

“Many young people do not realize how the Singapore of today came about, how we came from a period of abject poverty and changed the country,” Tong observes. “Or, that we started our antipollution efforts way back when most people were barely even thinking about it; there were many antipollution programs for the air, the water and the environment, and the Prime Minister’s Office was directly involved. In the greening of the country, for example, tree planting was made an annual affair and, as a result, thousands of trees were planted.”

As the Singapore River cleanup approached its finish in the late 1980s, the Prime Minister proposed a bold idea for augmenting the country’s water reserves. Singapore had been building on its existing reservoir system since the mid-1960s and had already dammed a number of rivers and estuaries to serve as catchments and reservoirs where rainwater runoff could accumulate. The new thought was to dam the mouth of the Marina Channel, where the country’s five principal rivers conjoin, turning nearly the entire island into a reservoir. The vision was realized twenty years later in the engineering feat known as the Marina Barrage.
Completed in 2008, the Marina Barrage is an innovative combination of dam, bridge and flood control system spanning the 350-meter-wide mouth of Marina Channel. Past generations of sailors knew the place for Clifford Pier and their entry point into the Singapore waterways. Future generations will know it for the Barrage and Marina Reservoir, which, at 10,000 hectares, is one-sixth the area of the island. In 2009 the Marina Barrage won the prestigious Superior Achievement award from the American Academy of Environmental Engineering.

The Barrage is both a barrier against the sea and a relief valve for overflowing rivers. When the tides swell too high, steel gates shut out the sea and protect low-lying parts of the city, such as Chinatown and Boat Quay, from flooding. In excessively heavy rains, the gates are opened to allow storm water into the sea when the tide is low. Should there be a storm during high tide, drainage pumps capable of moving 280 m³/s send excess storm water out to sea.

As a result, the water in the Marina no longer fluctuates with the tide and has become a venue for recreational activities ranging from boating and windsurfing to picnicking and cycling. Also, because the dam keeps rainwater in and seawater out, the brackish water in the basin became fresh water in 2010. The subsequent completion of two more reservoirs made water catchment areas equal to about two-thirds of Singapore’s land mass, according to the PUB.

Creating the 3rd National Tap

The third cornerstone to Singapore’s water independence is wastewater reclamation and the production of the purified water known as ‘NEWater’. The PUB began investigating wastewater reclamation technologies in 1974 and built an experimental membrane filtration plant, but closed it within a year due to issues of materials cost and technology reliability. When the 1998 reclamation study revealed membrane filtration and desalination technologies to be affordable and reliable enough for long-term, large-scale operation, the organization resumed its investigations and planning.

Between 2000 and 2004, the PUB built three small experimental water reclamation plants. Once the experimental plants proved successful and their product deemed safe for human consumption, the reclaimed water was branded ‘NEWater’ and the treatment plants renamed ‘factories’. To underscore the safety of the product, at the 2002 National Day celebration the Prime Minister publicly drank NEWater as 60,000 bottles of it were handed out to the people.

The water reclamation method Singapore uses today is a three-stage purification process of microfiltration, reverse osmosis and ultraviolet radiation, which takes place after conventional processing in a waste treatment plant. The technology is on display at the NEWater visitors’ center, which is also a functioning water treatment facility.

In the first stage, the water is forced through straw-like membranes that block all particles greater than 0.2 micrometers (µm) in size. The reverse-osmosis stage uses sheet-like membranes, tightly wound into large cylinders, which block particles greater than 0.0001 µm in diameter. This stage removes just about everything, but any bacteria or microorganisms that might slip through are given the coup de grace in the third stage, via UV radiation under mercury lamps. The PUB reports that the resulting purified water has passed 65,000 scientific tests and surpasses the drinking water requirements of the World Health Organization.

In 2004 the PUB decided to build its first public/private partnership NEWater factory, awarding the contract to Keppel Seghers, the environmental technology arm of Keppel.
Corporation. Keppel had been preparing for such a moment since 2002, when it acquired Seghers Better Technology, a Belgian environmental engineering company. Today a division of Keppel Integrated Engineering (KIE), Seghers brought the Keppel Group a long legacy of global environmental technology projects ranging from water treatment to waste-to-energy incineration and air pollution control.

When commissioned in 2007, the Keppel Seghers facility was the world’s second-largest, with a daily output of 32 million gallons (148,000 m³) reclaimed water – a milestone for Singapore that was inaugurated by Prime Minister Lee Hsien Loong. Two years later the PUB commissioned a follow-up plant with a daily output of 60 million gallons (228,000 m³), built by Sembcorp on the grounds of a new waste treatment facility.

The four NEWater factories in operation today supply enough purified water to account for 30 percent of Singapore’s needs. About 95 percent of NEWater goes to such industries as computer chip fabrication and electronics manufacture; the balance is mixed with the island’s potable water supplies. The PUB plans for NEWater to cover 50 percent of the country’s needs by 2060.

**BUILDING FOR THE FUTURE**

The unseen support system for Singapore’s Third National Tap is the Deep Tunnel Sewerage System (DTSS), a network made of two massive underground tunnels joined to a linked sewer system that, like a superhighway of waste, will one day conduct all of the island’s household and commercial effluents silently and odorlessly to new waste treatment facilities and NEWater factories. The four components of the DTSS – North and South Tunnels, two centralized water reclamation plants and deep-sea outfall piping – are being developed as a 20-year, two-phase plan that, in the end, will eliminate all the old sewage and sludge treatment plants and free the land they now occupy for more fragrant uses.

Phase 1 of the DTSS was completed in 2008, comprising a 48-km deep tunnel sewer, a centralized water reclamation plant, two 5-km deep sea outfall pipes and 60 km of link sewers. Named Water Project of the Year at the Global Water Awards 2009 in Switzerland, the DTSS was cited as the water project making the most significant contribution to water technology and environmental protection.

In September 2005, Singapore turned on its fourth National Tap with the opening of a desalination plant on Tuas Island. Today Singapore has one of Asia’s largest reverse-osmosis desalination facilities, providing 30 million gallons of water (136,000 m³) per day to meet about 10 percent of the country’s needs. A new plant with a capacity of 70 million gallons is slated to go online by 2013 and, by 2060, the PUB plans to have increased its desalinated water supply so as to meet a projected 30 percent of the country’s ongoing water needs.

