CHRISTIANI & NIELSEN

NINETY TWO YEARS IN THAILAND

1930 – 2022

AND

118 YEARS WORLDWIDE

1904 - 2022

CHRISTIANI & NIELSEN (THAI)
PUBLIC COMPANY LIMITED

Engineering Excellence

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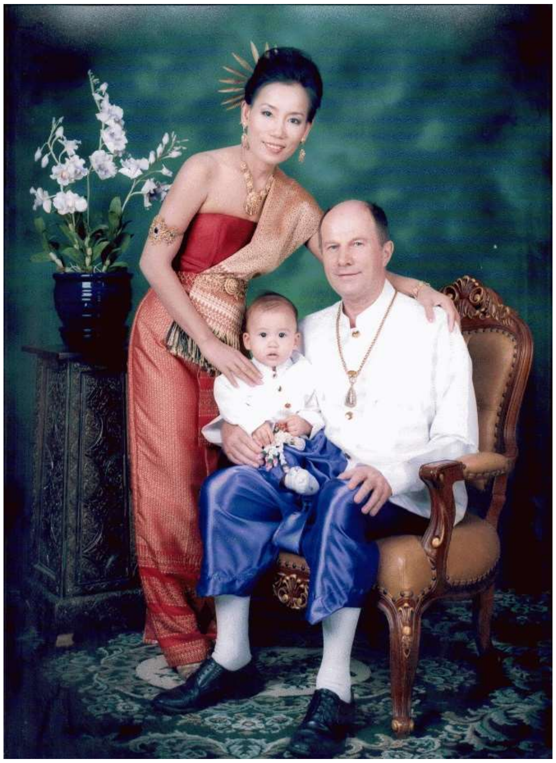


Over the years, as branch companies closed one by one, more and more documents have been irretrievably lost and staff have scattered far and wide. I felt the need to compile this book, before remaining documents are lost and memories have faded away, and because I will retire in 2022.

This is not intended to be an exhaustive historical record. Rather, I have tried to convey a snapshot of the magnificent engineering history for which the name of Christiani & Nielsen is highly respected, not only in Thailand, but in many parts of the world. Many thanks to former colleagues for helping me fill in some technical and financial gaps in the record.

I, and surely many thousands of others, am proud to have played a part in the unique history of this fine organisation.

David Greenbank, Commercial Director
Christiani & Nielsen (Thai) Public Company Limited

92 Years in Thailand

From its humble beginning in 1930 the Company has been through good times, and some bad times, to emerge 92 years later as one of Thailand's oldest and finest civil engineering and construction companies.

This book commemorates this special occasion by looking back at the history of the Company, and highlights some of the notable construction projects, as well as socio-economic events, that together not only changed the face of the country during this period, but also contributed significantly to the development of Thailand and the well-being of the Thai people.

As Christiani & Nielsen (Thai) Public Company Limited celebrates 92 years in Thailand, it looks back with pride on past achievements, and looks ahead to the future.

The book also looks back at the achievements of Christiani & Nielsen worldwide over its 118 year history.

The Company's Head Office in Bangkok (since 2014)

The First 25 Years
(1930-1955)

*C*hristiani & Nielsen (Thai) Public Company Limited has its origin in Denmark 118 years ago when, in 1904, Dr. Rudolf Christiani, a twenty seven year old civil engineer, and Captain Aage Nielsen, an officer of the Royal Danish Navy, founded Christiani & Nielsen Partnership in Copenhagen. The initial aim of the new partnership was to utilise its technical and design expertise to build reinforced concrete structures, particularly bridges and marine works.

Dr. Rudolf Christiani

Captain Aage Nielsen

At that time, reinforced concrete was a revolutionary new construction material and method, still in its infant stages of development. Europe's first reinforced concrete multi-storey frame building was built in Britain in 1897 and the first reinforced concrete bridge in 1901. When the first 15-storey high-rise building was constructed in the United States in 1903, speculation in the news media and many sceptics in the construction profession predicted that, once the temporary supports were removed, the building would crack and collapse under its own weight. Much to their surprise, it did not. Christiani & Nielsen went on to play a pioneering and leading role in the development of not only reinforced concrete, but other concrete related materials.

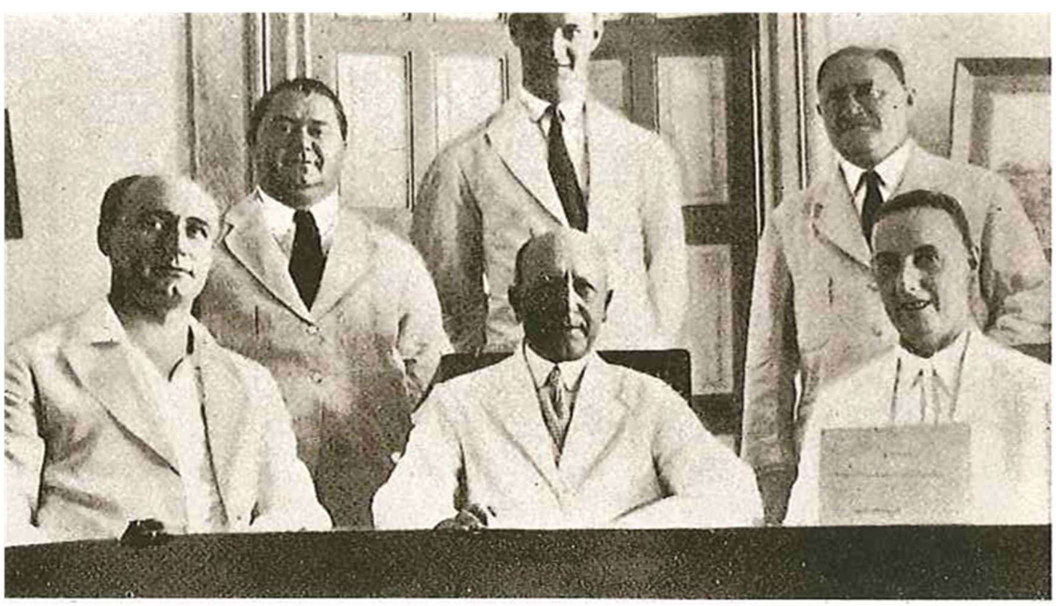
Less than ten years after formation, Christiani & Nielsen established a branch in Germany (1908) and the United Kingdom (1913) and after World War I, further extended its operations to other European countries, South America (1919) and South Africa (1938).

Siam's economy had grown rapidly following the signing of the Bowring Treaty with Great Britain in 1855, in the reign of King Rama IV, which opened up Siam to international trade with the West. Other trade treaties soon followed with the United States, France and several other countries.

Dr. Rudolf Christiani made his first visit to Siam in 1928 on the initiative of a Danish sea captain, Captain H.N. Andersen, who had founded a trading and shipping company in Bangkok in 1884 (later to become The East Asiatic Company in 1897). Dr. Christiani was quick to realise the potential of Siam, which had abundant natural resources but poor infrastructure.

Due to the elevated business and social status enjoyed at that time by Captain Andersen and The East Asiatic Company in Siam and in Denmark, Dr. Christiani had the good fortune to be introduced to His Majesty's Privy Purse Bureau (today the Crown Property Bureau). The Privy Purse Bureau was the King's personal institution, and dates back to the reign of King Rama II. It was, and still is, a major landowner, particularly in the central district of Bangkok, and so played an important part in the development of the city.

Subsequently, Christiani & Nielsen (Siam) Ltd. was founded on 28th February 1930 and formally registered as a limited liability company later that year on 10th September 1930. Its principal shareholders were the Privy Purse Bureau, The East Asiatic Company and Christiani & Nielsen, Copenhagen.



The founding of Christiani & Nielsen (Siam) Limited on 28th February 1930. In the front row from left to right: Mr. S. Brighouse, Managing Director of law firm Tilleke & Gibbins, Dr. Rudolf Christiani and Mr. Hakon Christiansen, Managing Director of The East Asiatic Company Limited

The Statutory Meeting of Shareholders in

Christiani & Nielsen (Siam) Ltd.

Wednesday the 3rd September 1930 at 9 a.m.

Present were H.M's. Privy Purse (by Proxy)
Messrs. The East Asiatic Co. Ltd. (by Proxy)
Messrs. Christiani & Nielsen, Ltd. Copenhagen (by Proxy)
Dr. F. R. Christiani, Copenhagen (by Proxy)
H.E. Phya Boriboon Raja Sombat (by Proxy)
H.E. Phya Pradibhad Bhubal
H. Christiansen, Esq.
S. Brighouse, Esq.
H.E. Nielsen, Esq.
A. Castonier, Esq.
A. Holm, Esq.

being 11 subscribers out of a total of 12 and representing in all Tcs. 599.000.- of the Share Capital.

On the proposal of Mr. Brighouse seconded by H.E. Phya Pradibhad Bhubal Mr. H. Christiansen was unanimously voted to the Chair.

The chairman presented the Articles of Association of the Company which were taken as read and moved that same be adopted. The motion was seconded by H.E. Phya Pradibhad Bhubal and carried, whereafter the chairman signed two copies to be filed with the Registrar of Companies.

On the proposal of H.E. Phya Pradibhad Bhubal seconded by Mr. S. Brighouse Dr. F.R. Christiani, Copenhagen and Mr. H. Christiansen were elected Directors of the Company and on the proposal of H.E. Phya Pradibhad Bhubal seconded by Mr. H.E. Nielsen, Mr. A. Holm was elected Auditor of the Company for the current financial year at a fee to be arranged by the Directors.

Mr. S. Brighouse moved and Mr. H.E. Nielsen seconded that the power invested in the Directors and the Auditor should be as prescribed by the Articles of Association of the Company and as laid down by law. This motion was carried unanimously.

This concluded the business.

Minutes of the first Statutory Meeting of Shareholders held on 3rd September 1930

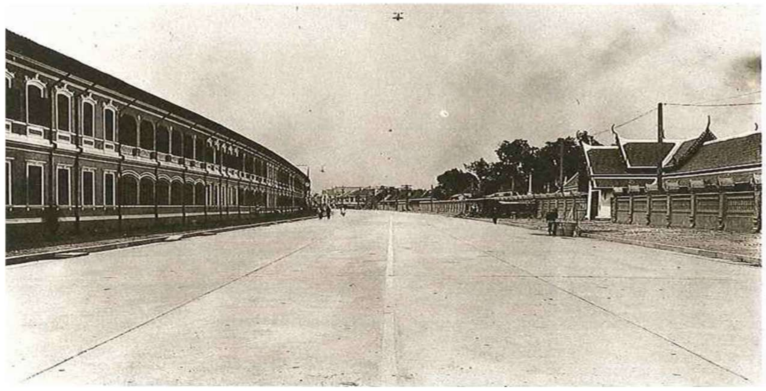
At that time, Siam was ruled by a system of absolute monarchy under King Prajadhipok (Rama VII). Bangkok was a bustling port-city, thriving on international trade, having a built-up area of around 38 square kilometres. and a population of 750,000. The first state rail service from Bangkok to Ayutthaya had opened in 1894, and by 1930 the total lines open to rail traffic amounted to around 2,000 km. However, despite the existence of this rail network, more than 80% of exported rice was still carried on the rivers and canals from the provinces to the rice mills in Bangkok.

Despite the extensive working canal system, the city had effectively been transformed into a land-based city following a hectic period of road building which saw 135 roads constructed in Bangkok between 1890 and 1925. The minor roads were of earthen construction, whilst great sections of the massive city wall had been demolished to provide surfacing material for the major roads, including the 60 m wide, 3 km long Ratchadamnoen Avenue. Such transformation was being driven by the introduction of western vehicles such as trams, bicycles, and later automobiles, from the late 1880's. However, there were no paved roads linking Bangkok and the provinces. A tramway system with a total length of 42 km was operating in Bangkok, mainly in the inner city area. Wage rates for unskilled labour working in Bangkok in 1930 were 1 Baht a day, dropping to 0.8 Baht during the period 1931 to 1938.

The Company's first project in 1930 was to construct a water tower, with a capacity of 250 m^3 at Bangsue for the Royal State Railways of Siam. This was followed in the same year by construction of a swimming pool at the Royal Bangkok Sports Club, aircraft runways at Don Muang Airport for the Department of Aeronautical Workshops, concrete roads and a quay wall for The East Asiatic Company and concrete roads and a market building for the City Engineer

Water Tower at Bangsue (now demolished)

Following the first seven projects in 1930, the Company managed to secure a further seventeen projects in 1931. These projects included new locomotive sheds at Hua Lampong and a railway bridge near Lampang for the Royal State Railways of Siam, and Tripetch Road and Oriental Avenue, believed to be the first concrete roads in Bangkok. The Company also embarked on its first industrial work, by constructing a factory for Siam Match Co., Ltd.



