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MEGA-PROJECTS OF THE 1970s
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GOLDEN YEARS

Why the 1970s was the age of the mega-project – although you would not have heard it described as such at the time... By BEN HARGREAVES

Many giant projects from the 1970s had unprecedented complexity and unparalleled ambition. The value of some projects – such as those in the North Sea – ran into the billions. It was a time when new offshore oil and gas fields were discovered and exploited, spurred by energy crises that saw the price of oil quadruple. In the US, the Boeing 747, a new wide-body commercial airliner, first produced in 1970, and undoubtedly an early mega-project, helped to serve the burgeoning demand for long-haul air travel. Meanwhile, the record-breaking Concorde, first flown in 1976, illustrated the power of international collaboration between France and the UK on a major civil aerospace scheme. The decade even saw the tail end of the groundbreaking Apollo space programme, with the Apollo 17 launch in December 1972 remaining the most recent manned mission to the moon.

APM Honorary Fellow Bob Laslett worked on many North Sea oil and gas projects during the 1970s that would qualify as 'mega-projects' today due to their size, complexity and financial value. "There was a feeling we were part of something new and exciting," he recalls.

The advent of deep-water drilling in the North Sea meant overcoming formidable technical and environmental challenges. "That was a step change for the oil and gas industry," says Laslett. "We were starting to drill in very deep water. We were dealing with significant – and often atrocious – weather and high waves. There were big fields of oil to be discovered and put into production."

The challenges of working on these offshore projects included bringing together very large structures with petrochemical process plant and drilling rigs, and subsea connections and marine operations. There were "unprecedented engineering challenges" in platform installation, hook-up and commissioning, says Laslett. In terms of risk management, it was necessary to introduce extreme weather and deep-water locations to the risk register. Probabilistic project planning became the norm for offshore operations, making use of new software applications such as Monte Carlo simulations – used to model the probability of different outcomes in a process that cannot easily be predicted – for weather-dependent operations. In fact, there was a technological boom occurring every bit as significant as today's fourth industrial revolution.

"The 1970s was when computing really started to impact on project management," Laslett explains. "We had to be able to use it effectively, while ensuring we maintained the core values of project management."

Over the course of the decade, he explains, there was a move from punch cards and mainframe computing to mini-computers and relational databases: "In the early days, I would fill in bits of paper and punch cards and give them to the computing department for them to run a report on critical-path analysis. By the end of the decade, I could actually input the data directly into a computer. That gave us greater access to the project data, rather than having to go through a third party that didn't necessarily understand the reports they were generating for us."

There were also big changes afoot in terms of the human resources working offshore. When it came to safety, workers had to be trained in firefighting and offshore survival. Resource management

"DESPITE THE ENDLESS SOFTWARE AVAILABLE, THE TRADITIONAL VALUES OF PROJECT MANAGEMENT HAVE NOT CHANGED"

now included managing large fleets of helicopters. Offshore workers were flown to Sumburgh, the main airport on Shetland, from Aberdeen by fixed-wing aircraft, and then onto the rigs by helicopter. This operation grew. At its peak there were 30 Sikorsky S-61N flights daily from Sumburgh, and, by the end of the 1970s, Aberdeen had become the world's largest commercial heliport, flying workers and suppliers offshore.

Supply boats to the new rigs also faced challenges. There were few lay-down or storage areas for materials on the platforms, while weather conditions could adversely impact resupply. Heavy lifting offshore was initially carried out by derrick barges, but, by the late 1970s, special-purpose semi-submersible crane vessels had become available. The timely procurement of materials and equipment was a constant challenge, says Laslett.

Although there was considerable industrial unrest in the UK in the 1970s, this was one factor that didn't have too much bearing on the development of North Sea oil and gas. "This was a new industry, and the money involved was significant. Many people wanted to be a part of it: companies wanted to be involved and suppliers wanted to supply. The unions were generally happy. Rightly, they focused on worker safety. But labour relations were generally positive, as is often the case when work is relatively plentiful in a growing industry."

Laslett says the term 'mega-project' was not common in the 1970s – but these projects qualified, involving enormous capital investment, unprecedented movement of people and goods, new technology, and exploitation of untapped natural resources in hostile environments.

"We entered uncharted water and made these projects successful," he says. This paved the way for managing today's mega-projects. "If you look at Hinkley Point C, Crossrail and HS2, they are technically extremely complex. That is something we got good at in the 1970s – integrating complex technical management into overall project management."