Hand-in-hand with the technology development went ongoing campaigns to promote water conservation among the population; the PUB reports to have reduced home consumption from 165 liters per person per day in 2003 to 155 per day by 2009 and has a target of lowering it to 140 liters per day by 2030.

“Singapore was one place where, if your water bill suddenly shot up, you would get a call from the water authority to check if you had a leak somewhere that you didn’t know about,” Tong recalls. “They were so anxious about water that they became very efficient in using it and monitoring its consumption. And today we are a world leader in all these technologies of water treatment and conservation – it’s really quite extraordinary how we were able to turn a weakness into a strength.”

❖
Tapping Synergy for Energy

Keppel Seghers, the company that designed, built and currently operates Singapore’s first private sector-run NEWater plant, is the largest member of Keppel Integrated Engineering (KIE). When acquired in 2002, it brought to Keppel Group a legacy of some 350 global environmental technology projects including wastewater treatment, water reclamation, waste-to-energy incineration and air pollution control.

After its success with the NEWater plant, in 2005 KIE won a contract to build Singapore’s first privately-owned waste-to-energy incineration plant; the next year the Group won about S$3.2 billion (US$2.6 billion today) worth of contracts to develop solid waste management and wastewater treatment and reuse facilities in Qatar. The wastewater treatment component will treat up to 439,000 m³ effluents per day and the clean water will be used for irrigation. Riding on these successes, the Group went on to win two contracts totaling about £390 million (US$624 million) for phase I and II of an integrated waste-to-energy plant in the UK.

Harnessing synergies has been a key component of success for the Keppel Group, a global concern valued today at about US$22 billion. For example, in 2002 Keppel privatized three separate public companies – Keppel FELS, Keppel Shipyard and Keppel Singmarine – and brought them into the single entity Keppel Offshore & Marine, which has since become a world leader in the construction of drilling rigs.

“Bringing the divisions together was how Offshore & Marine took off and our success story started,” notes C.H. Tong, who is both Chairman of KIE and CEO of Keppel Offshore & Marine. “We were able to synergize the various capabilities in the group much more effectively. As long as the companies were separate, with different boards and different shareholders, they were limited in the ways they could cooperate. With them all under the same management, we are able to do much, much more.”

◆
For the Love of Ships

Offshore supply veteran Rony Sudjaka puts five decades of experience into creating some of the OSV sector’s most innovative, high-quality vessels.

Offshore support vessels (OSVs) have come a long way in the past half-century. Once little more than upgraded fishermen’s boats and tugs, they have developed into sophisticated, specialist vessels the size of small ships that are now critical links in the world’s long chain of energy supply.

Rony Sudjaka has participated in that entire evolution, serving as an operator, a builder and an owner during his 51 years in the offshore support sector. As Director for Southeast Asia of Zapata Gulf Indonesia, he once ran a fleet of 200 OSVs. As a builder, he supplied vessels to the oil exploration boom of the 1970s. Today, as Chairman and Managing Director of Pacific Richfield Marine, the Singapore-based OSV owner/operator that he founded in 1989, he commands an owned fleet of 55 vessels. After five decades in business, the 75-year-old Sudjaka still talks about the virtues of his boats with the animated intensity of a young father describing his children – and still looks to the future with excitement, designing and building high-quality OSVs that have earned a reputation for outstanding innovation and performance.

Sudjaka started in the offshore supply sector in 1961 at the age of 23, operating boats for Zapata Offshore. Previously, he had been General Agent for General Motors in Jakarta, Indonesia, and even today cites the training in marine engines he received at GM’s Detroit headquarters as a key part of his professional success. His dynamic charisma is another part. During his 17 years with the Zapata organization he struck up a friendship with the company founder – a relationship that continues to this day – and, over the course of his career, made lifelong friends with energy industry pioneers around the world.

Rony Sudjaka, Chairman and Managing Director, Pacific Richfield Marine
In 1971, Sudjaka opened his own shipyard in Indonesia, building landing craft (very popular in Asia as general service vessels), utility boats, tugs and small craft. He sold the yard, which was located on Batam island, to focus on shipowning and operating, but returned to building vessels for himself in 2008.

"Four years ago, when the market was very good, I wanted to build some vessels. I went to the shipyard, and they told me I would have to wait three years and, on top of that, they bumped up the price!" he recalls. "So I rented a shipyard in Singapore and named it PRM Offshore Heavy Industries Pte, Ltd. and started building my own vessels." He built eight new OSVs the first year and, over the past three and one-half years has built a total of 19 vessels, with the aim of renewing his entire fleet. "Today I build for myself," he says. "In the future I may build for other people."

Rony fell in love with boats and shipbuilding while still a child helping out in his father’s shipyard in Indonesia. The elder Sudjaka got his start in the building business working at the old Taikoo Dockyard in his home town of Hong Kong. He left there in 1926 to work as a construction contractor for Shell Oil and Esso operating in Indonesia.

"The oil companies needed welders to build their refineries, but they couldn’t find any in Indonesia; the people were still riveting at the time. So they asked my father to go back to Hong Kong and pull the Chinese welders over to build the refinery in South Sumatra," Sudjaka recalls. "After building the two refineries, he had enough money to start his own shipyard. I remember him laying land-based oil pipes and building many small vessels to take people and supplies upriver for the oil companies – I learned a lot about shipbuilding in my father’s small shipyard."

LIFE IS HIS SCHOOL
Sudjaka learned something valuable to his career at every place he worked. One of the most important things he learned at Zapata, he says, was the ins and outs of chartering vessels to oil companies.

"I know 100-percent the biggest thing the oil companies want: they want to know the boats they hire will work nonstop until the contract is done," Sudjaka says. For this reason he has built for PRM a fleet well known for what some might call extreme redundancy – not as a crazy excess, he says, but as a commitment to reliability.

"My vessels have very good backup systems," he says, pulling out the plans of one of his latest vessels, named 888, to show a visitor. "Count the generators: seven; 300 percent backup. Why? Because, if I sign a contract to work, I don’t want the boat going off-hire for even one day. If an oil rig stops drilling for just one day, it loses $1 million. Many people like to build cheap vessels that meet minimum requirements; I build to very high quality and I guarantee no complaints. My quality is right up there with Norwegian North Sea vessels," he says proudly, "or maybe a little higher because my ships have more redundancy and special innovations."
PRM owns two design companies that execute the concepts springing from Sudjaka's dynamic brain. Developed through a lifetime of observation and listening to operational reports from his crewmen about the boats and their equipment, his ideas have brought some striking new OSVs to the market.