Tripetch Road, one of the first concrete roads in Bangkok

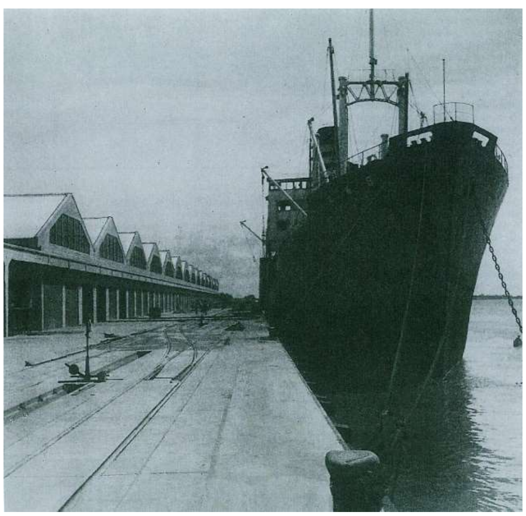
This promising start suffered a setback in 1932, with the Company managing to secure only seven relatively small projects in the year. This was due partly to the effects of the great depression triggered by the crash of the New York Stock Market in late 1929 and partly the dramatic bloodless coup, which saw 800 years of absolute monarchy come to an end when King Rama VII abdicated the throne, and on 24 June 1932 consented to become King under a constitutional monarchy system of government. Thailand's first constitution was signed on 10th December 1932.

The great depression had less of an effect on Thailand and Southeast Asia than it did in the Western world. Even so, the falls of both the volume of exports and commodity prices caused export revenues in Thailand to drop by 44% from 1929 to their lowest point in 1932, recovering quite quickly after that time.

Boonrawd Brewery

After the upheavals of 1932, political and economic changes saw Bangkok start to develop from a port-city into a financial and business centre, with the beginnings of state-led industrial enterprise, and a growing centre for Thai, as opposed to Chinese, migrants. As the Thai economy steadily picked up, in 1933 the Company designed and supervised construction of the Boonrawd Brewery on the banks of the Chao Phraya River and began designing and building two cinemas in Bangkok, Chalerm Buri and Chalerm Thai, as well as the Sri Krung Sound Film Studio.

By the mid-1930's, the Company was earning increasing recognition for quality construction, following the completion of several concrete roads, including Hua Lamphong (Rama IV) and Sathorn Road, a river bridge, two road bridges, a number of klong bridges, a machine shop and foundry for the Department of Aeronautical Workshops, a cadet school for the Royal Navy, a dry dock for the Naval Dockyard and new private factories to produce candles and nitro-cellulose and a factory to produce paper for the Royal Survey Department.



After seven years of gradually building the business the Company received its first big break when, in 1937, it won an international competition held by the Ministry of Economic Affairs for the design and construction of a large modern port at Klong Toey in Bangkok. The works consisted of a wharf, 1,860 m long, 43,500 m^2 of warehouses and transit sheds, and 15,000 m^2 of reinforced concrete pavement. The depth of water was to be 10 m at low water level. Due to the considerable depth of water and the difficult soil conditions of soft clay, the problem of constructing a stable and economical wharf was a very difficult one. The Company worked closely with its parent company's experienced design office in Denmark and proposed an earth-filled reinforced concrete load-relieving box platform, 15.8 m wide, supported on a large number of mostly raking/inclined wooden piles and anchoring a sheet-pile front wall to the wharf. Behind this wharf structure was a 40 m wide warehouse/shed reinforced concrete floor, supported on mostly vertical wooden piles with reinforced concrete extensions above water level.

This solution was accepted in principle by the Siamese Government, and the contract was awarded to the Company, its largest contract since establishment of the

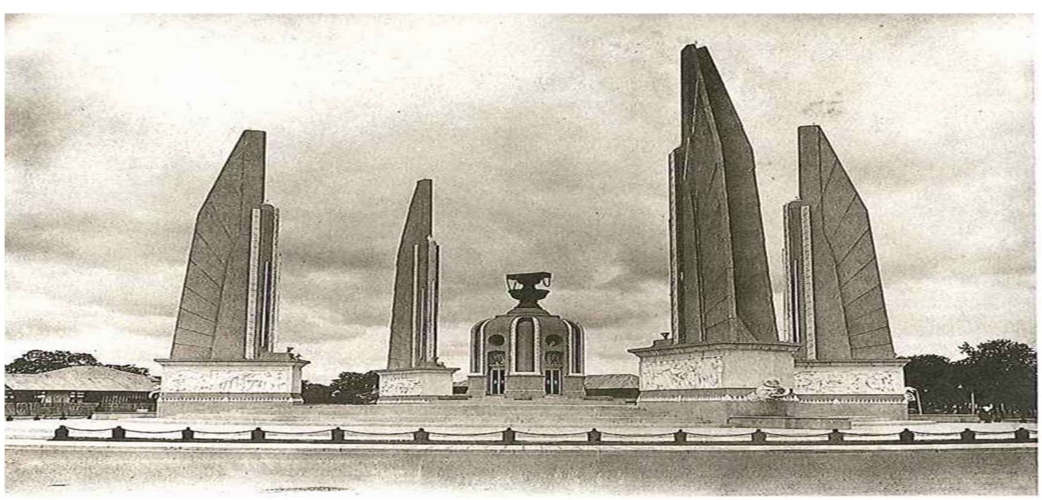
Company. It was, however, specified that an adequate calculation be made to prove the sufficiency and stability of the proposed design. This problem was a difficult one, since at that time no acceptable method existed for the computation of sheet-pile walls in clay. Christiani & Nielsen successfully developed a completely new method of calculation for such walls.

This technique of wharf construction had been developed and used previously by Christiani & Nielsen in Europe and South America. Over the years, it became recognised internationally as the "CN-wharf", and the principle of the design was even been adopted by many authorities for their own projects submitted to public tendering.

As the Klong Toey port facility required about 22,000 wooden piles of exceptional length of up to 16 m, the Company took the opportunity to establish a modern fleet of heavy-duty pile driving equipment imported from Denmark, the first such equipment to be used in the country.

These machines were put to use again when the Company subsequently won a contract in 1939 to build a Monument to Democracy on Ratchadamnoen Avenue. The monument commemorates the introduction of democracy (constitutional monarchy) on 24th June 1932, and the design symbolises this date. The four wings of the tower are 24 m high, the central pedestal is 3 m high (June is the third month of the Thai calendar) and the 75 cannons that encircle the structure represent the Buddhist Era calendar year of 2475 (1932). The 4-ton copper tray supported on the central pedestal holds a copy of the first Constitution.

Democracy Monument, completed in 1940



In the same year of 1939, Siam changed its name to Thailand, although an official proclamation was not issued until 11th May 1949. The word "Thai" means "free", and therefore "Thailand" means "Land of the Free". From that time, the Company was known as Christiani & Nielsen (Thai) Ltd. The Company prepared to celebrate its first decade of operations with an impressive record of successful projects. It had not only established itself as an outstanding civil engineering and construction firm, but had also built factories and other facilities in neighbouring Burma.

The spacious Ratchadamnoen Avenue near the Grand Palace continued to be the scene of many other significant projects, including large Thai-style government and public buildings such as the Government Savings Bank and the Royal Hotel, until the outbreak of World War II interrupted business activities.

Government Savings Bank

As a result of the war, much of the work being undertaken by the Company at the turn of the decade was abandoned until post-war reconstruction. This included the construction of Klong Toey Port. Japanese troops arrived in Thailand by land and sea on the night of 7th December 1941 and remained until the surrender of Japan on 15th August 1945. Forced to side with the Japanese, Thailand was heavily bombed by the Allied Forces.

During the course of the war itself, the Company devoted its efforts to finding as much work as possible to retain the management, staff and work force it had built up over the previous decade.

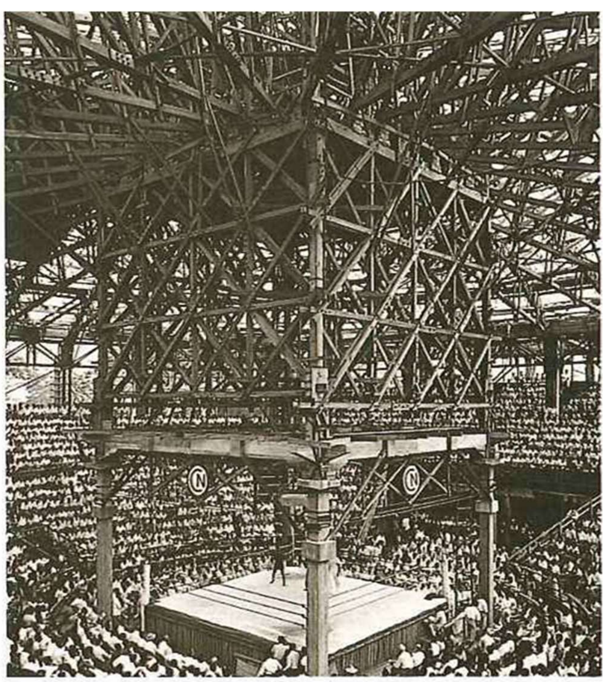
They were difficult years, as there was a shortage of steel and other building materials. Among the projects at that time were the building of bomb shelters, fourteen bridges in the North East, school buildings for Mater Dei Institute and Assumption College at Siracha, a bridge at Phrakhanong and the design/build of a concrete paddy (rice) silo in Bangkok, the first in Thailand, with 3,000 tons capacity complete with small concrete jetty.

The end of World War II saw much of Thailand's infrastructure in a dilapidated state, and the Company played a significant part in the monumental task of rebuilding the bomb-damaged power stations, railways, roads, bridges and other public and private works.

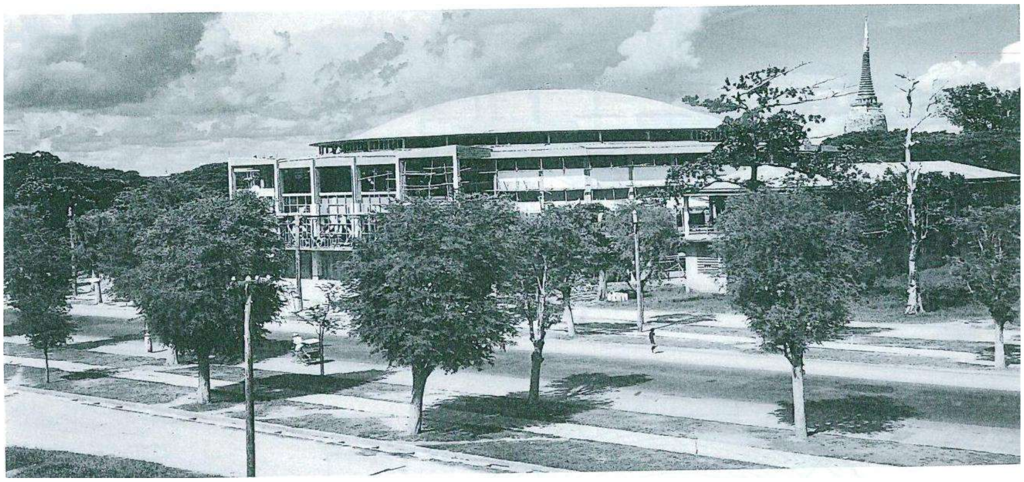
Progress was rather slow since building materials and construction resources continued to be in short supply, and available finance was limited. However, on the whole, Thailand recovered quickly from the effects of the war. Expanding again in a modest way, by 1948 the Company had completed the Ratchadamnoen Avenue projects, and in 1949, finished remodelling and enlarging the Oriental Hotel.

A young and caring King Bhumibol Adulyadej (Rama IX), who ascended the Throne in June 1946, has steadfastly adhered to the momentous Oath of Succession to the Throne pledged during the coronation ceremony on 5th May 1950: *"We will reign with righteousness for the benefit and happiness of the Siamese people."*

In the same year, the Company faced the challenging prospect of constructing a dome to cover the central part of the Ratchadamnoen Boxing Stadium. The design featured a spherical shell with a diameter of almost 100 m, a rise of 5.7 m and a thickness of only 8 cm. This innovative reinforced concrete structure was superimposed onto the frame of the building, using a complex system of temporary supports, while boxing matches continued as usual below.



