The goal for innovation economics essay

In the past decades, people keep improve the oil tanker and make the tankers bigger and bigger and bigger again. Why do the people continuously create new tankers? The trigger is the greedy of money. Innovation costs money but creates more money!

The willingness to stay a competitive advantage drives the shipping innovation. Successive upgrading of competitive advantages is associated with a progressively rising economic prosperity.

As Blackwell and Eilon said in the book “ The Global Challenge of Innovation “(Blackwell & Eilon, 1991), the shipping market belongs to the market model where market needs (and not technological reach) the genesis of innovation. Rothwell and Zegveld define such a market as need (market)-pull market, which implicate that the shipping market stimulate the shipping industry to innovate and develop.

b) The driving force on the innovation

As we all know, the shipping market is a highly competitive market. A few shipping companies share the same shipping line so every company try to survival from the competition and then force the rival out of the market. In term of competition, the company form the economy market should keep increasing the quality of the product and lowering the cost.

As the figure 1-1 depicts that t any product goes through the process of introduction, growth, maturity and decline.

Figure 1-1 the product life cycle

The curve shows the variance over time of the volume of sales of a new service. The product itself passes through a period of adaptation and improvement. The sales go skyrocket in the introduction period. Then the goods are enhanced and the sales keep rising but in a relatively slow speed. After that, the sale stops rising and starts to drop in the maturity stage. The final phase for the cycle is the decline time when the sale shrinks in a stunning speed. Because of the product life cycle, if a company wants to avoid the recession in the sales, it has to continuously introduce a new product or service to the market. The growth of the sales brought by the new product can offset the decrease created by the old product. Because the high competitiveness in the shipping industry, if a company fails to bring a new product to the market, it will lose a lot of market share. The product life cycle is unchangeable so the only for the companies to survival is innovation.

Figure 1-2 shows another conceptual model, which is more technologically specific. According to the model, the rate of the innovation slumps when a new product entre into the market. More emphasis will be set on the new product rather than the old one. As a result, the new product goes into a rapid development process.

Figure 1-2 the product and process innovation

The product life cycle model explicate the competitive strategies o f the industrial companies. The 2 figures point out that the competitiveness is the driving force behind the innovation. Because all the companies want to stay the competitiveness advantage and maintain a high volume of sales, they spare no efforts to innovation, development and improvement. Continuous

innovation is critical for the companies to compete with others. (Wijnolst and Wergeland, 2009, p. 422)

c) The critical role of innovation

The aim for the innovation is to stay the competitive advantage in the business world. With the globalization of the shipping industry, the competitiveness gets more and more fierce, which speeds up the innovation in the shipping industry.

I would like to take my country China as an example. In recent years, Chinese ship building industry has a steady development. China has successfully taken place of South Korea, and become the largest ship building country in the world. According to the figure released by the China Association of the National Shipbuilding Industry, 41. 1 percent of world's ships were built by the Chinese shipyard, but Chinese ship-building industry is different from the industry in the opponent countries, such as Japan and Korea. Both Japan and South Korea dominate the ship-building industry by the technology and innovations. Chinese does not produce so much innovation in the ship building market as its opponent does. The reason for the rapid development is the huge investments in the ship-building market. Zhang Shengkun, president of Shanghai Society of Naval Architects and Marine Engineers, pointed " Although China has become the world's largest shipbuilder; it is still not a powerful ship manufacturer." Chinese shipbuilding industry design lags 10 years behind counterparts in the United States, Japan and South Korea, while manufacturing and management ability lags four to seven years behind. In the shipping industry, the innovation weights more than the investment. The shipping industry is a business lead by innovation.

Imitating other’s design is a short cut for Chinese ship-building industry, but it is not a ideal way to run the business in the long term. As a leader in the shipping industry, following others idea is not an option.

How to strengthen the innovation and the creation is on the top priority of Chinese ship-building industry. It is the innovation that decides the shipping design, throughput, even the trend of shipping industry.