Flipping through a book of photos from 888's launch, he points out one of the special effects of his design methodology. “When my ships launch they go evenly into the water; sometimes after launching you can see the propeller of the boat, and they have to ballast it to get it on an even keel. Not mine,” he says. “How is that? Because I listen to my crews and I watch the boat’s performance, I know what equipment works best; then, I can design the ship knowing in advance the weight of all the equipment that will go on board. Some people tell the designer what kind of ship they want and then decide the equipment. I buy the equipment first. Then I design the ship around the equipment and balance the whole thing according to what will be installed. The result is a perfectly balanced ship.”

**Innovating for Safety**

While PRM’s offices are as orderly and organized as those of any modern shipowner, Sudjaka’s own office looks like a snapshot from a past era of the maritime industry. A lifetime of glass-enclosed memorabilia and awards look down from the crowded walls on a roomful of furniture submerged under deceptively organized piles of plans, books and technical documents, all held in place by an army of paperweights shaped like turtles, the Chinese symbol of longevity. But while his office has the face of the past, his vessels carry the face of the future.

From one stack of vessel information he pulls photos of his latest boat, calling attention first to its fully enclosed bow. “Look at this: my supply boat looks more like a cruise vessel than an OSV – the winch, the anchor windlass, all the towing equipment is enclosed, safe and easy to maintain. The big windows in the wheelhouse give the captain full visibility. I compete with the best vessels worldwide, even on cosmetics,” he says with a radiating pride that even energizes his visitors. “It’s 100-percent beautiful, but beautiful with a purpose.”

He then draws attention to the hullform. “You know what hull optimization means?” he says. “It means I can go faster by two knots than competitors with the same length and power. A normal anchor handling tug/supply boat takes 80 horsepower for one ton of bollard pull. Mine can make it with 65 horsepower – better efficiency by 20 percent. How? Through hull design and direct-drive azimuth propellers. A rudder reduces efficiency by maybe 8 to 10 percent,” he explains. “Azimuthing propellers eliminate the rudder. So the boat becomes like an airplane: streamlined, fast, and 100 percent power.”

All that purposeful beauty comes at a premium price, which he is not shy about discussing. “So, the bollard pull is stronger, the boat is more efficient, we save fuel and are faster than normal OSVs – and are more expensive to build by 30 to 35 percent, I guarantee” he says. “It takes me more time to pay back the bank, but it’s worth it. My
boats have very few problems. And for the charterers, as soon as they open the tender and see my specs, I get the job."

Another feature of the latest PRM hulls, setting them apart visually from the rest of the world fleet, is the absence of used rubber tires hanging over the side. For fenders, instead, his boats use an array of lozenge-shaped rubber bumpers. Molded from solid rubber by a tire factory and held by stainless steel bolts in special recesses, the bumper array adds a touch of grace to the vessels – and, he says, lasts much longer than old tires and performs better.

"OSVs normally use old tires for fenders, which hang off the side by a chain. That chain sometimes drops off and causes problems, like fouling the propeller. My bumpers stay in place, give better protection and are easy to change. They are also expensive, but worth it – they cost six times what a secondhand tire costs," he notes. "Why do I do this? For safety. There has already been one serious accident due to old-tire bumpers in Indonesia, sometime about 20 years ago," he explains. "An OSV using rubber tire fenders came alongside a rig to take out cargo. Previously, one of the tires had fallen off, but the captain didn’t know. There was gas in the air, and then, because there was no bumper, there was a spark, which caused an explosion on the platform that resulted in casualties," he says solemnly. "My bumpers will not fall off."

One innovation of which he is most proud is his patented auto-release bollard. Activated from the wheelhouse, the electro-hydraulically operated bollard slides up and down inside a stainless steel sleeve, releasing a vessel’s tie lines without human intervention – one of those concepts that seem so simple you wonder why no one thought of it earlier.

Asked where he gets his ideas, he says simply, "I see accidents and I try to make something that solves the problem."

"Normally, the OSV backs up to the rig and drops anchor, and the oil rig crew put two ropes to the bollards to secure the vessel. Sometimes, rough waters will pull the ropes so tight that they cannot be freed; when that happens, one of the crew has to go to the stern to cut the rope so the boat can leave," Sudjaka says, explaining the origins of his invention. "Sometimes the boat is moving so much that the people will cut their hands very badly, or get seriously injured. In the North Sea, big waves have suddenly come over the deck and washed people away," he says with earnestness.

"So I figured out how to prevent those accidents: I made the bollard move automatically," he continues. "On my boats, the captain presses a button and the bollard drops into the deck and the rope slides away, no matter how tight it is – total safety, plus a holding capacity of 150 tons. The oil companies know it, the crews know it and everybody likes it. One of the big operators asked me if he could buy it for his vessels," he recounts with a smile. "I said, no, sir, it’s not for sale, but I’ll give it away to you – it comes free when you buy my vessel!"
TECHNOLOGY INCUBATOR

The Singapore Offshore Technology Center helps new ideas develop into new knowledge and become new technologies.

"A 'crazy' idea is not always 100-percent crazy," says Jer-Fang Wu, Manager and founding member of the ABS Singapore Offshore Technology Center (SOTC). "Sometimes a crazy idea contains the seeds of a great new development. That is why I listen to all ideas, even so-called crazy ones. I always tell my staff, don’t be shy about sharing an idea, even if you think it is ridiculous; when we close the door for a brainstorming session at the SOTC, everybody listens and nobody laughs – and sometimes one person’s ridiculous idea will inspire another person to come up with a really good idea," he says.

As an example, Wu recounts one brainstorming session on ice simulation between SOTC staff and two professors, one from the National University of Singapore and one from the University of Minnesota. After a long day of work they had the whiteboard covered in equations and concepts and, as fatigue set in, began tossing forth increasingly far-out propositions. At a certain point they realized that, by combining parts of several ridiculous ideas they could develop one complete methodology for performing ice failure simulations. The result of that work adds a new dimension to modeling the behavior of offshore structures in Arctic environments – the ability to model the structural failure of ice.

Although developed for application to fixed structures, the methodology can also be applied to floating structures, because it deals with ice types rather than rig types.

Development of the ice failure methodology exemplifies the kind of achievement possible in an atmosphere of frank and open discussion, says Wu. “Almost every day we have a new reason to say ridiculous ideas aren’t always ridiculous,” he notes. “It’s a nice experience, bringing ideas together to make something useful; that’s a good description of what we try to do here."