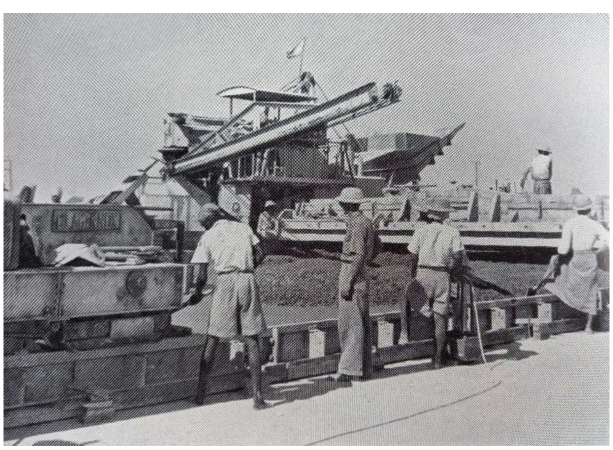
Ratchadamnoen Boxing Stadium, temporary support system for construction of the large reinforced concrete dome



Ratchadamnoen Boxing Stadium, completed dome

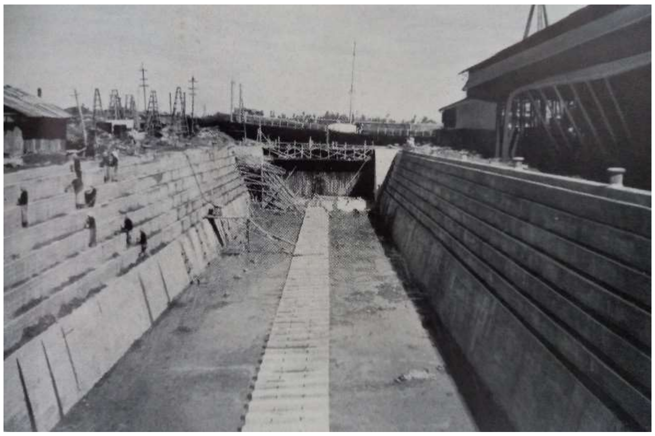
In addition, the Company was awarded a contract by the Government of the Union of Burma for the survey, design and reconstruction of Rangoon Airport,

including a main runway, taxiways, parking apron, drainage, terminal building and control tower. The new facilities had to be superimposed on the layout of the existing airport facilities, which had to be kept fully operational during construction. The concrete main runway was 2,438 m long and 61 m wide, with a thickness varying from 30-40 cm. Special attention was given to the problem of drainage of surface water, and the system was designed to cater for an intensity of 127 mm (5 inches) of rain per hour. The total length of gutters, sewers and ditches was nearly 16 km. Some surprises were encountered during excavation when, on several occasions, an excavating machine suddenly dropped into an underground cavity about 3 m wide and deep. It turned out that these cavities were bomb craters.

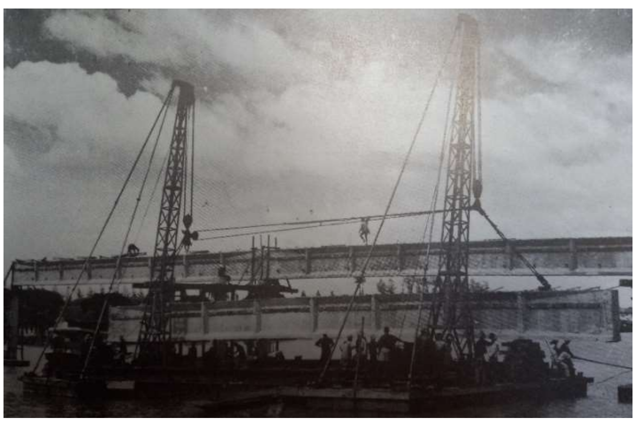


Concrete paving

During the early 1950's, the Company designed and constructed a dry dock for Krungthep Dock Co., Ltd., a major bridge across the Bang Pakong River and a number of other river bridges in the North East for the Department of Highways. Instead of the proposed reinforced concrete tender design, the Company offered a more economical design that used prestressed concrete support beams, 30 m long, for the main river spans.



Krungthep Dry Dock, 110 m long



Bang Pakong River Bridge, placing of 42 ton main girder

By now, the Company had become a recognised and respected name in Thailand, particularly in the area of marine works. Also, the Christiani & Nielsen organisation had spread to many parts of the world, with branch companies in Europe (Germany, France, United Kingdom, Norway, Sweden, Finland and Holland), South America (Brazil, Venezuela, Peru, Mexico, Argentina, Paraguay, Uruguay, Ecuador and Colombia), U.S.A, Africa (Union of South Africa and Mozambique) and Thailand. One of the original founders, Captain Aage Nielsen, died suddenly in 1945, and the following year, Alexander Christiani, the son of Dr. Rudolf Christiani, left the Paris Branch after a stay of 7 years to join Christiani & Nielsen, Copenhagen.

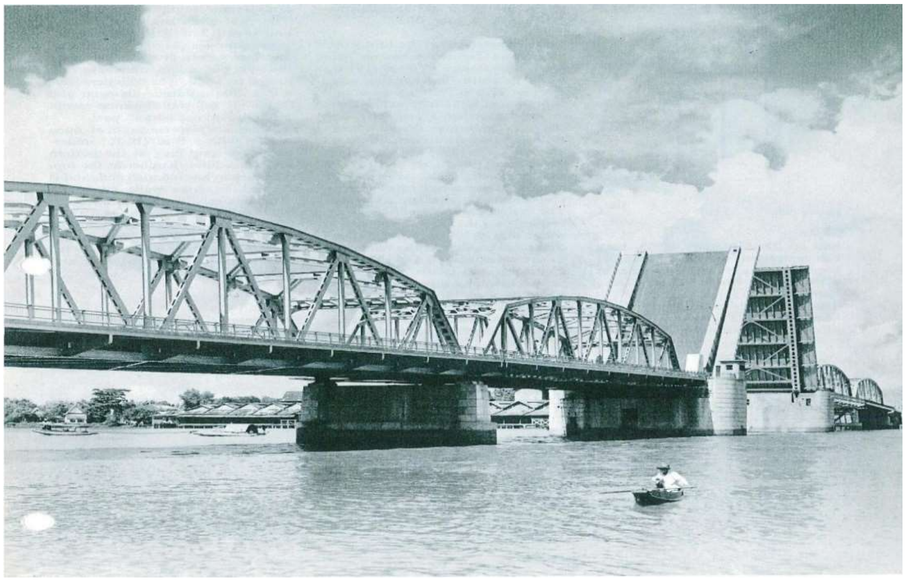
The Second 25 Years
(1956-1980)

The face of Bangkok, principally a collection of one and two-storey timber and brick structures, began a dramatic change in 1957 when the Company completed a 10-storey tower extension to the Oriental Hotel, beginning the high-rise construction which has continued to the present day.

Once again, the Company demonstrated its ability to meet its client's needs with innovative and economical solutions.

Oriental Hotel, the addition of a 10-storey extension marked the beginning of high-rise construction in Bangkok

The late 1950's were a busy period for the Company, during which it built a jetty and sea wall at Sattahip, a major concrete bridge at Chachoengsao, a pharmaceutical factory, the Seaman’s Clubhouse at Klong Toey, a power plant at Tha Luang, a cement silo at Bangsue, the Rama IV, Krungthep, Krungthon and Nonthaburi bridges, as well as airfields at Chiang Mai, Udon Thani and Ubon Ratchathani for the United States Department of the Navy.



Krungthep Bridge, across the Chao Phraya River at Bangkok

As Thailand developed, so the Company constantly developed and adapted itself to meet the challenges brought about by ever-changing conditions and circumstances. The end of the decade sadly witnessed the passing away of the joint founder of Christiani & Nielsen, Dr. Rudolf Christiani.

As a result of the First National Economic and Social Development Plan (1961-1966), a number of canals were filled to build new roads and widen existing roads, including Silom and Rama IV. In the early 1950's there were still nearly one hundred functioning canals in Bangkok and Thonburi, but by 1970 only one-third remained, with some reduced to narrow channels in the middle of major roads. The disappearance of canals in the 1960's was a feature of the period.

A similar feature was the disappearance of the tramway system in Bangkok. In 1968, the tramway system ceased operation in accordance with a government directive, issued in 1961, ordering (for the sake of progress) that all Bangkok tramways must close for good.

The First National Economic and Social Development Plan stated that the government would reduce its involvement in manufacturing, and that the public sector would instead focus on providing private companies with investment incentives and constructing vital infrastructure needed for industrial development. For this purpose, the Board of Investment (BOI) had been set up in 1959. This triggered the start of the explosive growth in the industrialisation of Thailand, fuelled by a large pool of cheap migrant labour from the rural provinces, and the Company was very active in servicing this business sector.

The Company built many new factories throughout the period from 1960 to 1980 and beyond, for household names such as Colgate-Palmolive, Philips Electric, Mitsubishi, National, Jotun, Cerebos, Bayer, Kimberly-Clark and Lever Brothers, to name just a few.

The booming economic conditions opened up more and more opportunities for the Company, enabling it to become involved in constructing all types of infrastructure and industrial projects from harbours, jetties, dams and airports to factories, power stations, government buildings, hotels, offices and residential accommodation.

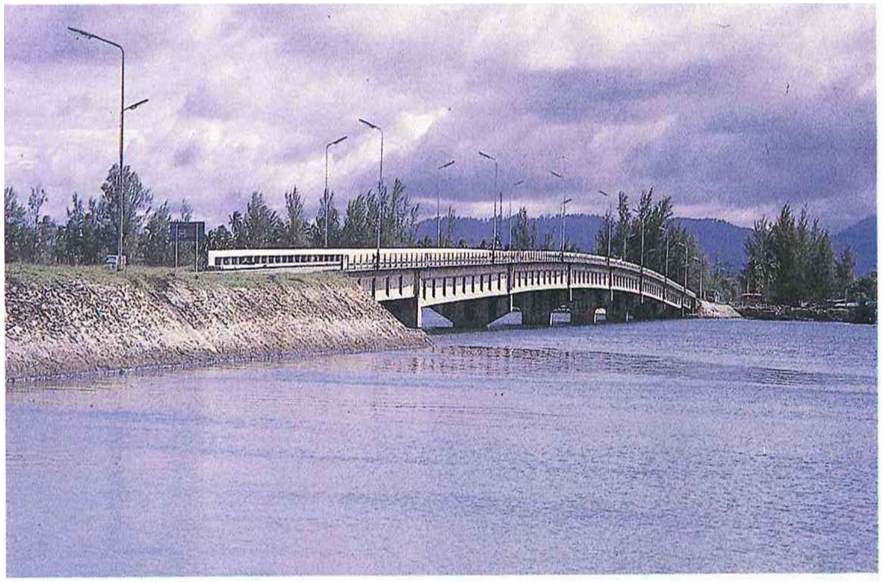
In 1950, the total length of national highways was nearly 4,000 km, of which 800 km, all within a 250 km radius of Bangkok, were paved. By 1970, over half the national highway network was paved and major road routes radiated from Bangkok to all parts of the country.

As development spread across the country, the Company played a key role in providing a modern and integrated nationwide road network.

The Bangkok to Nakhon Pathom Highway, constructed for the Department of Highways during 1963-65, consisted of a 40.5 km long reinforced concrete road, 7.5 m wide and 23 cm thick, including ten short bridges which totalled 124 m in length.

Bangkok-Nakhon Pathom Highway

The Sarasin Bridge, constructed for the Department of Highways in 1965-67, linked Phuket Island to the mainland across 360 m of sea via six 50 m and two 30 m spans, and concrete pavement forming the bridge approaches. For this difficult project, the Company designed and built reinforced concrete caissons measuring 5 m in diameter to support the piers and longitudinal beams of prestressed concrete, weighing 200 tons each. A floating batching plant was set up in the Andaman Sea to supply the project with concrete, while a launching rig moved in at low tide to lift up the 50 m long beams with the rising tide.



Sarasin Bridge, designed and constructed by the Company, linked Phuket to the mainland

In addition to the above, the Company undertook other highway projects including:

1973-76 Khon Kaen to Udon Thani, 53 km asphalt highway.

1975-78 Ron Phibun to Phattalung, 70 km highway where the work was hindered by attacks from bandits, insurgents and severe flooding which washed away a completed 5-span concrete bridge.

1975-78 Bang Pakong River Bridge and Interchange

1979-82 Phitsanulok to Den Chai, 128 km highway in flat to mountainous terrain including excavation in rock (340,000 m^3).