FIVE 1970s PROJECTS THAT MADE A BIG IMPACT

1. THE KRASNOYARSK DAM is a 124m-high concrete gravity dam on the Yenisev River, 30km upstream from Krasnoyarsk in Divnogorsk, Russia. On its completion in 1972, it was the world's largest single-power plant – a record held until the opening of the Grand Coulee Dam in Washington, US, more than a decade later. The Krasnoyarsk Dam supplies 6,000MW of power.

2. THE SPACE SHUTTLE PROGRAMME – ultimately costing $196m – commenced in 1972. It was the fourth human space-flight programme carried out by NASA. The Space Shuttle, composed of an orbiter launched with two reusable solid rocket boosters and a disposable external fuel tank, carried up to eight astronauts and 23,000kg of payload. The shuttle is the only winged manned spacecraft to have achieved orbit and landing, and the only reusable manned space vehicle to make multiple flights into orbit. The first test flight of the shuttle took place in 1981.

3. THE PIPER OILFIELD is a substantial North Sea oilfield covering more than 30km². It lies roughly halfway between Aberdeen and Bergen on the west coast of Norway. Oil production started in 1976, with about 250,000 barrels a day, later increasing to 300,000 barrels a day. The Piper Alpha disaster in 1988 was one of the oil industry's worst oil-platform accidents when it was destroyed by an explosion, killing 167 people.

4. THE GENERAL DYNAMICS F-16 FIGHTING FALCON is a single-engine supersonic fighter aircraft, originally developed by General Dynamics (now Lockheed Martin) for the US Air Force. Designed as an air superiority day fighter, it has evolved into a successful all-weather multirole aircraft, with more than 4,500 built since production was approved in 1976, serving 25 nations. The fighter has become the most numerous of its type globally.

5. THE GLOBAL POSITIONING SYSTEM – originally Navstar GPS – is a satellite-based radio navigation system owned by the US government. The project was originally launched by the Department of Defense in 1973 for use by the country's military. See page 38 for more information.


The Krasnoyarsk Dam

But some values hold true no matter how advanced projects may become technically. "Despite there being an endless amount of software available, the traditional values of project management have not changed," says Laslett. "We know that, to deliver a successful project, it is vital to have good leadership; a competent, skilled and experienced project team; and professional planning and scheduling from day one.

"The devil really is in the detail – and that's one thing that hasn't changed."

BEN HARGREAVES is editor of *Project*

FROM THE ARCHIVES

ALBERT LESTER looks at one of the earliest mega-projects in the UK – the design and construction of the Teesside Terminal

Mega-projects can be defined as projects with a contract value of more than $1bn.

One such early example in the UK was the development of the Teesside oil terminal at Seal Sands, near Seaton Carew, Hartlepool – the first facility in Britain built to receive North Sea oil. The design was started in the second half of 1973. With a contract value of more than £320m, equivalent to £2.3bn today, it was, at the time, the largest petrochemical construction project in Europe.

The purpose of the terminal was to receive, process, store and distribute crude oil from the Norwegian Ekofisk complex, which was operated by a consortium of oil companies led by Phillips Petroleum, and including Petrofina, Agip, Norsk Hydro, Elf, Total, Aquitaine and three smaller companies. The main terminal and process unit, which included the natural gas liquid (NGL) plant at Seal Sands, together with the tank farm at Greatham, two miles to the north, were planned to be commissioned in three phases.