Step 2 – Innovation Triggers in Shipping

The innovation in the shipping industry is triggered by the willingness to compete with others. A shipping industry faces a series of changes in the daily operation, such as the fluctuation of oil price, the unpredictable change of the economy, the up and down of the cargo volume and even the threat from the pirate. In the long term, more factors will force the shipping companies to improve their ships, services, route, and management. For example, if the European Commission confirmed that it would include shipping companies into the European Union Emissions Trading Scheme (ETS), the shipping companies’ daily operation cost will increase in a large scale. As a result of the regulation, more ship yards will spare more effort to improve the fuel efficiency and the shipping companies will optimize the route further.

The development of the industry

With the development of the Second Industrial Revolution, the demand of oil skyrocketed in Europe. Before the Second Industrial Revolution, the European annual oil consumption is 100, 000 tons in 1864. Because of the huge achievement in the technology, the demand for oil grew in the end of

19th century and the production of oil increased as well. In1900, approximately 12, 000, 000 tons oil was extracted out from the earth. The industrial development caused the rise in the oil production and the rise in the oil production stimulated innovations in the way oil was shipped.

In the very beginning, there was no big difference between the way oil was transported and the general cargo was transported. The oil was filled into wooden barrels which were stowed in the holds of ship. Because the wooden barrels tended to collapse in the heavy sea, the dedicated designed ship appeared. Such kind of ships substituted the cargo holds with the iron tanks, which is more adaptive to the hard environment than the wooden structure.

To tackle with the growth of the oil demand in the second half of the 19th,, England launched Gluckauf in 1886. Gluckauf is another ingenious designed ship which stimulated the specialization of the oil tanker dramatically. There is a trunk which eases the expansion of oil. And the engineer separated the tankers form the engine room by a pump room, which increase the safety of the ship. Gluckauf can carry so much cargo that the waves could wash over her deck. Before Gluckauf appeared, oil had been shipped in barrels or drums, which is a very primitive way to transport the dangerous goods. The innovation in the Gluckauf made the oil tanker come ture.

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Gluckauf 1

The improvement in the propulsion.

The secret of the law of physics attracts the people for thousands of year. The development in the physics helps people work out the secret of the boat, and encourages people to improve the ship again and again. In the past hundreds of years, the ingenious people tried many methods to make the ship bigger, safer and faster.

On 19th November 1861, Peter Wright & Sons of Philadelphia chartered Elizabeth Watts and they shipped 224 ton of oil to England safely. At that time, Elizabeth Watts was driven by wind which is a very primitive way of propulsion. Due to the strength of wind is not stable and the direction of the wind is unpredictable, the whole sailing cost 45 days, which is quite a long time.

Fichier: Elizabeth Watts. jpg

Elizabeth Watts1

After a decade later, the first oil-tank steamer, the Vaderland, changed the way people propel the oil tanker. Vaderland was built by Palmers Shipbuilding and Iron Company for a Belgium shipping company.

Model ship of Vaderland3

In the following years, the sail-driven oil boat was substituted by the steam boat, which raised the sailing speed and provided a greater house power to the oil tanker.

In 1903, engineer Karl Hagelin and Johny Johnson put the first internal combustion on the ship as opposed to the older steam engines. The deadweight of Vandal was 750 ton and the ship was driven by a diesel-electric engine. The ship used the diesel engine to power the electric generator and the propeller was powered by the generator. In the ship, there were a bulkheads running form the bow to the stern, which was the first time that the bulkheads appeared on the ship. Three diesel engines pumped out 360 horsepower to make the ship reach 8. 3 knots.

Up to now, the diesel engine is still the first choice for the oil tanker. The oil tankers have a relatively big breath, which means that the tankers deal with a big friction force. Generally speaking, the speed of tankers is between 12 to15 knots.

Economies of scale

The first oil ship Elizabeth only carried 224 tons of oil. It did not take shipping industry long to realize the more oil that one ship could carry per voyage, the more money ship owners would make. So oil tankers got larger and larger. Every oil tanker owner wants to maximize the profit at the lowest cost. One of the ways to realize the aim is to build the bigger oil tanker so as to carry as much as possible in one voyage.

In terms of economics, if you can ship one more barrel of oil, your operation cost will remain almost the same and you can get nearly all the marginal profit created the additional oil. It is the diminishing marginal product that stimulates the ship owner to buy a larger oil tanker.