Moving a house from the Right of Way

Apart from highways, some notable projects included:

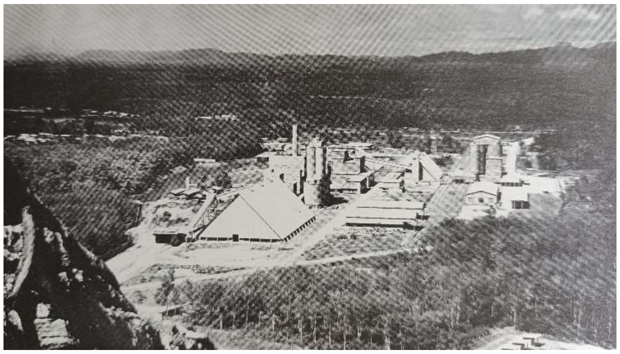
1961-64 Lignite power plant, 40 MW, at Krabi, including construction of 9 substations at various locations.

1963-67 Banknote printing press in Bangkok for the Bank of Thailand. Construction of 5-storey building complex where the printing hall was made of precast concrete shells.

1964-65 Nam Pung hydroelectric power plant, 6 MW, at Sakon Nakon in N.E. Thailand comprising 1,720 m long by 41 m high rockfill and clay-core dam, 630 m tunnel in rock, installation of M&E equipment and all other associated works. The reservoir covers an area of 21 km^2.

The crest of the dam can be seen snaking around the bottom of the reservoir

1965-66 Cement factory for Siam Cement at Thung Song with 15,000 m^2 plant buildings, clinker storage, 10,000 tons capacity concrete silos and raw mill.



1966-69 Flour mill and wheat silos at Phra Pradaeng, capacity 33,000 tons for United Silo and Services. Design and construct 44 circular bins 6.5 m dia. by 30 m high, mill building 38.5 m high (tallest in Thailand). With new high-rise buildings getting taller and taller, the Client wanted to keep the record and so ordered the addition of an extra floor on the mill building (for conference centre) and a 6 m tall steel pipe to form a viewing platform, which increased the overall height to 50 m above ground level. Also ordered were berthing facilities for vessels up to 14,000 dwt and a general cargo wharf.

1968-71 Sirinthorn (Lam Dome Noi) hydroelectric power plant, 36 MW, at Ubon Ratchathani in N.E. Thailand. Similar construction to Nam Pung, dam 940 m long by 42 m high and a reservoir area of 288 km^2. After completion, with Royal permission, the name was changed in honour of HRH Princess Maha Chakri Sirinthorn.

1977-82 New Prachulachomklao Naval Dockyard at Pom Prachul at the mouth of the Chao Phraya River. The existing Naval Dockyard, designed and constructed by the Company in 1937, is situated nearly 45 km up-river in Bangkok. Every naval ship had to pass through 2 bascule bridges which inconvenienced both naval craft and growing traffic on the bridges. Works included construction, in consortium, of 2 dry docks, shiplift, quays, riverside jetties, harbour basin, workshops, stores and other ancillary buildings and services.

Other projects included:

1960-63 In collaboration with the Japanese main contractor, design and construct concrete river piers and approach viaducts for the first bridge across Tonle Sap lake in Phnom Penh, Cambodia (steel superstructure by main contractor). During the civil war 1972-1973, an explosive-packed vehicle on the 876 m long bridge was detonated causing several spans to collapse.

An old prophecy in Cambodia said that when the citizens of Phnom Penh can walk dry footed over the Tonle Sap, the river will turn red from blood.

1962-64 Design and construct Jetty and Causeway for Thai Oil Refinery Co. in Sriracha consisting of 210 m long causeway (earthfill with stone facing), an 860 m long concrete jetty, pier head and dolphins on tubular steel piles for vessels up to 2,000 dwt.

as well as, Pattani Harbour in 1961-62; a bridge in Laos in 1967-68; a cement plant at Kaeng Khoi in 1969-71; a 30 MW steam power plant at Surat Thani in 1971-73; a shipyard for Bangkok Shipbuilding & Engineering Co., Ltd. in 1971-73 and concrete storage reservoirs at Samsaen for the Metropolitan Waterworks Authority in 1975-76.

F.E. Zeullig Building, Bangkok

Completed in 1970, the F.E. Zeullig Building in Silom Road remains a fine example of the Company's excellence in design and construction. The appearance remains modern despite the passage of 52 years and ever changing trends of architectural design.

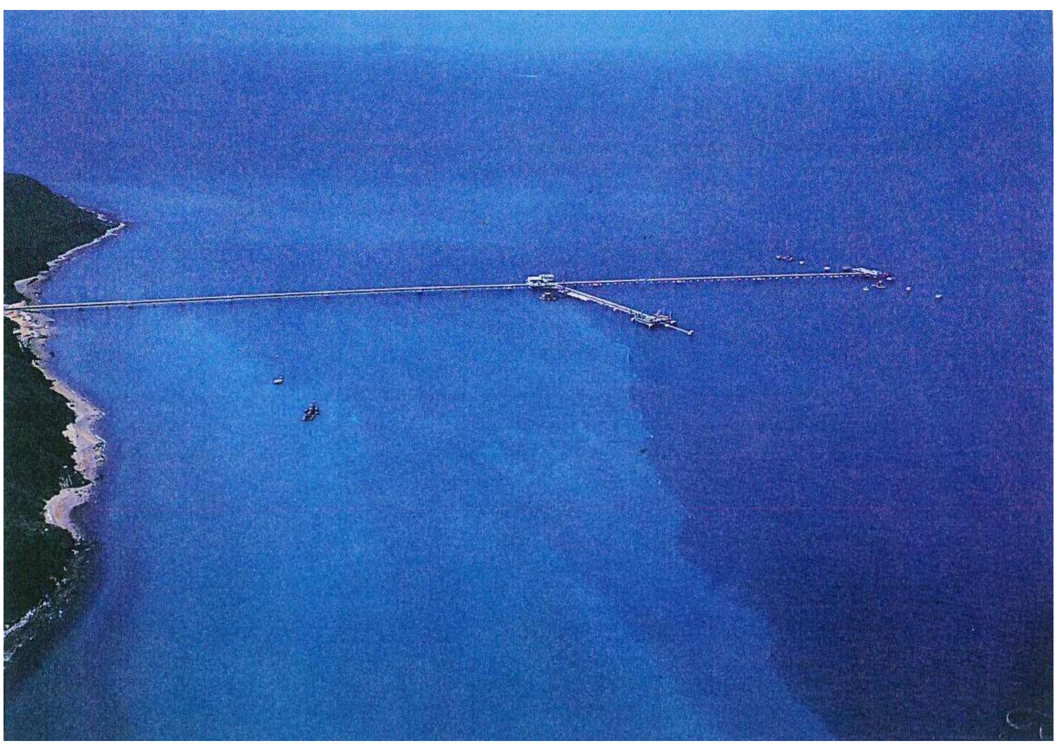
During this period, Christiani & Nielsen, Copenhagen converted from a partnership into a limited company in 1958, with Alex Christiani (son of the founder) as Managing Director.

The Third 25 Years
(1981-2005)

Oil and gas became the focus of the national spotlight in the 1980's, and the Company was involved in developing the Sirikit Oil Field in the Sukhothai-Kamphaengphet-Phitsanuloke area for Thai Shell Exploration, by building roads, railway transfer stations, pipeline facilities, drilling platforms, and housing and recreational facilities for the use of the oil company's employees.

An important element in Thailand's industrial development during this period was the development of the eastern seaboard in Chonburi and Rayong Provinces, as a major alternative industrial zone to relieve over-congestion of industrial activities in Bangkok and its surrounding provinces. The Fifth National Economic and Social Development Plan (1982-1986) included the setting up of the Eastern Seaboard Development Plan following the discovery of natural gas in the Gulf of Thailand.

The Company's attention was therefore directed towards the development of the petrochemical industry on the eastern seaboard, with construction of the on-shore tank farm and the design and construction of the 1.6 km long jetty for the Petroleum Authority of Thailand's Gas Separation Plant at Laem Chabang.

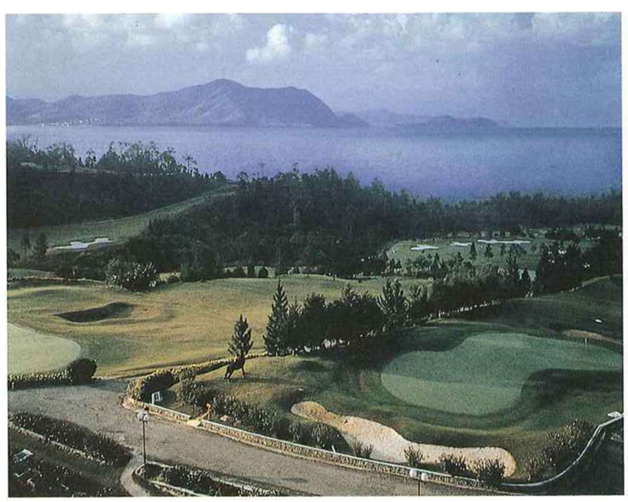


Jetty, Petroleum Authority of Thailand's Gas Separation Plant at Laem Chabang

The Company also cooperated with its Danish parent company, Christiani & Nielsen A/S, to design and construct a Wide-Body Aircraft Maintenance Centre at Don Muang, capable of servicing Boeing 747 'jumbo' jets, for Thai International Airways. This was a complex project which required extensive structural steel fabrication, using advanced design techniques.

Aircraft Maintenance Centre, a Boeing 747 inside the hangar

The early 1990's saw a proliferation of projects related to leisure and tourism. The Company constructed a number of prestigious golf courses including Lake View Golf & Yacht Club, Phoenix Golf and Country Club, Springfield Royal Golf and Country Club and Tanya Tanee Country Club, and the luxurious Baan Taling Ngam Resort and Spa at Koh Samui.



Phoenix Golf and Country Club, Pattaya

Springfield Royal Country Club, Cha-Am

Baan Taling Ngam Resort and Spa, Koh Samui

This period also saw phenomenal growth in high-rise construction with tower cranes seen dotting the skyline throughout Bangkok. A joint venture between Christiani & Nielsen (Thai) and Philipp Holzmann AG, a large German construction company, constructed the 38-storey Lumpini Tower office building on Rama IV Road, the luxurious Beaufort Sukhothai Hotel on Sathorn Road, the Tridhos City Marina on the banks of the Chao Phraya River, and the Sinthorn II Building on Wireless Road. The Company itself later went on to construct numerous other high-rise buildings. Recognised projects included SCB Park Plaza, Centre Point on Langsuan Road, Watercliff Condominiums, Baan Piya Sathorn condominiums and All Seasons Place on Wireless Road.

The Beaufort Sukhothai Hotel

SCB Park Plaza, incorporating the Head Office of The Siam Commercial Bank PCL

All Seasons Place, on Wireless Road

A backbone of the Company's business has been industrial work, which commenced in earnest from 1960 and continued throughout this 25-year period. The names of new factories built by the Company are too numerous to list here, but among the most notable projects was another factory for Thai Match Co., Ltd. (a repeat of the Company's first industrial project in 1931), and factories/industrial plants for Nobel's Explosives, Nestle, Foremost Friesland, Metalbox, Meyer, Berli Jucker, Siam Guardian Glass, Du-Pont, Thainox Steel, AT&T Microelectronics, Thai Baroda, Thai Beer, Thai Pure Drinks, Gardenia Foods, BHP Lysaght, Thai Amarit, Olic, General Motors, Ecco, Sika, Q-Con, CP Foods and Betagro.

General Motors Plant, Rayong

In addition, the Company constructed almost all of the Makro cash and carry stores over a period of 17 years (1988-2004) as well as a number of retail stores for Carrefour, Tesco Lotus and Foodland.

Other notable projects constructed during this period included Panya Resort comprising a 2,150 rai recreational and housing development with artificial lakes, parklands and a 27-hole golf course; Bangkok Patana School; Fashion Island shopping complex; Royal Princess Srinakarin Hotel; Samitivej (Srinakarin) Hospital; the Asian Games Stadium and Aquatic Centre; Lampang-Lamphun and Nakhon Si Thammarat Highways; Tourist Exhibition Centre at Chiang Rai; Sheraton Krabi Beach Resort; Armed Forces Precadet School at Nakhon Nayok; a Royal Palace at Krabi; campus developments at Thammasat University, Mahidol University, Bangkok University and New International School of Thailand (NIST); marine facilities at the ESSO Refinery at Sriracha; grain/meal silos for CP Group; In-Flight Catering Services and Ground Services Equipment Maintenance Facility Buildings at the new Suvarnabhumi Airport; and, although mostly underground, major parts of the Bangkok Metropolitan Administration (BMA) Wastewater Project.