SOTC brainstorming sessions are closed-door meetings, but, if the confidentiality level of the matters to be discussed allows, are also open to anyone with a concept crying out for development. “It’s always good to share ideas with other researchers,” Wu says, but cautions that, although the sessions are conducted in an atmosphere of respect, they are nonetheless often very spirited evenings.

“Sometimes we argue and shout at each other, but our culture is that, once the door is open, we forget about the shouting,” Wu says. “That’s because we all share the same goal: trying to find the truth about the engineering issues we study."

ADVANCED TECHNOLOGY OUTREACH

ABS opened the SOTC in 2006 as part of a technology outreach to the world’s leading rig builders and the surrounding engineering community. The nature of the organization can be visualized as something like the intersection of a think-tank, engineering research group and academic facility. Created to support development of new ideas and technologies in local industries and to build technical capabilities within ABS, the SOTC has been so successful that it has inspired imitations around the world. In recent years, ABS has used it as a model for three other international technology centers in Brazil, Canada and China.

The SOTC often engages in highly confidential work that involves cultivating novel concepts originated by a client and tied to the client’s future plans, which puts it the
unusual position of enjoying success but not being able to talk about it. Examples from the Center's early days that can be shared include a 2007 project with engineers from Singapore's Jurong Shipyard, which began when that builder started development of new hull designs for deepwater semisubmersible drilling rigs, and an educational/skills development effort to help engineering teams from China's Hudong Shipyard with vibration analyses for LNG carrier designs. One of today's public projects, highlighting the SOTC's educational angle, involves training engineering staff from the Singapore technical community in vibration analysis of specific vessel types.

"Clients come to us because our technical capabilities can help specific parts of their overall research and development projects" says Wu. "We typically work with shipyard teams from Day One of a project that involves advanced ideas and novel technologies, especially when developing these new ideas requires new techniques that, often, defy conventional analytical approaches."

Ongoing research projects at the SOTC include: developing structural evaluation systems for offshore structures using computational fluid dynamics (CFD); developing guidelines for incorporating CFD in regular analysis and design; studying novel design concepts and new materials for floating structures; and advancing knowledge about floating concrete structures and structural steels in Arctic applications.

If any of that calls to mind the ABS Advanced Analysis department, there is good reason for the thought. Wu is a veteran of the groundbreaking department, joining the team when it was formed in 1991 to be a special technical resource applying rational analysis methods and first-principles engineering to new ship designs and novel concepts – often products of increasingly available computer-aided design programs – that were moving beyond traditional analytical abilities of ABS and its clients. He remained with the department for 11 years, enjoying the challenge of tackling its most difficult projects, and brought its investigative spirit with him when he was asked to start up the SOTC.

One legacy of the Advanced Analysis department shows up at the SOTC as a novel design spirals towards completion. "The SOTC does not get involved in plan review; when I see a design is mature enough, maybe as it progresses towards the final stages, I bring the ABS Engineering department into the process," Wu says. "This allows them time to understand the reasoning behind the design, to examine it and to identify any class-related issues, which we can then address right away. Later, their understanding of the design speeds up turnaround time during plan review."

Another legacy of his former work is some long-range thinking about the technology base of the ABS Rules. "One of our goals at the SOTC is to create a knowledge management methodology and a knowledge bank for the ABS Rules: a single place where the background, development and rationale of every Rule and Guide is kept," Wu says. One reason is to aid first-principles engineering by providing easy access to in-depth information about the Rules; another is to build for the future. "It is important to collect and share knowledge about the Rules and how they were derived, so that when evolution of the Rules is called for in the future, the people doing the job have a firm place to start," he explains.

"In a wider sense, I believe this effort to be part of our mission to improve safety of life and property at sea: you must have a full understanding of whatever tools you use in order to make the fullest use of them."
SEMISUBMERSIBLE EXPERTISE
For the past five years the SOTC has focused on semisubmersible rigs, delving into the mysteries of their hydrodynamics and critical responses and developing methodologies for global strength assessment – load mapping and modeling – and fatigue assessments. Over the next five years their analytical work on semis will continue in stationkeeping, air gap analysis and mooring analyses and add a new approach known as coupled analysis.

Coupled analysis is a whole-system approach based on the idea that, in order to truly understand what happens to a floating rig at sea, one must not only understand how the unit behaves, but also how everything that is attached to it – risers, mooring system and so on – behaves and how those individual behaviors affect each other.

“In the motion analysis of floating structures, the forces on the rig are treated as constant force – but, actually, they are not constant. We want to couple them for more accurate analysis of the whole,” Wu explains.

One truth underscored by all this advanced analytical work and brainstorming is that there is no universal best answer for developing floating production systems. The wide diversity in existing semisubmersible configurations tells of the unique combinations of design factors at work in the offshore world. The variety of semis at sea today, with hulls ranging from four to eight columns that are stiffened by bracing systems, ring pontoons and twin-pontoons, are the end products of equally valid packages of considerations ranging from project economics to the technical preferences of the owner.

“For a floating unit, all design parameters are coupled – if, say, you make a change as simple as altering the plate thickness of one part of the structure, we cannot say, without analysis, if the change is for the better,” says Wu. “We can only say how a particular design can be optimized based on site conditions.”

After concentrating on semisubmersibles for the past five years, the SOTC will widen its focus to include tension-leg platforms and spars, says Wu. And, he adds, although the SOTC, by name, specializes in offshore technologies, its scope of work has, from the start, also included ship structures.

ACADEMIC COLLABORATION
One important aspect of the SOTC’s work is its program of collaboration with universities and technical institutes. Among its most fruitful efforts is an ongoing collaboration with Professor Lee Fook Hou of the Civil and Environmental Engineering department of the National University of Singapore (NUS).

The joint effort involves two important projects in offshore engineering research which are funded by the Agency for Science, Technology and Research (A*STAR) and the Maritime and Port Authority of Singapore (MPA) through a Joint A*STAR-MPA Offshore Research and Technology grant. The first project, now nearing completion, focuses on developing a better understanding
of spudcan fixity – the capability of a spudcan (the ‘foot’ at the bottom of a jackup drilling rig’s leg) to remain in place, which directly affects the rig’s stability. This work has yielded promising results for improving jackup stability and for mitigating damage to the rigs when a leg punches through the seabed during the jacking operation. The second project, just getting underway, involves a study into the holding capabilities of torpedo piles, the rocket-shaped anchors used to hold deepwater floating rigs in place.