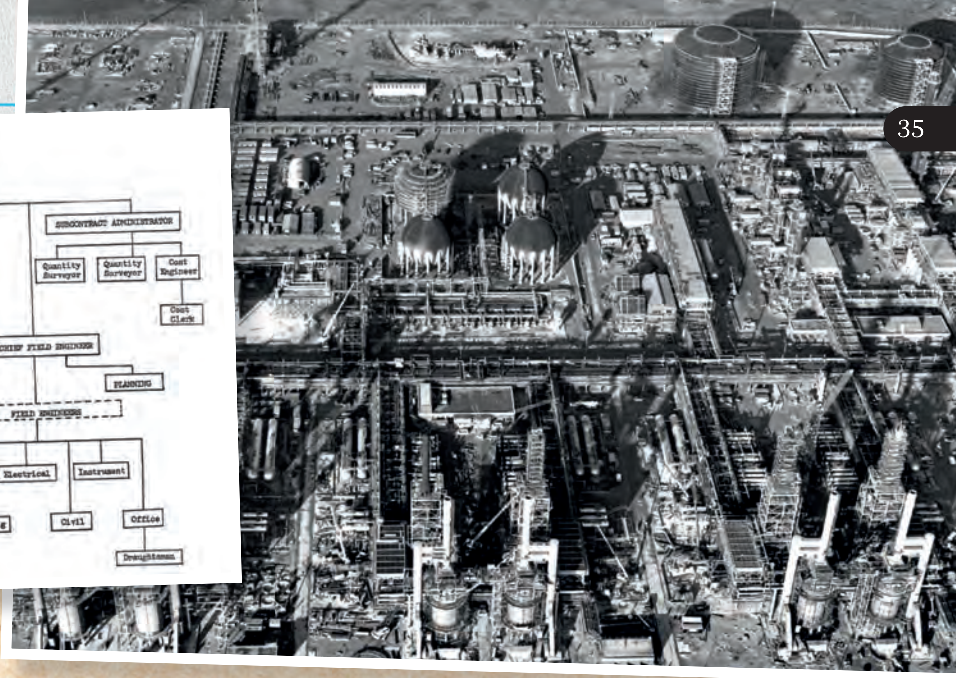
Phase one of the project, the largest and most important, but least complex, comprised the construction of the receiving spheres, four desalting and stabilisation units, tank farm, metering station, deballasting facility, effluent treatment plant and harbour with six tanker jetties. This was scheduled to be completed in the summer of 1975 to coincide with the completion of the undersea pipeline from the Ekofisk field. Despite the three-day week crisis in 1974, which adversely affected many of the suppliers, it was commissioned exactly on schedule and was officially opened by representatives of the British and Norwegian governments. Phase two, the NGL plant at Seal Sands, was completed in August 1979. Phase three, the commissioning of the last three stabilising units, was completed in mid-1980.

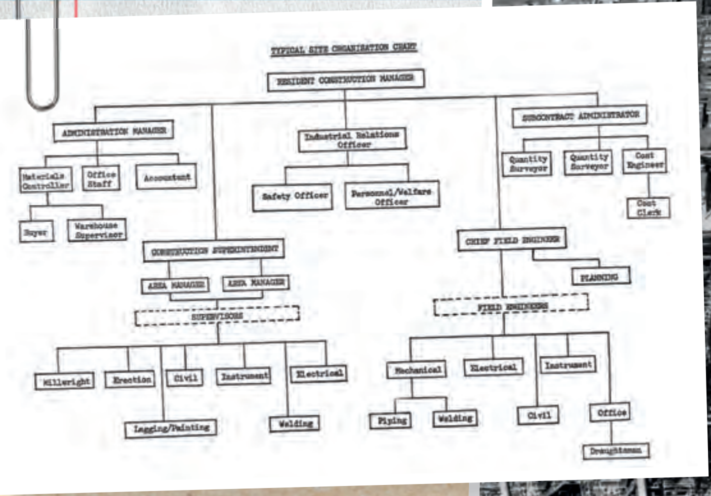
1.5 MILLION MAN-HOURS

The Sim Chem division of Simon Engineering, the main contractor responsible for project management, design and construction, established a bespoke project management, design and procurement office in London for the delivery of the project. The NGL plant was designed at Simon Engineering's head office in Cheadle Heath, Cheshire, augmented at one stage by 50 engineers and technicians flown in from the company's Indian office. All civil engineering design was carried out by independent consultants. The combined engineering departments of Sim Chem expended approximately 1.5 million engineering and procurement man-hours, producing more than 40,000 drawings, over 7,000 piping isometrics and some 12,000 purchase orders.

The entire Seal Sands site was built on sand dredged from the shore to form a deep-water harbour for four 150,000-tonne crude oil tankers and four smaller NGL tankers. The dredged sand was pumped inshore and consolidated mechanically by massive concrete blocks dropped from cranes. Apart from the reception spheres and the ethane, propane, butane and isobutane tanks, which were piled, all the buildings, stabilisers, fractionation columns and other tanks on Seal Sands had reinforced concrete slab foundations, as did the crude oil storage tanks at the Greatham tank farm.