Bangkok Patana School

Main Stadium and Aquatic Centre, designed and constructed by the Company, at Thammasat University Rangsit Campus

Lampang - Lamphun Highway, upgrade 10.1 km to dual-carriageway

Feed Mill & Silos Complex for CP Group, slipform in progress

To complete the picture for this period, in 1987 Danish businessman Mr. Arne Groes acquired a majority shareholding in the Danish parent company, CN-Copenhagen, and thereby took control of the CN-Group.

Over recent years, prior to the acquisition, the number of branch companies had been gradually reduced to those in Denmark, Brazil, United Kingdom, Germany and Thailand. Soon after acquisition, in 1988, CN-Copenhagen (Mr. Groes) made the decision to sell CN-Brazil, the largest branch company in the Group. The reason for this sale is explained later.

In the same year, CN-UK was assigned management control of all international construction and subsequently changed the leadership of the Company from Danish to British in March 1990.

Around this time, Mr. Groes devised an exit plan, whereby the Company would be made public and then acquire all of his shares to take control of the CN-Group. This would not only enable Mr. Groes to recoup his capital investment, but also give the opportunity for the Company to strengthen operations worldwide due to its relatively strong financial position at that time,

Subsequently, the Company became the first construction company to be listed on the Stock Exchange of Thailand early in 1991 and in November 1992 changed its name to Christiani & Nielsen (Thai) Public Company Limited.

In February 1991, Mr. Groes suffered a massive and devasting stroke (loss of blood flow to the brain) which rendered him incapacitated, with no prospect of recovery. His trusted solicitor assumed full control of the CN-Group and proceeded to action the plans set out previously by Mr. Groes.

By prior agreement, the Company completed the reverse takeover of the publicly listed parent company in Denmark in December 1992, and this was the first such transaction in Thai history.

The Company promptly embarked on an aggressive expansion campaign with pursuit of further rapid growth in Thailand and entries into the construction markets of Malaysia and Vietnam, as well as major investments in property development projects in Germany and Vietnam, and the acquisition of a Danish mechanical and electrical engineering contracting company.

By the end of 1995, the Company's turnover had more than doubled. However, the expansion campaign was abandoned abruptly to enable the Company to restore a proper level of management control over its operations and investments. As part of the reorganization/restructuring process non-performing operations and investments were either closed or disposed of.

The financial crisis in Thailand and the region in 1997 had a severe impact on the Thai economy, with a resulting downturn in construction activity. In addition, CN-UK, established in 1913 and renowned for innovative marine and bridge works, began to encounter increasingly severe cash-flow difficulties to the extent that the financial institutions cut-off further financial support. The major shareholder of the Company (a Thai Bank) provided emergency funds but when those funds drained away rapidly, the shareholder lost confidence and refused further funding. This led to the sudden closure of business on 17th November 2000, and a devastating impact on its head office and project staff. [The administration, liquidation and dissolution process was completed nineteen years later on 10th December 2019.]

Subsequently, a number of multi-million Pounds Serling claims were made by UK employers under Parent Company Guarantees. To avoid bankruptcy, in May 2002 the Company was forced to apply for legal rehabilitation under the Central Bankruptcy Court in Bangkok. This process lasted until July 2009.

The Past 17 Years
(2006-2022)

A decade of political turbulence began when, in September 2006, the Royal Thai Army staged a coup d'état against the government, the first non-constitutional change of government in 15 years. There followed a series of elections, street protests which led to a further coup d'état in May 2014. The military remained in power to the end of this period and beyond, albeit without major impact on the construction market.

Having built up a strong and lasting relationship with Siam Makro PCL since 1988, the Company was entrusted with a further fifty or so cash and carry stores throughout Thailand. Similarly, more than twenty retail stores were constructed for long term client Tesco Lotus and new relationships were formed after successful completion of stores for HomePro and MegaHome.

Industrial work remained a prime focus. A notable project in 2008 was construction of two double-skin prestressed reinforced concrete tanks 80 m diameter and 50 m high with reinforced concrete roof on a metal deck forming part of the LNG receiving Terminal Project for PTT LNG Co., Ltd. at Rayong.

This was to lead to an award in 2019 to construct a further two Tanks at the same location (completed in 2022). PTT was formerly named the Petroleum Authority of Thailand.

LNG Tanks

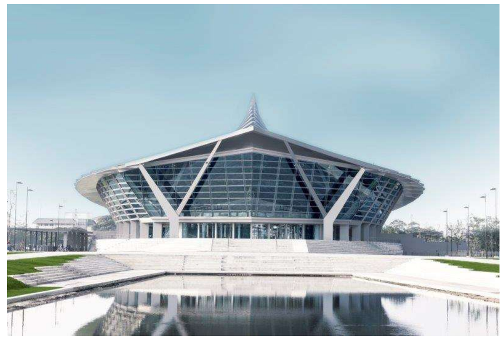
Many other factories / industrial plants were built for well-known clients including Pacific Pipe, TOA Paint, Thai Oleochemicals, Prachinburi Glass, Golden Foods, Cargill Meats, Advance Paper Mill, TC Pharmaceutical, Chalybs Cylinders, Phoenix Pulp & Paper, Knauf Gypsum, Bangchak, CPF, Bayer Thai, Michelin and American Axle & Manufacturing, Delong, Schaeffler, Green Spot, Nestle, Betagro, Siam Glass, Alliance and Inteqc Foods.

Design and Construction of 80,000 m^2 Long-Term Warehouse for Michelin

Many buildings of all types were constructed by the Company. Notable projects included:

SCG Head Office building built to Platinum LEED Standard, 21-storey with 10-storey Car Park building

14-storey Chulalongkorn Hospital Medical Centre; Renovation of Wan Saranrom Palace; 5-storey Mahamakut Buddhist University in Nakhon Pathom; Sports Complex for Chulalongkorn University; 4-storey Head Office for Thai Public Broadcasting Service; 9-storey Kidney Institute; 29-storey Building for Chulalongkorn Hospital and Thai Red Cross; 6-storey TOA Office & 9-storey Car Park in Samut Prakan; 8-storey with 3-level basement Mahidol University Education Centre in Nakhon Pathom; 14-storey Rachapreuk Hospital in Khon Kaen; 20-storey EGAT Headquarters Building to LEED Standard in Nonthaburi; 15-storey Chia Thai New Office; 26-storey Nurse Dormitory for King Chulalongkorn Memorial Hospital in Bangkok; 8-storey Klaimor Hospital in Lamphun; 8-storey Thai Oil Head Office in Chonburi and Indian Embassy Residence Complex in Bangkok.



Prince Mahidol Hall in Nakhon Pathom (music auditorium & convention centre)

PTT LNG Administration Building in Rayong

The Company constructed various leisure and resort facilities including 37-storey Ocean Portofino Condominium in Pattaya; 5-star Six Senses Erawan Spa in Phuket; Sala Resort in Pattaya; expansion of Dusit Laguna Resort in Phuket; 5-star twin 20-storey tower Centara Grand Mirage Beach Resort in Pattaya; additional villas at Banyan Tree Resort in Phuket; 5-star 25-storey Avani Bangkok Riverside Hotel in Bangkok; Somerset Maison Asoke Hotel in central Bangkok; 7-storey Courtyard Hotel Suwarnabhumi and 13-storey 250 room Hotel Nikko Amata in Chonburi.

Of particular note, in the period, was the high-value expansion and renovation of passenger terminal buildings at Khon Kaen and Krabi regional airports (completion due in 2023).

Avani Bangkok Riverside Hotel

Infrastructure projects included Phitsanuloke-Lomsak Highway (18.4 km widening 2-lane to 4-lane); Thung Phra Men Flyover in Nakhon Pathom (424 m long double reinforced concrete box girder); Thung Song Interchange in Nakhon Si Thammarat (2 prestressed concrete ramps 609 m & 944 m long, railway overpass, U-turn ramp); Pak Tho Interchange in Ratchaburi (4 prestressed concrete bridges); Bang Yai Spur Line in Nakhon Pathom (3.8 km new 6-lane motorway in progress); Highway 3191 Map Ta Phut in Rayong (13.6 km widening 4-lane to 6-lane in progress) and Highway 11 Den Chai (14.6 km widening 2-lane to 4-lane in progress).

Indochina Interchange

The period saw radical changes in the shareholding structure of the Company. To comply with new regulations of the Bank of Thailand, in May 2008, long standing major shareholder Siam Commercial Bank PCL sold their stake of 41.5% to the second largest shareholder, Crown Property Bureau, giving them a majority share of 71.4%. Owning a construction company did not fit with their long term business strategy and, on 11 November 2011, the Crown Property Bureau sold all their shares, and so ended a shareholder relationship with the Company that began more than eighty years earlier when the Company was formed in 1930.

Having purchased a stake of 52.0% from the Crown Property Bureau, the GP Group (through Group companies Globex Corporation Ltd. and Victor Investment Holdings Pte Ltd.) became the new majority owner of the Company. Following a mandatory tender offer, their stake increased to 71.6%. In 1918, a Bombay based trading company Gangjee Premjee & Co., made the bold decision to move their operational base to Bangkok. Having later adopted the name 'Shah', a Gujarati word meaning 'merchant or 'trader', the family business flourished. Under the leadership of current Chairman, Kirit Shah, the GP Group expanded and diversified its business interests to include shipping (Precious Shipping PCL is the second largest shipping company in Thailand), hotels (Atrium Hotel in Bangkok) and manufacturing (Alva Aluminium, Linaria Chemicals and MegaLife Sciences).

For the first time in many years, the Company had an owner intent on leading the Company to greater success. As one of the first steps, the Company purchased land and moved into its newly-built Head Office building at Bangna on 28 April 2014. The previous office building, nearby on the same Lasalle Road, had been home since 1988 but the land was leased, not owned. The plant and steel fabrication yard had been established there, amidst the rice fields, 19 years earlier in 1969. In late 2013, the plant and steel fabrication yard moved to newly-purchased land at Sriracha on the Eastern Seaboard. To complete the history for the record, the Company began life in 1930 at the East Asiatic Building in Oriental Avenue, home of one of the founding shareholders. In 1961, the Company moved into new offices at New Petchburi Road in downtown Bangkok where it stayed for 27 years before moving to Bangna. Further details are shown on the next page.

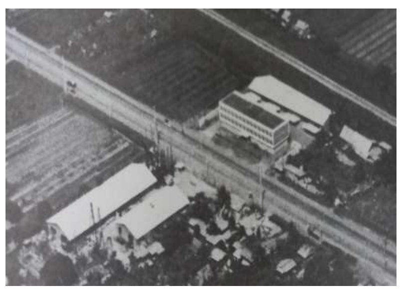
Sadly, on 13 October 2016, the Thai Nation mourned the passing of H.M. King Bhumibol Adulyadej The Great, at the age of 88 years, after a reign of more than 70 years.

1930 Head Office located on 2nd Floor, East Asiatic Building, Oriental Avenue, Bangkok.

East Asiatic Building and Drawing Office

1944 Workshop & Storage Yard set up on purchased land at New Phetchburi Road, Bangkok. In 1960 an extension of New Phetchburi Road divided the Workshop & Storage Yard area into two halves. Construct new 3-storey Head Office Building adjacent to Workshop.

1961 Relocate Head Office from Oriental Avenue to New Phetchburi Road.



1969 Relocate Workshop & Storage Yard from Phetchburi Road to Sukhumvit Road, Soi 105 (Lasalle), Bangna.

1988 Relocate Head Office from Phetchburi Road to newly-built 3-storey Head Office at Bangna (within Workshop & Storage Yard compound).

2014 Relocate Head Office to current 7-storey Head Office building further along Soi 105 (Lasalle), since renamed Lasalle Road. The Plant, Workshop & Storage Yard was relocated to new premises at Sriracha, Chonburi Province in 2013.

Toward the end of the period, in 2019, the Company established a subsidiary, Christiani & Nielsen Energy Solutions Co., Ltd., engaged in the renewable energy business. The aim is to provide a long term income stream to supplement the more volatile income from construction.

It is worth mentioning that in 2021, the Company secured its highest-ever value contract for construction of mixed-use buildings for a private development project in Bangkok (due for completion in 2023).

The first case of Covid-19 in Thailand was reported in January 2020. There followed a series of strict lockdowns, curfews and movement restrictions, all of which had an impact on construction activities but, by far, the greater impact was on construction market volume. The volume of private sector works reduced dramatically as investors postponed proposed projects, as did public sector works where the government diverted funds to support Covid-19 measures. Improvement seems unlikely until the tourism sector continues to open up, starting in mid-2022, and the economy improves to near pre-pandemic levels.