The relationship between the SOTC and the NUS began in 2007, when Wu and Professor Lee were introduced by one of the SOTC’s first new hires, a PhD engineering candidate named Xiying Zhang. With the offshore industry turning to questions of jackup stability, Wu realized his new group needed a geotechnical engineer on staff; advertising for the position in the local papers, he found a perfect fit with Zhang’s experience in offshore foundations and interest in spudcan fixity. The young engineer had been Lee’s student and knew of his interest in offshore engineering and his studies on stabilizing soil for underground construction. Together, her new boss and her old teacher developed a proposal for research into spudcan fixity that won a grant from Singapore’s Maritime and Port Authority and its Agency for Science, Technology and Research.

As recently as ten years ago, very little was known about spudcan fixity – it wasn’t even known for certain whether a jackup leg resting on the seabed was more like a pencil standing on its head or balancing on its point, in terms of stability. While some of the mysteries of the spudcan remain to be revealed, the SOTC-NUS project is bringing the offshore energy world much closer to understanding fixity, quantifying it and being able to make practical use of the data during site engineering.

The centerpiece of the SOTC-NUS research effort is the geotechnical centrifuge belonging to the NUS Engineering department. The massive device consists of a hinged basket, or sample holder, attached by an arm to a rotating unit that makes it turn rapidly around a fixed axis. Through centripetal acceleration, this spinning motion creates great forces in the sample holder, which are measured in multiples of ‘g’, or g-force, the acceleration due to gravity at the Earth’s surface.

The geotechnical centrifuge is critical to testing scale models of engineering works and phenomena involving soil, such as studies of underground constructions like bridge foundations and tunnels, the underground effects of explosions and earthquakes and, in this instance, the behavior of the soil around the spudcan as it presses into the seabed during jacking operations.

The centrifuge is necessary to these investigations because soil is a material whose behavior depends on the stress placed upon it. This behavior cannot be scaled linearly, so the only way to get meaningful results from a scale model test involving soil is to re-create the forces present in the real-life situation that is being studied. This is done in the ‘artificial gravity’ condition developed by the centrifuge.

Say, for example, a tunnel needs to be built 10 meters underground and the permitting authority wants to be sure its walls won’t collapse. If the investigators decide to create a 1/100 scale model of the installation in order to test the builder’s design, they will be using a layer of soil 10 centimeters thick in their experiment. In order for that 10-cm model to behave realistically and generate useful data, it must be subject to the same pressure as its 10-m real-life counterpart. This pressure is re-created by increasing the g level (force of gravity) on the model by 100 times, which the investigators accomplish by placing their model in a geotechnical centrifuge.

Using their centrifuge, the SOTC/NUS team simulated and analyzed many cases of spudcan/soil interaction for various ground conditions and leg configurations. The four-year project has yielded three new and improved avenues of knowledge. First is the dynamics of the spudcan pushing into the soil while the rig is jacking up. As the can presses in, the soil is forced up and around it, which causes a tremendous increase in pore pressure (the pressure of water held in tiny spaces (pores) inside the soil). This pressure dissipates over time – the actual number of months depends on the site – and the soil consolidates around the can, gripping it more tightly and improving its fixity, or resistance to movement.

“Previously, people had an impression that spudcan fixity improves with time, but how to account for the improvement no one could figure out,” says Lee. “We were able to develop a set of computer simulations, which, I believe, are the first in the world able to describe the increase in pore pressure as you install the
spudcan; how the pore pressure dissipates over time; and how the stiffness and strength of the spudcan increase over time.”

**SPUDCANS DEMYSTIFIED**

“The second project we worked on is the effect of the truss or lattice structure of the jackup leg on the fixity issue – and what we’re coming up with is quite new and interesting,” Lee adds. “Most of the time, the leg truss is not taken into account during spudcan design; experimenters usually model only the can, leaving the truss out of their simulations. But not only the spud gets immersed in the soft soil, which may be a layer 25 to 30 meters deep; there’s also a lot of embedment of the leg itself,” he notes.

Following this lead, the engineers began investigating the interaction between leg and soil, reaching the conclusion that soil flowing around the leg and in-between the truss members has potential to change the fixity of the spudcan and, in turn, the dynamics of the rig. In turn, this led to a development that for two big reasons may ease the minds and stomachs of jackup operators around the world: a sleeve enclosing the lower 30 meters or so of the jackup leg. The sleeve acts like an extension of the can; by giving more surface area for the soil to grip, it perforce improves the can’s fixity.

“Basically, what we can conclude so far is that current design guidelines for spudcan bearing capacity and push-in are actually fairly conservative; and, because of the pore pressure dissipation, in the long term you will probably see an increase in spudcan fixity of about 30 to 50 percent,” says Lee. “It is very useful for people to know that they have this reserve. With the sleeve you will probably get another 50 percent fixity increase – as a general approximation, of course.” The leg sleeve may also provide a remedy for one of the jackup operator’s worst nightmares: punch-through.

As a rig jacks up, its spudcans slowly force a way through the soft seabed until coming to rest on solid ground somewhere below. Occasionally, rather than truly solid ground, a can comes to rest on what is just a solid crust over a deeper soft layer. Temporarily supported, the rig continues jacking, increasing pressure until the can punctures the hard layer like a needle driving through an eggshell and drops rapidly through the soft soil below.

The fall occurs too swiftly for any remedial action from the crew. If the soft layer is thin enough, the can will hit the solid ground underneath and come to rest in a scary bump; if, instead, the soft layer is even just a few meters deep, the punch-through can throw the whole unit off balance, twisting the legs and wreaking havoc with the rig’s hull.

A leg sleeve may give the operator enough control over the rate of descent in a punch-through to prevent damage to the rig. According to the engineering team’s experiments, just as the sleeve provides extra surface area for soil adhesion and enhances spudcan fixity, so too may it slow the fall.

“In the case of a pile penetrating the ground – for engineering purposes, a jackup leg can be considered a pile – the resistance to that penetration has two components; the most important is the end-bearing component, or the force on the bottom of the spudcan,” Lee explains. “The other component is shear friction, or the force gripping the side of the can. The leg sleeve increases the overall shear friction between the leg and the soil, which translates into more stability. In a punch-through, it might even restore stability completely, if the total resistance on the sleeve is enough to take the entire load. A sleeve won’t prevent punch-through,” he notes, “but it should give the operator more time to compensate for it and, perhaps, save the rig from serious damage. If the sleeve enables you to control the rate of penetration, such that you can slowly jack the rig through the soft layer until you find solid ground, then you should be fine.”