The access to the Suez Canal

The Suez Canals is an artificial waterway the Africa and the Europe. The reason why Suez Canal earns such a big name is the geological advantage of the canal. Suez Canals links the Mediterranean Sea and the Red Sea. Because of the advantage in the geographic, the Canal provides a convenient access to the India and the East Asia, which enables the Arabic countries to export the oil to the two important developing countries, China and India.

In the eyes of ship owners, the Suez Canal is a Highway for the tankers. But in the very beginning, because of the property of explosion and flammability, the canal is forbidden to the oil tankers. In the second half of 19th, a small British trader Marcus Samuel, tried to export oil through the Suez Canal, but Prior bids had been rejected by the Suez Canal Company as being too risky. In order to access to the Canal, Marcus Samuel adopted a new design which allow the ship can go through the Canal. Marcus Samuel built a cofferdam at both the bow and the stern of the tank. On August 24, 1892, Murex went through the Suez Canal, which the first tanker used the canal.

Step 3 – Performance Benchmarking and S-Curve Limits

The development of the oil shipping business is accompanied by the revolutions and the innovations. We use S-curve to depict the improvement in several aspects.

The package of oil

In the past, all ships were general cargo ships, so the good must be packed as a general cargo which adapted to the characteristics of the ship. In the

very beginning, the oil was packed in wooden barrels and charge and discharge by the derrick.

The oil barrel on the port

In 1878, British engineer built the ZOROASTER whose mission is to shipping nothing but oil. The length of ZOROASTER is 56 meter and the deadweight is few hundred tons. From the picture, we cannot tell the difference form her to other general cargo ship.

ZOROASTER

But the shipper found that the wood was too weak to sustain the heavy sea. Many barrels crushed in the shipping process which brought a huge lost to the shipper. So the shipper must have to found a revolutionized way to store the oil.

Performance

Year

1860 1890 1920 1950 1980 2010

General cargo ship

Oil Tanker

In 1886, British built the GLUCKAUF for German, whose hold was divided into 14 small holds and equipped by the pipeline system. The design of GLUCKAUF was a real breakthrough at that time. After the lunch of GLUCKAUF, almost all the oil ship between the America and Europe adopted the GLUCKAUF’s design.

S-Curve for Ship Types

The propulsion

In the very beginning, all the ships were driven by orals. But human power is a very inefficient way to propel a ship. With the ship getting bigger, human power cannot provide energy for the ship any more. So people found a very environment friendly way to drive the ship: wind. At first glance, wind is such a nice power, when we enjoy the nature power, we do not pay anything back to the nature. So, the sail ship became a first choice in a relative long time. All the cargo ships were equipped with the big sails when sailing on the sea. Through hundreds of years' development, mankind still could not know the secret of the nature. It was difficult for people to predict the direction and the strength of wind. Wind power was not so stable. After the steam engine invented, mankind put the ingenious machine on the board, which became the steam ship. At first, the steam ship still needed the help of wind, because the steam engine did not work efficient enough to propel a ship. This is the reason why GLUCKAUF had 3 big sails on the board.

In 1903, engineer Karl Hagelin and Johny Johnson introduced the diesel engine to the ship, which is another big step improvement in the tanker. The first diesel engine ship had only 360 house power, but it was developed rapidly and the house power goes up in the following years.

Performance

Year

Human power

Wind power

Steam power

Diesel power

Before 1000BC ... 1000BC 1700 1800 1900 2000

S-Curve for propulsion power

Economies of scale

Because the shipping market follow the rule of economics of scale, the trend of enlarging the tanker is inevitable. ZOROASTER is 56 meter and the deadweight is few hundred tons. In the next a few decades, the size of the tanker grew with the increase in the demand of oil. In 1913, SAN JERONIMO was the biggest tanker in the world, whose deadweight is 1239 ton. 15 years later, the Germany tanker C. O. STILLMAN got the first in the deadweight list, and she kept the top position for 21 years. In 1956, the Suez Canal was closed for the tanker for some reasons. So the oil shipping route changed dramatically. Many tankers have to go through the Good Hope Cape which added 5000 miles distance. In order to set off the side effect of the route, the shipping owner preferred the bigger ship. Because the bigger the tanker was, the less the shipping cost. Additionally, the weather in the Good Hope Cape was not nice to shipping industry. Huge waves and the storm were really common in that region. Only the big tanker could survival through such test. As a result, UNIVERSE APOLLO was built by Japan in1959, which broke the recode again. UNIVERSE APOLLO is 288 meters long and 104520 ton weight. Just 7 years later, IDEMITSU MARU doubled the deadweight record set by UNIVERSE APOLLO. The tanker weighting more than 200000 ton became realistic.