As mentioned previously, the backbone of the Company since the 1960's has been industrial work. Official statistics show that inward foreign direct investment (FDI) for construction has been in continuous decline for a number of years. Further, while FDI into ASEAN countries as a whole has continued on an upward trend, the percentage share into Thailand has been in decline in recent years. This is attributed primarily to higher labour costs and availability of skilled workers, compared to the emerging and rapidly expanding markets of Vietnam, Cambodia and Laos, which are attracting an increasing share of FDI due to their lower cost base.

Since design and construct contracts are rare, generally the Company has to secure new work by competitive bidding under intense competition, and an increased willingness to cut bid prices to unrealistic and unsustainable levels in order to gain a short term market share. Repeat and expansion work for existing foreign companies and major local companies (such as PTT, the state-owned oil and gas company) will play a more dominant role in securing future industrial projects.

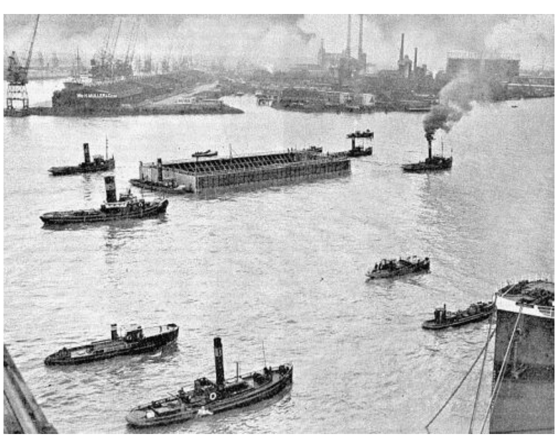
The Company is aware of the constant need to monitor and adapt, as and when necessary, to meet the ever changing and increasingly competitive construction market.

118 Years Worldwide
(1904-2022)

This book closes the chapter on 92 years of Christiani & Nielsen in Thailand. At the same time, it closes the chapter on 118 years of construction activity worldwide, in more than seventy countries, by Christiani & Nielsen.

Although construction activities worldwide may have come to an end, at least for now, the name and splendid reputation of Christiani & Nielsen lives on in the thousands of projects constructed around the world. To mention all these projects would fill a number of books, but just three examples that typify the engineering excellence and innovation of Christiani & Nielsen are the design and construction of the Maas River immersed tube tunnel in Holland in 1937-1942 (construction work was interrupted during WWII hostilities in Holland); the 2.1 km long docking pier built in 1937-1941 at the Port of Progreso in Mexico; and the Kish Bank Lighthouse in Dublin Bay, Ireland in 1963-1965.

The Maas Tunnel was the world's first immersed tube tunnel of its kind with nine box shaped sections, 24.8 m wide by 8.4 m high by 61.4 m long. The principle of this type of construction was to precast the reinforced concrete tunnel sections on land, float into position, sink onto temporary supports in a dredged trench, align accurately, connect underwater, fill the space beneath the tunnel sections to provide a solid foundation and finally backfill the trench. The design proposed by Christiani & Nielsen was feasible only if the 75 cm deep space between the underside of the tunnel and the bottom of the trench could be filled with uniformly compacted sand without cavities, in order to avoid excessive settlements. Prior to award of contract, Christiani & Nielsen developed, in model tests, an ingenious triple-tube system to pump sand beneath and across the entire width of the tunnel. By using suitable velocities, it was possible to make the water circulate in a stationery flow pattern, and so form a uniformly compacted layer of sand.



The Maas Tunnel, still in active service today, was the forerunner of the one hundred or so such immersed tube tunnels that have been constructed around the world since that time.

Maas Tunnel (last tunnel section being floated into position)

To enable use of local porous limestone as concrete aggregate in the harsh corrosive marine climate, Christiani & Nielsen designed the pier at Progreso as a series of mass concrete pillars, cross-girders and arches with anti-crack stainless steel reinforcement used only on the cross-girders. Thirty years later, the road and rail traffic became too heavy and an additional pier was built by another company next to the old one, but using ordinary reinforcement. Today, the old pier still looks as good as new and, according to the Progreso Port Authority, no major repairs or routine maintenance activities have taken place over the lifetime of this structure. The new pier, however, has suffered a much worse fate. The entire length of the pier has completely disintegrated in the corrosive atmosphere and collapsed into the sea, and all that remains to be seen of the new pier are short stumps of concrete protruding out of the sea!

Progeso Pier, with the remaining parts of the new pier to the left

This was the first known use of stainless steel reinforcement on a major construction project, and there are no significant reported uses of stainless steel as reinforcement for at least the next 40 years.

This innovative construction in 1937 is even more remarkable considering that stainless steel itself was not discovered until 1913, with standard commercial grades subsequently developed in the period 1913 to 1935. Indeed, its beneficial use in structures to protect against corrosive environments has become widely accepted only during the past few years. For obvious reasons, the case of Progreso Pier is now used as a marketing tool for manufacturers of stainless steel reinforcement.

Consider the pocket telescope. A series of concentric tubular sections designed to slide into one another, reducing the instrument to a nice, compact size. There is nothing unusual about that. But what about a 6,700 ton telescope made of concrete and steel, reaching over 50 m at its full extent and designed to float upright on the Irish Sea? Now that requires a little more thought. This was the unique feat of engineering for Kish Bank Lighthouse that the citizens of Dun Laoghaire in Ireland saw being realised in the town's harbour 57 years ago. The harbour authority was utilising a stationary vessel as a lighthouse, previous attempts at constructing a permanent lighthouse offshore having failed owing to the severe weather conditions prevailing in that location. The authority became interested in the possibility of using a platform similar to those used as oil rigs and they asked nine engineering firms to submit design tenders for such a lighthouse. The design submitted by Christiani & Nielsen was eventually selected. This design was not for a steel platform like an oil rig but a concrete lighthouse designed to last for at least 75 years.

Construction of the lighthouse began within a sheet-pile cofferdam in the inner harbour in July 1963. The bottom portion of the lighthouse was built as a caisson with an outside diameter of 32 m and a 1 m thick base slab. There were three concentric walls of varying heights, the greatest being 28 m. The tower is a self-contained unit of twelve floors built within the caisson. It is 30 m high and surmounted by a helicopter landing pad. On 29 June 1965, the floating lighthouse structure was towed out of the harbour. Crowds had been travelling to Dun Laoghaire to see the extraordinary project as it took shape and a special viewing platform had to be built to accommodate them.

After being towed to its final location, 10 km offshore, it was sunk onto a level platform of stones which had previously been prepared by divers. This was done by flooding the lower caisson with water causing the tower to float up some 17 m and the final lift to 31 m above sea level was achieved by jacks and pre-stressing cables built into the lip of the base. The cables allowed for small corrections to ensure the tower was vertical. The water was then pumped out and replaced by 18,000 tons of sand and topped with concrete. The space between the tower and the caisson was sealed with concrete.

The Kish Lighthouse has now withstood the worst that 57 winters on the Irish Sea have to offer and looks set to withstand many more.

Christiani & Nielsen have traditionally been civil engineers and contractors. The two functions were often combined for alternative designs to benefit both client and contractor. The Engineering Division of the then parent company in Denmark not only provided an internal technical service for potential design and construction projects worldwide (e.g. Klong Toey Port, Jetty at Laem Chabang), but also provided external Consulting Engineering services to prepare feasibility studies and designs for governments and other clients, as well as providing design and supervision services for specialist projects such as immersed tube tunnels, ports and major marine bridges (e.g. the Saudi-Bahrain Causeway Project). The philosophy of design and construct was instilled into every branch.

Up until the early 1980's, the parent company in Denmark nominated the most trusted Danish engineers as heads of the autonomous branch companies. Each branch made a financial contribution to the parent company by means of a royalty set as a small percentage of contract revenue. It is worth noting that the founding partnership in Denmark had been established with capital of only 20,000 Danish Kroner (equivalent to around US$ 3,000), provided by the father of Captain Aage Nielsen.

As mentioned, in 1988, CN-Brazil was sold to a local construction company Carioca, which changed its own name to Carioca Christiani-Nielsen Engenharia SA. The reason for the parent company (CN-Copenhagen) selling CN-Brazil, the largest and most valuable asset in the CN-Group, needs to be explained.

In 1971, heavy losses were incurred on a major dam contract in Venezuela, where CN was a minority partner in an international consortium. According to Alex Christiani, this almost brought about the downfall of the CN-Group. A similar scenario developed in the 1980's due to severe cash flow difficulties within the Group. As an expedient remedy to quickly restore financial stability, CN-Copenhagen opted to sell CN-Brazil but, in doing so, left itself financially weakened and vulnerable (Group turnover for 1988 dropped by about 90%). This culminated in the planned and agreed reverse takeover by CN-Thai in 1992.

Sadly, Alex Christiani passed away in August 1998, and so ended the living family connection with the management and control of Christiani & Nielsen.

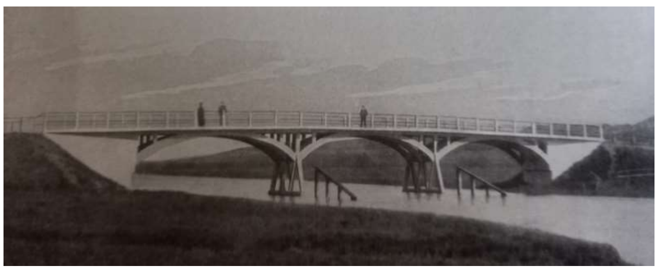
By 2012, the liquidation and dissolution process of the founding company in Denmark, together with the branch in Germany, was completed. This left the sole operating company in Thailand.

Without going into detail, it would be remiss not to highlight some notable achievements of Christiani & Nielsen (CN) worldwide since foundation in 1904:

1904 First ever reinforced concrete bridge designed and constructed in Denmark over the River Ry at Aabybro, now designated a national landmark.

1904 In the first two years, some twenty large and small bridges were designed and constructed in different parts of Denmark.

1905 Design and construct Antmand Hoppes Bridge, a three-span arch bridge across the Gudenaa River in Denmark.



1906 Invent a new and revolutionary type of quay wall featuring a sheet pile front wall anchored at the level of a horizontal relieving platform of reinforced concrete, supported on a system of vertical and raking piles which, by their arrangement and loads, ensured the stability of the structure. It was designed and constructed in its most primitive form in 6.6 m of water at Alborg and Assens in Denmark. As the design was perfected, this quay wall became known around the world as the 'CN-wharf'.

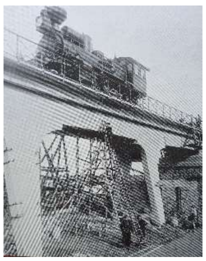
1907 Develop the design and construction of reinforced concrete caissons for wharves and quay walls. First used for a 220 m long wharf at Norresundby, Denmark.

1907 Design and construct the first reinforced concrete bridge in Iceland over the Fnjoska River, with 55 m span, the longest bridge of its kind in the Scandinavian region. It was used for automobiles until 1968, and thereafter for pedestrians only.

1908 The concessions for the supply of electric power in Brazil were principally in the hands of American concerns, but some concessions were in Brazilian hands. CN (Copenhagen) became actively involved and were commissioned to design and construct a 10,000 HP hydroelectric power plant on the River Piabanha at Alberto Torres (photo taken long after completion).

1911 After a long and tedious approval process, design and construct the first wharf at the port of Hamburg in Germany made entirely of reinforced concrete, using the CN-wharf system. Rather than being a stereotyped design, each case was thoroughly examined and the design adapted to suit local conditions. When the economical and construction advantages of the new wharf design had been established, CN developed a clear basis for the design calculations.

1911 Design and construct 600 m long railway viaduct approach to a bridge crossing the River Nava in Petrograd (now Leningrad), Russia.



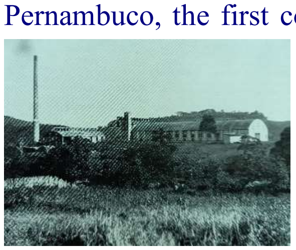
19xx In collaboration with an engineering firm, CN took the lead to develop the types of pile drivers generally used nowadays to drive concrete piles (rather than normal wooden piles).

1913 Design and construct a new type of 'flexible' jetty entirely in reinforced concrete on the River Thames at Erith Oil Works in England. It used a system of vertical and raking piles that were able to absorb kinetic energy from the impact of smaller vessels.

1914 Reconstruct failed wharf (by others) in Russia by replacing with CN-wharf.

1914 Design and construct 360 m long quay wall at Cuxhaven, Germany. The strength of a concrete pile was demonstrated to sceptical spectators by 25 men standing on the 19 m long pile.