**LOOKING TO A RICH FUTURE**

A second project for the SOTC and Professor Lee’s group, which recently obtained funding approval, will investigate the technological mysteries of dynamically installed deepwater piles – an offshore foundation system known in Brazil as torpedo piles and in Norway as deepwater dynamically installed anchors.
“The torpedo pile has been used extensively and quite successfully in Brazil, but many aspects of it remain unknown,” says Wu. “A torpedo pile behaves a little like a jackup leg in that, when it drops into the soil, it causes soil remolding and generates high pore pressures. It is known that as these pore pressures dissipate over time, the pull-out capacity of the pile increases. The all-important design parameter of torpedo piles is the ability to resist pull-out and hold the floater in place, so the big question for us is how to calculate the increase in pull-up capacity.

“We will be simulating the pile going into the ground, the soil being remolded, the pore pressures generated and dissipating over time, and the soil coming around the pile, gripping it and increasing its pull-out capacity,” says Lee.

In the real world, torpedo piles are aimed at their desired location and dropped into the sea, falling through the water and penetrating the seabed under the force of their own weight. In the engineering model – still being developed – it is expected that investigators will instrument the soil and the pile and measure the pull-out force over time. They will develop a calculation scheme to simulate the torpedo pile penetrating the soil and coming to rest; at some point, they may also try re-creating the drop in the centrifuge. Meanwhile, using computational fluid dynamics, they will model the entire process.

“The important part of this project is, once we get the numerical simulation skills developed, to develop design metrics and optimize the shape, weight, distribution and dimensions of the anchor,” says Wu.

“With torpedo piles today, there are more questions than answers – it is a very fertile research topic,” Lee notes. “I am very pleased that my two projects with the SOTC turned out as they have,” he adds. “We are on the tail end of the first project, as we are still developing some aspects of it; and we have a new project approved.”

SIMULATING ACTION ON THE SEABED

A n experimental setup devised by an engineering team led by Professor Lee Fook Hou of NUS in collaboration with members of the SOTC uses frameworks, seen in the lower photo, to simulate the lattice structure of a jackup leg. The spudcan is simulated by a disk and held in place inside the experimental model. The jackup model pieces fit onto the shaft in the center of the metal-framed model box, which itself is a mechanism to simulate the jacking-up of the rig leg. The sand inside the box is the ‘seabed’ on which the leg stands. The model is then mounted on the hinged sample platform of the centrifuge.

When the centrifuge spins, the platform raises up under centripetal force and the model setup is subjected to many times the force of gravity; in that way experimenters simulate the pressures, soil movement and conditions on the sea bed as the leg is jacked down. Using this model the SOTC-NUS engineering team was able to analyze spudcan fixity and modify the leg with a short sleeve at the bottom than can help minimize damage or maintain control when punch-through occurs.

MODEL SOIL & SAND

Technical consistency is the key to productive research. Geotechnical engineers use standard, generalized soil and sand for their experimental models. On an engineering level, it doesn’t matter how many individual types of soil exist as long as there are materials whose parameters describe soil friction, cohesion and other properties adequately enough for engineers to put pencil to paper and carry out an effective and workable design. Having standard soils allows experimental results to be shared and expanded upon by investigators around the world. Most investigators employ one material to substitute for the seabed: kaolin clay, the substance used to create fine china. Its properties are very well known and remain consistent from batch to batch and year to year. There are many types of experimental sand in use – the NUS team uses a standard grit-blasting sand, for example – but all are graded in size and properties according to international industrial standards.
The roll-on, roll-off (ro-ro) ship is a jack-of-all-trades that can haul just about anything to anywhere. Equipped with jumbo stern ramps and massive doors allowing vehicles to enter and leave, ro-ros are able to discharge and load cargoes without shore assistance. These versatile vessels are unsung heroes of the developing world, able to bring to even the most rudimentary ports everything from foodstuffs and building materials to automobiles and heavy equipment. Some also haul containers, with a few matching the capacities of small containerships – the latest vessels entering the fleet of Genoa, Italy-based ro-ro specialist Ignazio Messina & Company, for example, are able to move 3,000 containers at a time.

To reflect the flexible nature of the ro-ro, Messina Lines gives each of its ships the forename ‘Jolly’, the Italian word for the Joker in a deck of cards, which (depending on the game) can do the job of any other. The vessel type's versatility can be illustrated by two deliveries to Jeddah that took place almost exactly one year apart. In January 2011, Messina Lines' Jolly Bianco arrived from Naples bringing to the Saudi port a metropolitan railway passenger car measuring 37 meters long and weighing 88 metric tons; built by Italian manufacturer Ansaldo, it was the first of 22 cars destined for commuter service in Riyadh. In January 2012, the company's newest vessel, Jolly Diamante, arrived in port on its maiden voyage bringing 163 diverse vehicles and 524 containers carrying sugar, fruit juice, rice, bitumen, tile, marble and machinery.

Before heading onwards to Mombasa, Dar es Salaam, Durban and Maputo, the Diamante sparked a dual celebration in Jeddah port: the 90th anniversary of Messina Lines and the 75th anniversary of its regular service to Saudi Arabia.

Ignazio Messina & Company started up in 1921 as the small shipping line Giuseppe Messina Tabuso, carrying foodstuffs from Sicily to northern Italy. After transferring the company to Genoa in 1929, Giuseppe’s son Ignazio opened regular service to Libya, made the company a limited partnership and rebranded the enterprise with its present name. Success with this route soon expanded the company's activities across the Mediterranean and North Africa and, by
1935, Messina vessels were in regular service to Saudi Arabia and East Africa. In 1946, using a vessel owned by another Messina firm (a Swiss operator named Nautilus), the company opened service to West and Central Africa. Today, the Messina Group is a diverse organization active in such areas as real estate, industry, banking and private equity, and the ships of Messina Lines serve the whole of Africa, the Middle East, the Mediterranean and northwest India.

The Messina Lines fleet was entirely general-purpose breakbulk cargo ships until 1968, when the company began changing its business model and moving into full ro-ro services. Although the ro-ro vessel concept had been around for over a decade at that point, it was still an uncommon ship type that was just finding its niche in international service.