This storage facility was separated from the process unit by a navigable creek, which had to be crossed. This crossing was achieved by constructing a 417m-long pipe

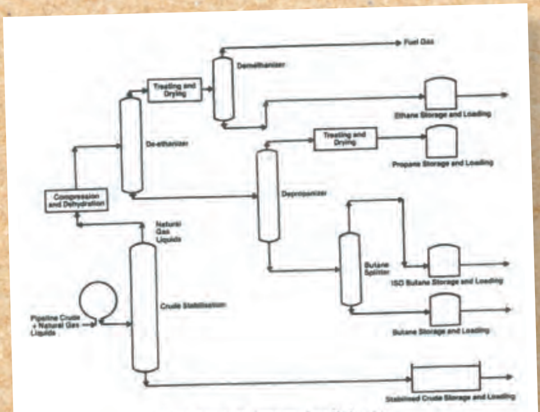




and cable bundle in a dry dock on the south bank of the creek protected by a coffer dam. After each of the nine 48in-diameter concrete-coated pipes in the bundle had been pressure tested, the coffer dam was removed and the 4,800-tonne bundle was floated out and sunk to the bottom of a previously dredged trench crossing the creek.

In operation, unstabilised crude was pumped from the Ekofisk field via a 34in pipeline to Seaton Carew and, from there, via the underwater pipe and cable bundle under the creek to the reception and storage spheres at Seal Sands. After stabilisation, the crude was pumped back to the tank farm at Greatham, where it was stored in the 10 stabilised crude tanks. From these tanks, the crude was pumped back under the creek to be metered and loaded into the oil tankers berthed at the jetties at Seal Sands.

The size of the project dictated the use of a task force type of project organisation, headed by a project director and three project managers, each with an assistant (deputy). 'Project manager A' was responsible for the design and construction stages of Area 1 – which comprised the reception and storage spheres, under-creek pipe and cable crossing, admin and control buildings, fire station, harbour, jetties, metering station, deballasting facility, effluent treatment plant and ground flare – and Area 3, the tank farm at Greatham.



Block Flow of Processing Scheme

'Project manager B' was responsible for Area 2, the design and construction of the stabilisation and desalting plant, NGL plant, tankage on Seal Sands, flare stack, gas turbines, propane compressors and boiler house. 'Project manager C' was charged with establishing and maintaining the critical-path analysis (CPA) project schedule, writing the general and special conditions of subcontract, and letting, monitoring and delivering over 120 subcontracts.

EPIC SCALE

Each of the three cost-coded areas had its own site office run by a construction superintendent responsible to the construction manager, who reported to each of the project managers. Each of the three area offices was staffed to administer and control its own civil, mechanical, piping, electrical and instrumentation subcontractors. The first function of the project managers was to write and distribute the two project coordination procedures and CPA schedules: one set for the design stage and one set for the construction stage. These documents contained or referenced all the systems, procedures and standards to be used on the project, and included the document distribution schedule, as well as the area and material cost codes.

All scheduling was carried out by the planning section using CPA. Although the client specified a computerised system, whose voluminous printouts – processed by a large, outsourced computer centre – were delivered monthly to their head office, it was found that manual Activity-on-Arrow networks, the basis of the printouts, were preferred by both the design office and site construction teams as the most effective scheduling and monitoring medium.

After receiving regular feedback from the design sections and site, the planning section monitored, updated and distributed the revised networks monthly. The monitoring of engineering and site costs, the distribution of cost and progress reports, and the all-important inspection and vigorous expediting of equipment, materials and subcontracts were carried out by the staff at London office. Before construction started, all general arrangement drawings were checked by the client's operators to ensure that every item of equipment and instrument was safely accessible for operation and maintenance.

The facility was nothing if not an epic construction project. It required more than 100,000m^3 of concrete, 7,000 piles, 10 miles of roads, 100,000 tonnes of steel, 300 miles of piping, 20,000 valves, 1,000 miles of cables, 80,000 panel- and field-mounted instruments, and three state-of-the-art computer control centres. At its peak, the construction workforce numbered more than 5,000 operatives, including hundreds of welders, some of whom had to be specially trained to meet the operator's exacting quality standards.

At its peak, the planned throughput of the terminal was one million barrels a day of stabilised crude oil and 67,000 barrels a day of NGL products. The total site area, including the tank farm, was 875 acres. The complex's four unstabilised crude reception spheres each had a capacity of 45,000 barrels, and the 10 floating roof crude storage tanks each had a storage capacity of 750,000 barrels – with a roof area the size of an American football field. Not for nothing was this classed as an early mega-project. P

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