SAN JERONIMO

UNIVERSE APOL

1800 1850 1900 1950 2000

Size

Year

Product tankers

SUEZMAX

Panamax

VLCC

ULCC

S-Curve for ship size

Step 4 Innovation targets.

In the term of technology, there should not be a limitation on the development, but the realistic set a lot of restrictions for the innovation in the tankers. The innovations not only have to deal with the challenge form the technology, but also the test of environment issues, security code, physical law, and the market performance. All of these factors have an effect on the innovation target of oil tankers.

Propulsion innovations

Now days, how to make money without making damage to the environment is a critical issue to anyone. The world international environment protection institutions have found a series of codes and regulations to prevent the environment pollution, such as EU, which launched EU ETS (The European Union Emissions Trading System) in 2005 to combat climate change. The oil shipping companies have to follow the regulation, which has a big inference on the strategy decision process. In order to lower the shipping cost, many scientists try to shift the diesel engine to other kind of engines, such as the solar engines, the nuclear power engines . etc. Even some imaginative scientists hope to put the wind turbine on the board as wind is a costless force.

Shipping design innovation.

We all know that the length breadth ratio determines the resistance created by sea against vessel. Generally speaking, the tankers have a relatively bigger length breadth ratio than container ships, which explains why the speed of oil tanker is lower than container ships. If the scientists can work out a structure to reduce the resistance, the shipping cost will drop, and ship owners will make a huge profit from the innovations.

Security innovation

Oil is nicknamed as the blood of industry, but it is devastating to the livings in the ocean. The spill of the oil is a true disaster to the environment. To minimize pollution of the seas, IMO proposed the Marpol 73/78, which has become t most important international marine environmental conventions. As the tanker getting bigger, the oil carried by the tanker is a really big

threat to the nature. One of the devastating spills occurred on March 24, 1989, when Exxon Valdez, an oil tanker got grounded. In the accident, approximately 550, 000 barrels of oil leaked, and the ocean around the ship got polluted instantly. A few years later, the spill threats the livings in the sea continuously.

Following the Exxon Valdez spill, Oil Pollution Act of 1990 (OPA-90) was passed by the congress in United States, which aims to prohibit single-hull tank in U. S. waters. People gradually realized that the single hull tanker was too fragile to protect the dangerous goods. Substituting the double hulls tanker for the single one is an inevitable trend. Because the Double hull can prevent the oil from spilling when crush occurred, more and more countries try to replace the single hull tanker by the double hull tanker. The demand for the double hull tanker in the market promotes the innovation in the ship design.

Step 5 – Generating Ideas

Revolutionized thinking

With the development of the shipping industry, the industry tried to make some breakthrough to maximize the profit brought by the tankers. And in the mean time, the safety is always the first consideration. We cannot make the money at the cost of scarifying the environment. How to build the tanker bigger with less resource consuming is an everlasting question.

The free ballast ship concept

A conventional VLCC uses ballast water for two different parts of its operations. In unloaded transit condition, the ballast is needed to obtain both

a fully submerged propeller and enough forward draft to avoid bottom slamming. During cargo operations, ballast water is used to reduce bending moments and compensate for trim and heel.

A tanker’s ballast operations give rise to three main unwanted effects: the ocean pollutions, the oil consumptions and the deadweight lost.

The dire consequences include the coastal organisms that can cause damage when released to foreign ecosystems. To offset the impact of ballast water on the environment, the IMO ballast water convention asserts performance criteria to reduce harmful aquatic organisms in ship ballast water and sediments. Hence, it is huge improvement to eliminate ballast while maintaining transverse stability, bow and propeller submergence.

The ballast tank is a load on the tanker so more effective power is needed to propel the tanker. The more power is required, the more fuel main engine does consume. If we can remove the ballast tank form the tanker, the power required and the fuel to consume are anticipated to decrease comparatively.

