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History of Offshore Engineering Development

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ABSTRACT: *This paper introduces a review and literature study of offshore engineering and constructions from 1920s to 2000s. The study was focused on the literature survey and the history of Brown & Root and J. Ray McDermott in the Gulf of Mexico and other offshore areas Understanding the offshore history and background of offshore development is an essential ingredient for the initial conceptual design. This study was motivated to enhance the capacity of conceptual design and Front End Engineering Design (FEED) of offshore structures in Korea.*

1. Before the Dawn

In 1936, the first offshore pipeline was laid from an offshore tank to onshore by Brown & Root. In 1938, a wooden trestle (pier) was built at McFadden beach in Texas near Louisiana. At the end of the 1.6 km long trestle, a drilling platform was constructed (Pratt et al., 1997).

A very large wooden platform was built at Crole field near the coast of Louisiana in 1938. Crole means white descendant of French settlers in Louisiana. The Crole field production is considered as the first open water oil in GOM.

Larger self-contained platforms were constructed within the sight distance from the shore using the so called the stick-building method in 1930s and 1940s. The most significant design limitation was the lack of knowledge of hurricanes on offshore structures in GOM.

2. Birth of Modern Offshore Era in 1940s

In 1947, a small platform "Kermac 16" was constructed offshore Louisiana at about one-fourth the cost of the larger self-contained platform. Reduction of the cost of the platform was achieved by using a tender (service) vessel to carry much of the equipment and personnel. A 12 m by 22 m non-self-contained platform was much smaller than the most previous offshore drilling platforms. The oil production from Kermac 16 platform is called as the birth of modern offshore oil and gas industry because the platform was located beyond the sight from the land (Pratt et al., 1997). Offshore oil had been produced in GOM before 1947, but always in sight from the land.

One of the major oil companies, Magnolia, built a large self-contained platform in 1946. This platform marked the birth of the steel age and death of the wood pilings in offshore platforms.

In 1947, an ambitious self-contained platform "Humble Grand Isle 18" was constructed, which was located 10 km from land, in 14 m water depth. This giant platform was all steel and it was built using templates or "jacket" fabricated onshore. The logic behind the use of jacket was overwhelming, and their widespread adoption altered the history of offshore platform construction. The concept of jacket provided more strength and solved many problems of the stick-building method. The jacket templates were adopted quickly on platform construction throughout the world. Table 1 summarizes the early offshore platforms till the 1940s.

Table 1 Early platforms till 1940s

Year	Description	Remark
1911	Oil produced in Caddo Lake	Inland lake
1920s	Platforms in Maracaibo, Venezuela	Protected sea
1934	Great Depression	
1936	Pipeline from offshore tank to onshore	First submarine pipeline
1938	Wooden trestle at McFadden beach,	Pier with a rig
1938	Creole field platform	First oil in GOM
1947	Kermac 16 platform	Birth of modern offshore industry
1947	Magnolia platform	First offshore steel
1947	Grand Isle 18 platform	First all steel
1947	Jacket Platform for Superior Oil	First jacket platform

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3. Offshore in 1950s: First Major Phase

During the World War II, offshore industry focused on military ships and supplies. Even after the WWII, indeed after the Korean War, military demands and steel shortages limited the growth of offshore industry. Tideland Act in 1953 accelerated the legal framework for leasing the offshore area. Offshore industry made advances of the first major phase of development. Many war surplus ships and barges were converted for offshore oil industry. The race to offer bigger and better offshore equipment had begun (Calvert, 1957).

Submersible type of drilling rigs were used in shallow water but they were replaced by elevating-deck or jack-up rig in mid-1950s. Former U.S. president George Bush founded Zapata Offshore Company in 1955. Mr. Bush, who was truly a pioneer in offshore industry, ordered a unique unproven, untested 3-legged jack-up "Scorpion" in 1956 and other innovative drilling rigs later. The 3-legged jack-up became the most common type of mobile drilling unit for offshore operations. Floating vessels and semi-submersibles also provided important advances during the 1950s.

In 1954, the first truly offshore pipeline was laid 17 km out from Louisiana. A number of full-time pipelayers were constructed in late 1950s. The first purpose-built laybarge "L.E. Minor" was built by Brown & Root in 1958. A novel device called a "stinger" was used to ease the pipeline to the bottom of deep waters in early 1960s.

In 1956, one of the largest platforms to date was constructed at a record depth of 35 m for CATC (Continental, Atlantic Richfield, Tidewater, Cities Service) group offshore Louisiana. It was the first battered-leg platform which provided more stiffness compare to vertical platforms.

The year 1958 marked the end of what might be called the first major phase of offshore development in GOM. Exploratory drilling dramatically fell off its rapid pace of mid-1950s. Table 2 summarizes the offshore development in 1950s.