1917 Through a Norwegian contact, design and construct a paper mill at Pernambuco, the first contract in Brazil before formal establishment of CN-Brazil in 1919.



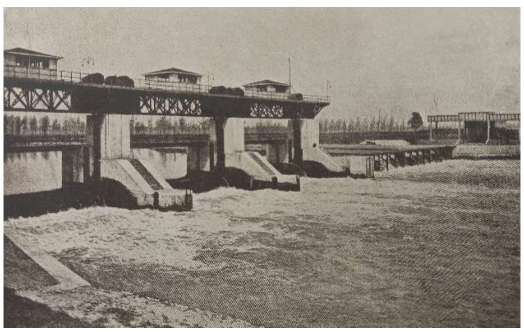
1918 Under pressure of war conditions and the shortage of steel, design and build

five sea-going 1,000 ton coal barges for the British Admiralty in the UK. Constructed in Tilbury Dry Dock, London, work included design and build of a reinforced concrete dock gate, the first of its type in the world, for which CN were granted a special silver medal.

1922 Design and construct first CN-wharf near Rio de Janeiro, in Brazil.

1922 Over the next 32 years, construct and mostly design some 400 road bridges (total length 20 km) in Sweden.

1923 Construct three barrages and locks along a 112 km long stretch of the River



Maas in Holland to make it navigable for 2,000 ton ships (instead of existing 300-450 tons) due to the rapid expansion of nearby coalfields. The flow in the river changes rapidly between 13-3,000 m^3/s. Each barrage is around 114 m long with 2-3 gates 17 m wide to regulate flow, and the adjoining lock is 97 m wide with a navigable channel 67 m wide suitable for 2,000 ton ships.

1924 Design and construct a second hydroelectric power plant, 700 m from the first plant built in 1908, at Alberto Torres in Brazil, comprising mass concrete dam, power house, 1,600 m long by 1,680 mm dia. (diameter) pipeline made up of riveted

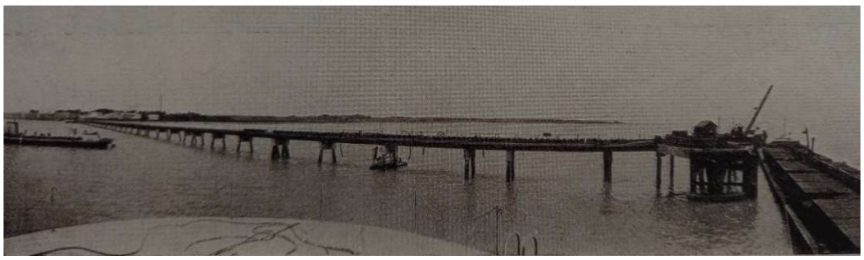
steel plates, 205 m long rock tunnel, 23 m long river bridge and two 230 m long by 1,219 mm dia. steel feeder pipelines.

Photo shows the power house and the feeder pipelines coming down the side of the mountain

CN also owned a small plant in Sao Paulo de Muriahe and had a concession to supply power to 54 towns over a transmission system of 600 km. In order to extend the supply of power, CN bought the waterfall Sumidouro on the River Pomba and, in 1926, went on to design and construct a hydroelectric power plant named Ituere (the old Indian name for the waterfall).

1924 Design and construct a Grandstand at Racecourse Gavea in Rio de Janeiro, Brazil, which had a striking cantilevered concrete roof projecting 22.4 m. At this time, it was a daring structural concept.

1925 Design and construct Shell-Mex Jetty at Hamble, England for 20,000 ton oil tankers. The ship is berthed against two heavy cylindrical dolphins 9.7 m dia. detached 38 m either side of the pier head, which is set back 1.8 m from the front line of the dolphins, so is not touched by the ship. The caissons, made up of reinforced concrete interlocking sheet piles, are filled with shingle to produce a heavy mass able to absorb impacts from heavy vessels with minimum deformation. This type of jetty was the first of its kind in the UK,



1925 Design and reconstruct a mainline steel-girder railway bridge (built about 1880) at Trollhatten in Sweden. The bridge had to be reconstructed under traffic without any change to plan or elevation of the track. The solution was to construct a new reinforced concrete bridge completely around the old bridge, so the latter could be removed after the new bridge was completed ready to carry traffic.

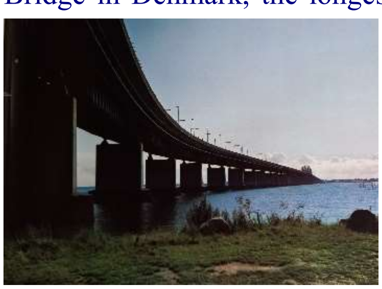
1926 Construct concrete arch bridge over River Kymmenealv in Finland with clear span 49 m. Due to the violent rapids in the river, scaffold to construct the arches was placed in position from a suspended cableway above the gorge. Free-spanning scaffold was used to construct the deck.

1926 Construct 2 km length of main sewers in Buenos Aires, Argentina. In spite of extremely variable soil conditions and passing the sewers under a dam carrying road and rail traffic, the success of the project led to the award of all remaining sewer work without tendering.

1927 Invent and develop the use of inclined hangers on arched bridges, from which the roadway is suspended. The hangers are slender steel rods capable of transmitting axial tension only, not compression. This complicated the structural analysis, but did lead to incredibly slender and elegant arch bridges. The first such bridge was designed and constructed in Belgium. Over the following twenty years, CN went on to design and construct about 80 bridges of this type in Sweden alone, as well as the well-known Castelmoron bridge in France built in 1933 (shown in the photo).

1932 Invent and develop the principles of design and construction that made rectangular immersed tube tunnels possible. CN was involved with design, supervision, construction of at least 24 such tunnels in Holland, Belgium, Sweden, Denmark, Germany, United Kingdom, Japan, Spain, Canada, Greece, Ireland, USA and Singapore. The photo shows tunnel elements for the Benelux Tunnel in Belgium, 93 m long by 23.3 m wide by 7.6 m high with 2 tubes 9.25 m wide and a central duct.

1933 Design (substructures) and construct 3.2 km long rail and road Storstrom Bridge in Denmark, the longest bridge in Europe. The 49 piers were constructed in double-walled elliptical-shaped floatable steel cofferdams, becoming a classic in civil engineering history.



1935 Construct 3.1 km long funicular railway up to a height of 1.8 km above sea level on the Cello Cathedral Mountain in the Andes, within the Nahual Huapi National Park in Argentina. The climate was such that work closed for 6 months of the year. Together with delays due to WWII, the railway did not open until 1950.

1938 Construct 60 km long El Palito to Palmasola railway line, half through virgin jungle, in Venezuela to provide economical transport from inland banana plantations down to the coastal harbour.

1938 Design and construct civil works and erection of M&E equipment for new steel mill at Joao Monlevade, Brazil adjacent to River Piracicaba, including 12,000 HP hydroelectric power plant on the River. Iron ore was mined at Andrade, 7 km from the steel mill, and the blast furnace was powered by charcoal. Further works to expand the steel mill were carried out over the following 38 years including:

1941: new buildings and addition of three blast furnaces.

1948: new sinter plant, the first in Latin America.

1956: new 100,000 m^3 charcoal receiving station at the steel mill and new 50 km conveyer from the forest area to the receiving station.

1957: extensions to steel mill buildings, including 5^{th} blast furnace to produce 350,000 tons/year of billet steel and new sinter plant at Andrade.

1976: new 1 million tons/year sinter plant close to the steel mill.

Note: Since it takes about 3 m^3 of charcoal to produce one ton of steel, this created a huge demand for charcoal and the Owner realized the need to reforest the devasted area with fast-growing Eucalyptus trees. Sintering agglomerates (combines) iron ore, waste products from the steel mill and charcoal to produce pellets as feed for the blast furnace. This enables economical use of charcoal and more stable operation of the blast furnace.

1941 Extensions to Durban Harbour, the busiest port in South Africa. Further extensions both big and small, were to continue, with few interruptions, over the next 36 years much according to CN design.

100 ton concrete blocks, first used as 70 ton blocks at Matola, Mozambique in 1962, and subsequently used for Harbour works at Durban, Cape Town and other locations in South Africa

1944 Over a period of ten years, (mostly) design and construct many structures related to water power in the Andes mountain range in Columbia, Peru and Bolivia. A typical scheme was the regulation of the Santa Eulalia River in Peru which included a storage dam (120 m long by 9.3 m high) on a plateau around 4.4 km above sea level, a

regulating dam (55 m high with 255 m long bypass tunnel in rock) at lower level and a 12.4 km long rock tunnel to allow water to drop 475 m into a power plant at the foot of the mountains. The structures were not huge but working conditions were very difficult, such as the need to use 300-400 llamas to transport cement, rebar etc. a distance of 40 km or more across the mountains at altitudes up to 5 km above sea level. Before regulation, the flows in the Santa Eulalia River were only 1.5 m^3/sec in the dry season and 10-120 m^3/sec during the wet season. After regulation, the river maintained steady flows of 4.5 m^3/sec in the dry

season and 6.5 m^3/sec in the wet season. Catastrophic floods practically disappeared and land around the capital city Lima was reclaimed from desert into fertile land for cultivation.

1947 Construct Forshage hydroelectric plant in Sweden. Between the two turbines in the Power House, a steel/concrete chute passed right through the building to allow passage of timber logs floating down the river. During the period from May to October some 8 million tree trunks pass through the chute on their way to saw mills downstream at Karlstad.

1947 Design and construct a small jetty for A/S Norske Shell at Hammerfest, Norway, the northernmost city in Europe, 966 km inside the Arctic Circle and only 2,150 km from the North Pole.

1947 Construct hydroelectric power plant at Dynjanfoss in Norway comprising small concrete dam, 1.5 km long by 25 m^2 rock tunnel, and power house 60 m long by 11 m wide by 12 m high blasted to fit completely inside the mountain face.

1948 Construct La Central hydroelectric power plant 1.8 km above sea level in the Andes mountain range at Caldas, Columbia to provide power to the city of Manizales and surroundings. Water is transferred from Campoalegre and Chinchina rivers by 2.5 km long by 2.5 m^2 rock tunnel to feed the reservoir.

1949 In JV, construct Maracana football stadium in Rio de Janeiro, Brazil holding

200,000 spectators, the largest such stadium in the world.

1949 Design and construct Oscar Weinschenk Pier 400 m by 83 m close to central Rio de Janeiro, Brazil. It was built especially to serve the largest passenger liners and has become a famous and distinctive feature of the city. During construction, there were no suitable subcontractors available for granite facing work. By good fortune, a ship arrived from Europe with fifty immigrant stone cutters, almost all of whom were promptly employed to work on the pier, allowing completion of the project on time.

1950 Design and construct new oil terminal at Fawley, England with 610 m long approach trestle, 980 m long pierhead trestle with four breasting islands on two 12 m dia. caissons for tankers, a berth for coasters and 14 caissons in the pierhead as strongpoints. The first jetty at Fawley was designed and constructed by CN in 1927.

1950 CN-Peru joined with two Ecuador nationals (one a former Ambassador to the USA) and Henry Simon Ltd. (UK) to set up a new company to develop a flour milling business in Ecuador, to supply the whole country's needs (all flour was being

imported). A plot of swampy land was secured by the riverside about 2 km from the city of Guayaquil. CN designed and built a flour mill (initially 100 tons / day increasing to 220 tons/day), silos (10,000 tons), pier for 8,000 ton ships, storage warehouses (10,000 tons), textile mill to make flour bags (200,000 bags/week), power plant, steam boiler house, water/sewage supply, provender mill to use the mill's by-products (e.g. as animal feed). Henry Simon Ltd. supplied and installed all the equipment. The new mill attracted local interest and a concrete road soon connected the mill to Guayaquil, and surrounding new business ventures started up. The new flour mill was a huge success. In 1950, 35,000 tons of wheat flour was imported into Ecuador, by 1956 not a single bag of flour was imported.

1950 Construct 24 km long railway from Corrales to Paz de Rio, Colombia to transport iron ore to a new rolling mill at Belencito. The terrain was very difficult requiring 90 bends, mostly very sharp, 5 bridges and 325 culverts.

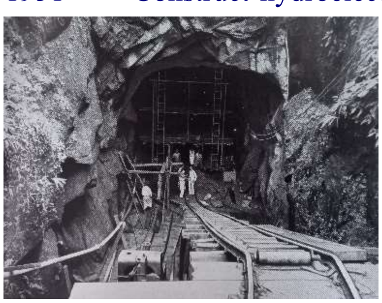
A steam locomotive (centre in black) pulling flat carriages loaded with goods and personnel.