The study of ballast free ship was conducted by the University of Michigan. They added two holes on the ballast free ship at both forward and afterward of the ship. Sea water run into the holes on bulb and eventually pops out the holes near the propeller. The design successfully removed the ballast tanker form the tanker and no ballast exists any more. As the water runs through the tanker, from the forward and gets out of the tanker at the stern, the water helps stabilize the tanker.

http://umich. edu/news/Releases/2008/Mar08/ballast_2. jpg

The ballast free ship

http://www. e-marineeducation. com/tr/wp-content/uploads/Location-of-Two-Ballast-Trunk-Discharges-Investigated. png

The hole at stern

This is one promising design to block hitchhiking organisms and terminate the entire requirements for expensive sterilization equipment like costly filters, ultraviolet irradiation, chemical biocides and other technologies. It creates a constant flow of local seawater through a network of trunks, running from the bow to the stern, below the waterline, thus reducing the potential hauling of contaminated water across the ocean. Plus it could be one giant economic winner by affirming a saving of net capital-cost of about $540, 000 per ship.

Tanker propelled by the sun

With the oil skyrocketing in the recent years, the fuel cost becomes a huge burden on the oil shipping company. To reduce the fuel cost, people plan to propel the tankers by solar energy.

Eco Marine Power is a Japanese company which believes that any ship could be powered by wind and solar energy in the future. Their concept is to add the solar battery on the board. The company unveiled a concept design that could be applied to virtually any type of ship, including monstrous ferries, survey boats, cruise ships, and oil tankers that could be equipped with gigantic sails of solar panels to reduce fuel consumption and even integrate an electric propulsion system in the future.

Eco Marine Power Co. Ltd unveiled a concept ship design called Aquarius Eco Ship. The Aquarius Eco Ship could include enough solar panels for 1MWp solar system or larger and enough energy storage modules so that the ship would not need to use auxiliary diesel generators whilst in port. These energy storage modules could be charged via the solar panels or by the ships main generators. This combination of technologies could lead to fuel savings of 40% or more and also dramatically reduce the emission of noxious gases such as Sulphur Oxides (SOx) & Nitrogen Oxides (NOx). In addition the use of renewable energy would reduce the vessels carbon footprint. Importantly the Aquarius Eco Ship has been designed to take into account the reality of operating rigid sails on ocean going ships and include a range specially developed safety features, which implicates that ship can come into reality probably.

aquarius_eco_ship_2b

Aquarius Eco Ship

Solar Sailor, an Australian company specialized in renewable energy, has just signed a contract with shipping giant COSCO to provide tankers powered by sails that are fuelled by sunlight. According to the company, the new ships will reduce oil consumption by 20 to 40% through wind energy and 5% through sun. The sails, managed by a computer that calculates the angle by exposition to wind and sun, become profitable after four years of use.

Solar-powered tankers designed by Solar Sailor

A higher energy efficiency

Although oil tankers are considered to be among the most energy efficient vessels today, their fuel efficiency had not improved in the last 20 years despite general improvements in ship systems. In order to improve the fuel efficiency, IMO proposed Energy Efficiency Design Index (EEDI), which is expected to become a mandatory standard for shipbuilding in the future. Simply speaking, EEDI is a simple measure of a vessel's inherent fuel efficiency and compares CO2 emissions to transport work. A reference EEDI is determined by IMO for each type of ship, e. g. for tankers. A particular ship's EEDI can then be measured against this reference. Future newbuild ships would then have to meet, at a minimum, this reference EEDI. This reference line would then be tightened, over time, as determined by the IMO. An individual vessel's EEDI can also be benchmarked against a competitor's vessel or against vessels within the operator's own fleet. GL currently offers a voluntary EEDI certification scheme based on the IMO's EEDI standards.

Germanischer Lloyd has developed a design concept for a crude oil tanker with improved energy efficiency. The design concept, the Aframax BEST-Plus design, maximizes profitability by optimizing the hull's hydrodynamic performance, taking into account long-term freight rate levels and projected bunker costs.

The speed at ballast draft of 7. 4 meters is 16. 8 knots. This represents a favorable speed increase when compared with recently built vessels of the same size. With a standard main engine for Aframax oil tankers, a MAN 6S60MC-C, the fuel consumption is comparable to similar vessels.