With few ro-ros around at the time, the company built its new fleet through a series of innovative conversions and, beginning in the 1980s, secondhand ship purchases.

“In order to build our business in Africa, we had to develop vessels that could deliver their cargoes to ports that were poorly-equipped – or not equipped at all – to load and unload vessels,” says Massimo Messina, third-generation Managing Director of the family-owned Ignazio Messina & Company. “We saw that the ro-ro offers the flexibility that ports in the developing world need. Of course, at the time, there were very few purpose-built ro-ros in existence, so we began converting our fleet of general cargo ships for ro-ro service, adding stern doors and transforming the holds into garages, giving vehicle access to the open decks by means of ramps.”

One of the few shipowners who is also a naval architect, he smiles with appreciation thinking of the clever shipyard work done by his predecessors in building the ro-ro business. “Those were some fantastic projects,” he says admiringly. “We were a pioneer in ro-ro conversions.”

**NEWBUILDING DEFINES NEW DIRECTION**

Interestingly, the ro-ro pioneer was in business for almost nine decades before deciding to build a ship for itself. One of the aspects to the Jolly Diamante that make it a very special vessel for Messina Lines, then, is that its delivery marked a departure from the past, being the company’s first-ever newbuilding.

The first of a series of four ABS-classed sister ships ordered from Daewoo in 2009, the 45,000-dwt Diamante is 240 m in length and 37.5 m wide, offering a total of 6,500 linear meters of vehicle deck space and a capacity
for over 3,000 containers – the world’s largest ro-ro/container vessel at the time of delivery in December 2011. Sister ships Jolly Perla and Jolly Cristallo followed during 2012 and the last of the group, Jolly Quarzo, will join them at end-February 2013. In addition to being the jewel of the Messina fleet, the Diamante also became a ‘living’ symbol of its new corporate direction.

The $300 million, four-ship order was part of Messina Lines’ response to the market shock of shipping’s recent financial crisis. As a major operator of ro-ro/container vessels, the company felt the sting when the container-carrying capacity of the world fleet increased while demand leveled, causing a heavy drop in freight rates. Messina responded with a new focus on improved economies of scale and reduced operational costs. In an atypical move for these troubled times, the company restructuring internally without cutting its labor force, opening new, directly-owned offices to reduce reliance on third-party agencies.

In its program of fleet renewal and cost reduction, Messina Lines sold its remaining pure container carrier and some of its older and less competitive ro-ros and con-ros. Different from a ro-ro/container ship, the con-ro is a hybrid vessel in which the fore part is divided into holds, as on a containership, and the aft part is arranged in garages that are accessed by a stern ramp and a stern door and served by internal ramps or elevators; because its forward cargo area can only be served by cranes (onboard or ashore), the con-ro has somewhat less flexibility than the ro-ro/container vessel, where the hull is arranged in specially-built garages that accept both vehicles and containers. To increase its own flexibility, Messina then began chartering in small containerships for certain routes. The centerpiece of the company’s coping strategy, however, was to draw upon its experience and develop a new series of vessels that would take ro-ro flexibility to a new level.

“The problem for us was to lower costs while increasing profit; we had to keep pace with the growing demand for goods in the markets we serve, but also to deal with the rising price of fuel and very low shipping rates – in short, we needed ships that consume less but carry more,” says Messina.

Recognizing that its needs called for a vessel of the future, which the secondhand market could not provide – existing ships being, after all, products of the past – Messina Lines decided that its time to build new had finally come. The company’s technical staff started out on this adventure by collecting the ‘better vessel’ ideas accumulated during three generations of ship operation.

“When we decided to enter the newbuilding market, we also decided that we had to design the ship ourselves,” says Messina’s newbuildings Technical Director Dr. Enrico Allieri. “After all these years of operation, only we know exactly what we need from a vessel, so only we could produce a design that achieves what we want and allows us to work most efficiently,” he explains. “We developed a well-grounded preliminary design – not just a sketch – and called on the yards to offer. And the yards responded. Typically, shipbuilders aren’t interested in custom designs; usually, the owners receive the specifications from the shipyards, which they are expected to approve with, perhaps, minor modifications. We, instead, supplied a 200-page specification when asking for quotes,” he says proudly.
“One particular technical challenge for us was how to satisfy the many port limitations in the developing world. In many ports, you cannot have a ship of great length; also, many of the ports we touch are at the end of rivers, so there isn’t much leeway in terms of draft, either,” Allieri explains. “So, we could only maximize our capacity by increasing breadth – this is most significant from the speed and fuel consumption points of view. Hullform in ships like ours is very critical to performance and must be done very carefully, because there isn’t as much design freedom as one normally has.”

Allieri also points out that another major design challenge for the in-house technical teams was how to make a high-tech, high-capacity vessel that would be as at home in a rudimentary port as in a modern one, which also had a built-in capability to deal with an aggressive and continually evolving regulatory environment.

“We wanted our own ship, not a ship similar to our ideas, but our ship,” affirms Dr. Messina, who notes that, aided by a newbuilding market in which even top-quality yards were hungry enough to listen agreeably, the company was able to get its ideal ship. Allieri, who led the design operation, describes the resulting vessel as a ship whose details, large and small, embody a wish-list written over many years of operational experience.

**Innovation Inside**

Possibly the most obvious innovation on the Diamante class ships is the large, slanted ramp door at the stern. Able to support loads of up to 350 tons, the 50-meter stern ramp, custom-built for Messina by MacGregor, lowers at an angle between the vessel and the dock, giving the ship greater accessibility to vehicular traffic than conventional ro-ros.

“Until recently, the ports we served in Africa and Arabia didn’t have equipment for loading or unloading vessels,” Allieri says. “Today, many ports have full handling systems, even in Africa, but this convenience is often offset by heavily congested traffic that requires the vessels to wait some time before unloading. These vessels avoid any such idle time. We go to the pier, open the stern door and can unload directly to the dock; trucks can drive on, attach the trailers and drive off. Being free to operate without any support from shore is one of our biggest assets.”