4. Offshore in 1960s: R&D with Computer

The offshore industries in GOM made a dramatic advancein 1960s. Engineers brought computer-assisted innovations to structural design and pipelining. These advances were made when the oil price remained in the $2 to $3 per barrel. Design considerations were complicated as the platforms and pipelines were built in 60 m of water in 1962 and 100 m by the late 1960s. One of the most significant innovations was the development of computer programs to analyze the offshore structures in 3-dimension. In late 1960s, offshore industries began to build new research & development (R&D) groups.

Table 2 Offshore development in 1950s

Year	Description	Remark
1953	Tideland Act was settled.	3 mile boundary
1950s	Geophysical explorations	After Tideland Act
1954	Jack-up rig appeared.	
1954	First offshore pipeline	by Brown & Root
1955	Zapata Offshore was founded.	by George Bush
1956	First 3-leg jack-up was built.	by George Bush
1956	First battered platform	by CATC group
1958	First purpose-built laybarge	by Brown & Root
1958	End of first major offshore development.	

By mid-1960s, California had become the world's primary site for deepwater activity. However, the offshore development in California was constrained by political pressures since an offshore blowout and oil spill in 1969. Consequently, the focus of deepwater moved to the GOM and Brazil (Howe, 1969).

In 1969, first annual Offshore Technology Conference (OTC) was held in Houston. The same year, the American Petroleum Institute (API) published its first Recommended Practice (RP) document for the design, fabrication, and installation of offshore structures. Table 3 summarizes the offshore development in 1960s.

Table 3 Offshore development in 1960s

Year	Description	Remark
1962	First commercial semi-submersible	by Shell
1962	Gulf Oil Platform	65 m water depth
1964	Aircraft software for offshore	IBM software
1965	3-dimensional computer analysis	
1967	Platform by Brown & Root	90 m water depth
1969	First O T C	Houston
1969	First API RP was published	Design code
1969	Microwave survey system	To control barge
1970	Dynamic launching analysis	FEM analysis

5. Scientific Project Mohole's Contribution

Project Mohole was a U.S. government sponsored project to drill to earth's crust and upper part of mantle from 1958 to 1966. Motivation of the project was to learn more about the interior composition and geological history of the earth and planet (Tonking, 1966).

A major scientific tie-in of this project was the scheduled offshore drilling simultaneous with the first moon landing in space science.

Original plan was to drill in 3,600 m of water and then drilling through an additional 7,000 m of earth's crust to the mantle. The maximum water depth drilled in late 1950s was only 60 m, and drilling in water depth of 3,600 m was totally beyond imagination.

Scientific debate, political and budgetary dilemmas and Vietnam War ultimately cancelled the project in 1966 (Lambert, 1966). The project had made tremendous advance in developing marine drilling technology. Table 4 summarizes the Project Mohole and its accomplishments.

Even though the drilling into the earth's mantle was cancelled, the space program was continued to land on the moon. In 1961, the U.S. president J.F. Kennedy declared that 'we will land on the moon within a decade'. Man eventually landed on the moon in 1969, overcoming the first major disaster of the Apollo I accident in 1967.

Table 4 Summary of the Project Mohole

Year	Description	Remark
1958	Test drill and search for the site	First phase
1962	Constructing platform and drilling	Second phase
1968	Study on crust and mantle samples	Third phase (not done)
1961	Trial drilling	950 m water depth
1961	Five holes to 200 m below seabed	3,600 m water
1965	Selection of 7,000 m drilling site	4,400 m water
1965	Semi-submersible with a DP system	by Brown & Root
1966	Cancellation of the project	by politicians

Concurrently, drilling into the mantling is planning in part of the International Ocean Drilling Program (IODP) by USA, Japan and several other countries. The drillship "Chikyu" was constructed in Japan and preparing for the drilling in the year 2006.

6. Offshore in 1980s: Deepwater Development

The oil embargo of 1973 by the OPEC provided a big impact on the offshore industry. Oil price jumped from $3 to $10 per barrel.

By the early 1970s, a water depth of 120 m was considered deepwater. The edge of the continental shelf at 200 m seemed as truly deepwater. Moving into 200 m water and beyond, introduced fundamentally new problems. Structural design had to consider the dynamic interaction between structures and waves.

In 1978, Shell Oil designed a giant 320 m Cognac platform and installed in GOM. It established records for the deepest water (320 m), the most wells (62 wells), heaviest steel platforms (59,000 tons), and most expensive ($275 millions).

But Union Oil proved that a single-piece jacket could be installed at similar depth (292 m) for less money by computer analysis. The jacket weighed 26,000 tons, less than half of the Cognac jacket. Union Oil cleverly named its platform "Cerverza", the Spanish word for beer, because at $90 millions it was only a beer budget compared to the expensive Cognac's $275 millions. The following year, Union Oil installed a companion platform, Cerveza Ligera (or Light Beer) in 285 m of water.