With this high speed and large cargo capacity, the vessel easily meets future EEDI requirements. Indeed, the attained EEDI value is merely 84 per cent of the latest published reference line value for this ship size. This means the vessel would be in compliance with EEDI regulations even if the first reduction to the required EEDI had already begun. At current estimates, this will happen at the earliest on 1 January 2015. Although a vessel contracted before EEDI has entered into force does not formally need to comply, competitive vessels entering the market, e. g. in 2017, will be more energy-efficient and, therefore, more likely to attract cargo than older vessels with lower energy-efficiency. The new BEST-plus design concept will remain highly competitive.

STEP 6 – Innovation Case Study

As we discussed in the step 5, many innovations have developed into concept models. With the demand of making profits without damaging the environment, the scientists of DNV pioneer in developing the next generation of oil tanker. After years hardworking, DNV introduced a new crude oil tanker concept that is fuelled by liquefied natural gas, has a hull shape that removes the need for ballast water and will almost eliminate local air pollution. This future ship demonstrates a big step forward in the oil transportation industry.

According to the project manger, the new crude oil concept vessel has been developed through a DNV innovation project. As its name Triality indicates, it fulfils three main goals: it is environmentally superior to a conventional crude oil tanker, its new solutions are feasible and based on well known

technology, and it is financially attractive compared to conventional crude oil tankers operating on heavy fuel oil.

Free ballast water

Ballast water which is used to keep the immersion of the full propeller, is necessary for a traditional tanker in the unloaded circumstance. Normally speaking, 80, 000 and 100, 000 tones of ballast water is enough to maintain seaworthiness for a VLCC after the vessel discharging. As we mentioned above, the ballast is a huge pollution for the sea eco-system. When the tanker discharges the ballast water, the microorganism form the foreign region will damage the balance of the local ecosystems. Additionally, transporting the ballast is a lot of cost for tankers. In another word, we waste the money and energy to carry the pollution when the tankers are unloaded. Last but not least, the coating of the ballast tanks during the operations is another big concerns for the tanker companies.

Removing the ballast tanker is an ultra solution for the problems of ballast water. To realize the dream, DNV introduced a new V-shaped hull form and rearranged the cargo tank layout. By the genius design, the ballast tanker is completely eliminated from the tanker forever.

Form the figure 6-1, we can tell the V-shape hull form the tradition hull easily.

Because of the shape of the hull, the tanker reduces the wetted surface in a large scale, which helps the tanker to improve the energy efficient performance.

Figure 6-1 hull shape

More environment friendly

The shipping industry is facing an increasing demand to reduce its environmental footprint. For ships built before 2016, the present challenge is to comply with and emission requirements. For a conventional VLCC burning heavy fuel oil (HFO), installing an exhaust gas scrubber and a ballast water treatment system (BWTS) are possible ways to address these issues.

The Triality takes LNG as a substation for diesel, to propel the tanker. Compared with the diesel, LNG is a clean energy with higher energy efficiency. We have a totally different engine system form the diesel engine to adapt to the LNG, so the scientists introduced inert gas system.

The new concept tanker has two high pressure dual fuel slow speed main engines fuelled by LNG, with marine gas oil as pilot fuel. Triality VLCC has two type C pressure tankers, which hold 13 500 m3 LNG. The pressure tankers are located on the deck in front of the superstructure. As the tankers are fully loaded, the tanker can cover the voyage of 25 000 nautical miles. The generators can use both LNG and marine oil, and the auxiliary boilers can produce steam for the oil pumps operate by recovered cargo vapors.

Triality has a significantly smaller environmental footprint than a conventional VLCC that burns HFO and has a BWTS and exhaust gas scrubber installed on board. Taking LNG as the fuel helps the tanker reduces the carbon dioxide emission by 34 percent. Less harm will also be caused to the health of people living close to busy shipping routes and ports as NOx

emissions will be reduced by more than 80% while emissions of SOx and particulate matter will fall by as much as 95%.

The cost efficiency

Can these improvements be profitable? This is a critical problem to the shipping owners. The answer form DNV is clear: “ It is possible to develop an environmentally superior ship and be profitable at the same time.” The smart design of the hull and the LNG engine will help the ship owners save 25% energy consumption.

According to the figure provided by DNV, to build Triality costs 15% – 25% more than a traditional VLCC, but it is estimated that the tanker can save 25% of the building cost during the life