Another noticeable design feature is the position of the deckhouse. “Usually, ro-ros in lightship conditions are very heavy in the stern and light at the bow, which means you need a lot of water ballast to modify the trim,” says Allieri. “What we did was move the superstructure forward to balance the ship; these ships need very little ballast water to be trimmed – much less than other vessels of this type.”
Many of the vessel’s special features are less easily seen, but have not gone unnoticed. Clients with very large, unwieldy freight welcome the lowest car deck, where huge objects up to 7 meters in height can be stowed. Other features reveal the depth of thought that went into making onboard cargo movement easier. For example, it’s a fact of life for ro-ro/container ships that the forklift operators moving containers on deck are not always able to see what’s in front of them; as a result, the forklift often bumps into the ship and, over time, damages the steel. Messina addressed this by installing steel bumpers as needed to protect structures and systems, such as vents, hydraulic equipment and electric machinery. Another reality is that systems and equipment needed on the vehicle deck – hydrants, for example – often become obstacles to maneuvering vehicles and can lead to damage during loading and unloading operations. In the Diamante design, all equipment is recessed; besides maximizing the vehicle turning areas, this protects the ship’s equipment and cargo from damage and makes for flat walls that let the cargo spaces be used most efficiently.

The ship’s environmental and efficiency systems have also attracted attention. Its ballast water treatment system, its pre-swirl stator for improved hull efficiency and its seawater-based exhaust gas cleaning system (EGCS) were among the equipment that won for the Diamante the first Green Plus certificate issued by Italian classification society RINA, which shares dual class of the vessel with ABS.

When the ship was delivered, in fact, EGCS manufacturer Hamworthy Kristallon touted it as the world’s first vessel to operate commercially with a seawater scrubber system. The five scrubbers, mounted inside the ship’s funnel casings, remove pollutants from the exhausts of its auxiliary engines and auxiliary boiler. “We can now meet the coming 0.1-percent sulfur emissions regulation for EU ports while burning residual fuels,” Allieri said at the time. “The shipping industry is changing and will continue to do so, especially regarding environmental issues. Preparation is key to meeting these challenges, and we are now ready to satisfy the regulatory requirements and seize the opportunities that such changes will inevitably bring.”

One example of such opportunities popped up in January 2011, when the North Europe ports of Rotterdam, Antwerp, Hamburg, Bremen, Le Havre and Amsterdam introduced the Environmental Ship Index (ESI), a voluntary ‘green reward’ program in which the environmental performance of vessels entering the ports would be assessed and given a score between 0 and 100, with each port setting its own terms for such green rewards as fee rebates. The score would be based on emissions of NOx (to rate main and auxiliary engine performance), SOx (to rate bunker sulfur content) and CO2: production (to reflect...
As his work touched many lives, so may his memorial: A gift to Genoa and a sentimental gesture emblematic of the family-run shipowning company. In 2001, Ignazio Messina & Company sponsored the erection of the Genoa Biosphere in honor of the company founder. Designed by famed architect Renzo Piano and located near the city aquarium in the old port of Genoa, the steel-and-glass sphere is 20 meters in diameter and houses a tropical botanical garden with freely roaming butterflies, birds, amphibians and reptiles. Able to accommodate 250 visitors at a time, the biosphere – or ‘bolla’ as it is also known – remains a popular attraction for tourists and locals alike.
The inconvenient truth about our industry is that we made a collective mistake during the past 20 years by not pushing for better fuel efficiency.

Owners didn’t consider fuel efficiency to be an issue because the cost of fuel was historically very low, and the yards didn’t want to build more efficient ships because such vessels have higher production costs. Most owners, particularly of tankers and bulk carriers, just wanted ships that could be delivered in the shortest possible time, at the lowest possible cost and the maximum possible deadweight. The shipyards obliged by increasing the block coefficient until they were turning out ships that looked like pontoons.

Because no one pressed for propulsive efficiency, we suffered two decades of fat ships with small engines and high-revolution, small propellers.

This trend should have been stopped by us shipowners. It should not have taken a regulator to force us to think about the responsibility one has when ordering a vessel. Sure, economics, competition and many strange factors do, in a certain way, close our eyes and force us to work in a market whose interests are no longer the interests of the world, but the interests of small individuals trying to maximize the profit from their investments. Still, owners have a great responsibility to minimize pollution from ships, because 90 percent of worldwide trade is done by sea.

This is why I say the Energy Efficiency Design Index (EEDI) is a wonderful thing that will make our shipowning job better. There is great potential to improve vessel efficiency through design. Many people who speak against EEDI appear fixated on the vessels delivered up to two years ago, saying that ship design can go no further and the only solution is to reduce speed. This is not true, and may reflect an attempt to defend bad commercial decisions. There are better hull designs, better choices of main engine/propeller combination and even some fuel efficiency devices that do what they claim. Simply put, you can improve your efficiency by building a better vessel.

This is what we are doing at Scorpio. Contrary to arguments that EEDI is impossible to satisfy, we have already taken delivery of a ship that is well below the EEDI curve – and we’re not inventing anything. What we are doing is, in a sense, returning to ship design of the 1980s: slimmer vessels with lower block coefficients and a low-revolution, large-diameter propeller coupled with a long-stroke engine.

We had such a drive train installed on a series of vessels we ordered a year and half ago; for a relatively low investment, we improved energy efficiency by a considerable amount over the shipyard design. It’s not magic; it’s basic hydrodynamics (bigger propeller, better efficiency), a well-known idea that was ignored for 20 years. On a later order we did our own hull design as well; reducing the block coefficient on a 50,000-dwt tanker, we lost some hundreds of tons in cargo capacity but gained further points in hull efficiency and increased our overall efficiency improvement even further – a fair trade-off for a superior ship.

So, EEDI asks for nothing new; it should neither be feared nor loathed. But we must remember that EEDI was invented to judge designs; it cannot be applied to ships built before it existed. That’s why we on the Intertanko Technical and Environmental Committee insist that EEDI be for newbuildings only, and that existing ships need a different efficiency rating system: the ‘Operating Index’ (EEOI). Without being prescriptive, EEOI asks for environment protection efforts from existing ships (slow steaming, for example) that embrace the whole of shipping activity, starting with chartering and the speeds agreed to in the contract. That is fantastic, because, up to now, chartering was considered untouchable. EEOI may not be perfect, but it’s at least a start.

Altogether, what I am most happy about concerning EEDI is that, finally, some rules and regulations are pushing directly for more efficient ships. Maybe for the first time in history, we are in a period where environmental and economic concerns are each trying to force an improvement in ship efficiency – and that is very good indeed.
“I must go down to the seas again, to the lonely sea and the sky, and all
I ask is a tall ship and a star to steer her by, and the wheel’s kick and
wind’s song and the white sail’s shaking, and a grey mist on the sea’s face
and a grey dawn breaking.”

– John Masefield,
1878 - 1967