In water beyond 300 m (1000 ft), the standard jacket design became less practical, because the dynamic behavior at these depths was too large. Tension leg platform (TLP) or spar platforms had been selected for the deeper waters in 1990 and after (Dunn, 1994). Table 5 summarizes the development up to early 1980s.

Table 5 Offshore development up to early 1980s

Year	Description	Water (m)	$ (million)
1973	Sun Oil platform (farthest)	110	
1973	Tennoco platform (largest)	115	
1976	Hondo platform in deepest water (2-pieces)	260	67
1979	Garden Bank platform (largest single piece)	192	43
1978	Cognac platform (3-pieces, heaviest, most expensive)	320	275
1980	Cerveza (Beer) platform	292	90
1982	Cerveza Ligera (Light Beer)	282	85
1983	Lena guyed tower	305	420

7. End of Boom in Mid-1980s

The booming period 1976-1984 of high oil came to near the end. The Iranian revolution and oil embargo in 1979 made the second oil shock. By the early 1980s, oil prices climbed to as high as $44 per barrel. Prices of $100 per barrel were projected for 1990. Platform and mobile rig cost skyrocketed. New marine yards opened to take new orders. Offshore industry appeared healthy by 194. In 1984, offshore production was 15 million barrels per day, about 28% of world production (Dhillion 2003). Oil price stopped rising in 1982 and began to decline gradually. The bubble burst in 1985. Oil price dropped to $10 per barrel as crude supplies over pass the demand. Many oil service businesses went bankrupt and restructured. Deepwater development was almost dead until the 1990s (Pratt and Castaneda, 2000).

8. Recent Offshore Industry: Ultra Deepwate

In 1990s, deepwater development came back with a high oil price. TLP, Spar, floating production system (FPS), and floating production storage and offloading (FPSO) had been major popular deepwater structures in 1990s and 2000s. There are many articles and well organized data about recent deepwater structures (Barltrop, 1998; Bai, 2003; Guo et al., 2005; Paik and Thayamballi, 2006; Nutter and Albaugh, 2005; Nutter and Albaugh, 2005; Speer et al., 2004).

In the year of 2000, oil price dropped near $10 per barrel, but did not last long. The oil price jumped up again in 2001 and it was over $70 per barrel in 2006 (see Fig. 1). Prices of $100 per barrel were projected again and major oil companies are investing into ultra-deepwater (1,500 m or deeper). Exploration and production (E&P) of oil and gas in deepwater is the clear choice of future projects for the major oil companies. Some Korean companies began to invest for the E&P projects.

By 2005, three major shipyards in Korea remain as competitive contractors in offshore industry throughout the world. Most of the major deepwater structures have been constructed in Korean shipyards in last few years. However, the basic design called as FEED is still in the hands of western offshore industries. The conceptual design and FEED require wide range of knowledge and background of offshore engineering. To enhance the capacity of FEED, there is no doubt that further study on the history and background of offshore engineering should be conducted for Korean offshore engineers.

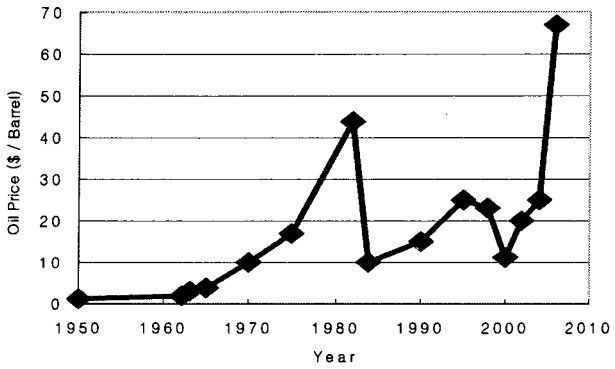

Fig. 1 Trend of oil price per barrel

10. Concluding Remarks

(1) Early offshore developments began in GOM and Venezuela in 1920s and 1930s by the stick-building method.

(2) A wooden platform built in 1947, is considered as the birth of modern offshore oil and gas industry.

(3) The advantages of jacket were easy installation, strength, and low cost.

(4) After Korean War and Tideland Act in 1953, the first major development occurred in offshore industry.

(5) The battered-leg platforms provided more stiffness and reasonable cost in 1950s.

(6) Dynamic analyses with computers contributed the development of offshore structures in 1960s.

(7) Scientific programs contributed the drilling technology and semi-submersibles in 1950s and 1960s.

(8) The period 1976-1984 witnessed stunning achievements in deepwater. Innovative technology provided continuous development of TLP, Spar, FPS, and FPSO for deepwater.

(9) The oil price of $10 per barrel in 1973 stimulated the offshore development, while $10 in 1984 discouraged it. $100 per barrel was projected in 1980s and 2006. The current price is likely to go up continuously according to the energy experts and major oil companies (see Fig. 1).

(10) Further study of offshore history and background is essential to enhance the capacity of conceptual design or FEED of offshore structures in Korea.

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