1950 Design and construct Olympic Stadium in Caracas, Venezuela to seat 35,000 spectators. The design of the 115 m long grandstand with 21.5 m cantilevered concrete roof attracted much local and international interest (and was essentially the same as the grandstand provided for the racecourse in Rio de Janeiro in 1924).

In 1953, design and construct an almost identical, but smaller, stadium in Copenhagen, Denmark to hold 18,500 spectators.

1951 Construct three small dams in Greenland to form a storage reservoir to provide water supply during the dry season.

1951 Construct hydroelectric plant at Anchicaya in Colombia. The gravity dam was 191 m long and 55 m high. A 210 m long river diversion tunnel 7.5 m wide by 8.0 m high was blasted in rock. Other works included a powerhouse, 1,350 m long tunnel in rock from reservoir to power house, 45 km long HV transmission line and a transformer station at the destination city of Cali.



1951 In Peru, divert water of-Chotano River to the Chancay River valley for irrigation, by constructing 1.3 km long open concrete-lined channel and 4.7 km long concrete-lined 9.5 m^2 tunnel in rock.

1952 Construct tunnel for passage of river Choqueyapu through capital city La Paz, Bolivia.

1952 Construct 148 m long, 5-span prestressed concrete bridge across the River Itchen at Northam to replace the old existing steel bridge (1889). This was the biggest such bridge in the UK. The bridge was reportedly haunted by the ghost of a soaking-wet young girl.

1952 Construct cableways for two mines to extract sulphur from an extinct volcano high in the Andes mountains in Argentina. The combined length was 28 km with 199 towers, up to 5.3 km above sea level with constant sub-zero temperatures.

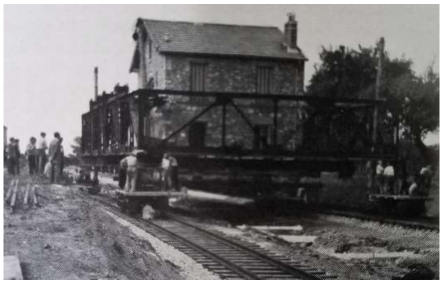
1953 Design and construct new 500 tons/day plant and modernise the existing largest tungsten mine at San Luis in Argentina.

!953 Construct Paucartambo hydroelectric power plant at altitude 2.9 km above sea level in the Andes mountains in Colombia, to provide power for copper, lead and zinc refineries and mining activities.

Site inspection on horseback

1953 Design and construct 456 m long, 15-span, prestressed concrete Ellis Brown Viaduct over the Umgeni River at Durban, South Africa. The two outside girders were constructed with an arched soffit to maintain the appearance of the original tender design. On opening the bridge, the Minister of Transport made a special commendation on the use of comparatively new prestressed concrete to produce a graceful and purposeful appearance.

1953 To make way for new roads in Paris, France, relocate 14 houses weighing up to 450 tons by designing a system of jacks to lift and slide the building onto a steel structure on bogies and move on steel tracks 300-500 m to the new location with several changes of direction. The successful operation led to further business and more than one 100 buildings were relocated in this manner.



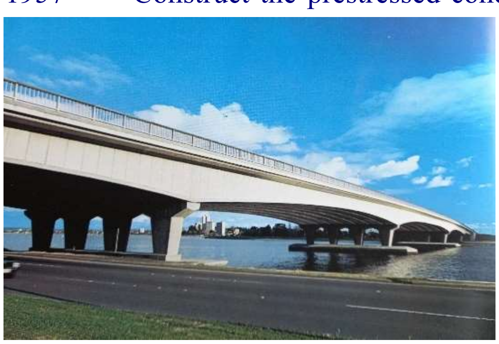
1954 Following erosion and collapse of an old sea wall in Beira, Mozambique, design and construct a new sea wall 342 m long.

1956 Design and construct 100,000 ton grain silos, mills and shipping gantry at Mersin in Turkey, the largest silo complex outside the Americas, as well as 60,000 ton silos at Ankara and Konye.

Silos at Mersin

1957 Construct dock and storage facilities on Uruguay River at Nueva Palmira, to provide transit shipment of Brazilian minerals (mainly manganese ore) brought by river barge through Paraguay and Argentina waters for transfer to marine vessels sailing to USA and Europe.

1957 Construct the prestressed concrete Narrows Bridge over the Swan River in Perth, Australia. It attracted much interest due to its slender and elegant design. Total length 335 m made up of 5 cantilever and suspended spans, with maximum span of 97.6 m and width 27.5 m.



1957 Design and construct Monaca Flour Mill and Silos at Puerto Cabello, the largest in Venezuela. After reading reports of an increasing number of cases of serious cracking in reinforced concrete silos, CN deviated from the traditional design and instead calculated the pressures based on limited full scale tests by a French firm of silo specialists. They found that the usual silo formulae underestimated the maximum pressure, which occurred when the grain was flowing out of the bin rather than when at rest, as assumed in the traditional design. This increased the area of reinforcement but, after several years of service, there were no signs of cracks.

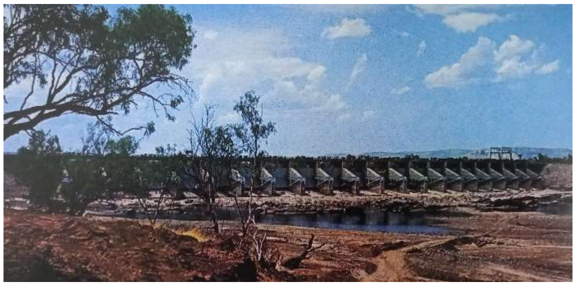
1958 Construct two natural draught cooling towers 85 m high for Athlone Power Station at Cape Town, South Africa; 67 m dia. at the base with the wall curving upwards in a hyperbolic curve reducing the diameter to 38 m before opening out to 42 m dia. at the top.

1958 Construct Cathedral of Our Lady of Aparecida in Brasilia, most of which is below ground with a capacity of 4,000 people. The hyperboloid roof 70 m dia., 40 m high has sixteen distinctive concrete columns, each weighing 90 tons, representing two hands reaching upwards toward Heaven. Stained glass infills the spaces between columns.

1958 Design and construct 330 m long, 13-span, road bridge at Vestervick, the first bridge of this size in Sweden, with precast pretensioned concrete main beams.

1959 Design and construct fishery wharf in 6 m deep water at Frederikshaab in Greenland, comprising five rock-filled, circular timber cribs (baskets) 6 m dia. by 9 m high with concrete deck slab. The empty cribs were assembled onshore, using 210 mm square pine timbers, before being rolled down a slipway, towed in position and filled with rock.

1960 Construct Ord River Diversion Barrage at Bandicoot Bar in the remote



Kimberly district of Western Australia to make a storage reservoir to divert water to fertile soil on the eastern side of the river. The barrage 335 m long by 17 m high with 20 distinctive radial steel gates, 14.9 m wide by 11.3 m high, installed between concrete piers, is topped by a prestressed concrete bridge roadway with 4.8 km of embankment beyond the eastern end of the barrage to form the storage reservoir.

1960 Construct 994 m long, 35 m wide prestressed concrete Medway Bridge in

England, with central span of 152 m, the longest prestressed span in the world.

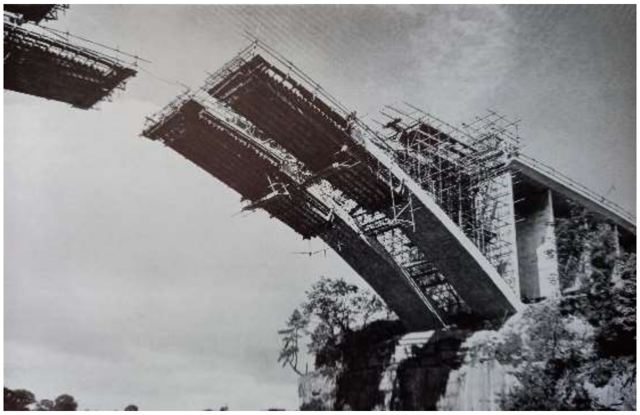
1960 Design and construct new paper mill and power plant at Maracay, Venezuela, one of the most modern in South America. Works included erection and installation of M&E equipment.

1961 Propose alternative design (from steel to virtually maintenance-free reinforced concrete) to construct 234 m high VHF Tower at Brixton, Johannesburg,

South Africa. The concrete shell tapers to its height of 168 m in an exponential curve. The shell is 20.1 m diameter with 56 cm thick wall at the base reducing to 38 cm at the top, built using jump formwork system in 2.9 m lifts. It has an internal steel lift shaft and a 66 m high steel mast on top of the concrete shell.

1961 Construct water supply and treatment plant in Oslo, Norway. Unusually, all treatment units and treated water storage are underground in caverns blasted from solid rock. Only the transformer station and ventilation plant are above ground. The raw water storage cavern 20.5 m^2 in section, with concrete vaulted roof, holds 7.7 million litres.

1962 Construct 120 m long Taf Fechan Arch Bridge in South Wales, with 69 m span crossing a river gorge 30 m deep. The arch ribs are constructed without any staging by cantilevering out from the abutments and tied back by external temporary prestressing cables. This was the first time such a technique had been used in the UK.



1962 Design and construct 300 m long, 18 m high wharf for export of 2 million tons/year of iron ore at Matola, Mozambique. The gravity wall wharf was, for the first time, made up of a stack of independent unbonded precast concrete blocks each weighing 70 tons, with rock fill behind the wall.

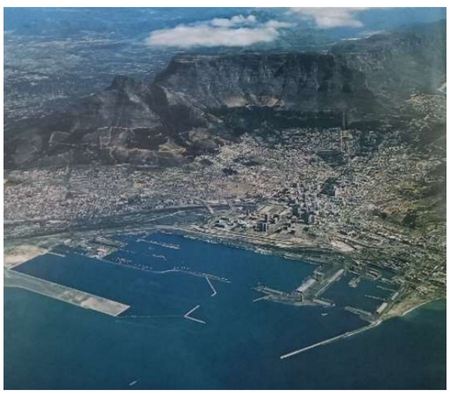
Shortly after completion, the use of concrete blocks each weighing 100 tons formed the basis of a tender for a major design and construct marine contract at Durban Harbour in South Africa with construction period of 64 months, and early completion bonus. The client was somewhat dubious, when a period of only 32 months was proposed. By increasing the production rate of the blocks, the contract was completed in only 25.5 months, earning a sizable bonus from the very impressed client.

1963 Blast two rock tunnels 2.4 km and 9.5 km long, section 2.2 m wide by 2.7 m high, with concrete-lined roof, at Natal, South Africa, using rock blasting experience of CN-Norway. The blast team achieved a South African record length of 310 m in 30 days on a single heading.

1963 Construct new high-level 912 m long prestressed concrete Sir Ernest Oppenheimer bridge over the Orange River, the longest bridge in South Africa. This bridge replaced the original low-level bridge built by CN in 1947, which was partially swept away by floodwater in 1957.

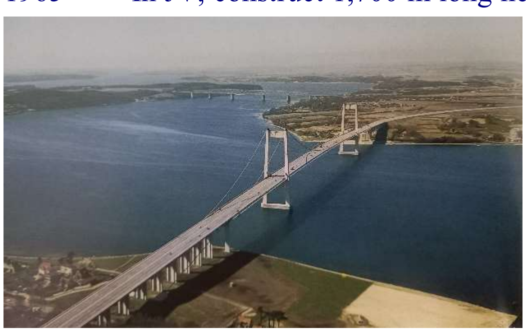
1963 In order to keep their modern plant workshop fully employed during a period of economic recession, CN-Venezuela began to make steel vehicle parts for General Motors and other vehicle manufacturers. In 1964, the workshop produced 156 tons of steel for 50 different types of parts, increasing to 350 tons of steel for 64 types of parts in 1965. As the recession came to an end, so did this interim venture.

1963 Part-design and construct Table Bay Harbour Extensions Stage I at Cape Town, South Africa, comprising 3.3 km caisson sea wall, 9 km rock-armoured sea wall, extension of main breakwater using 18 m by 18 m by 19.5 m high concrete caissons (largest in South Africa) and extension of quay using 100 ton interlocking concrete blocks. Stage II extensions followed in 1969 (largest contract for CN-South Africa). Earlier works for widening of Duncan Bay were completed in 1963.



The tender called for removal of 259,000 m^2 of shale rock by underwater blasting. This would require drilling 140,000 shallow holes in 15 m deep water affected by almost continual ocean swells, and meant that the project would not be completed on time. It was recalled that underwater blasting of the seabed (without drilling) had been carried out by the US Navy in WWII. It was essential to be reasonably sure that this method would work so, after reviewing the scant information available, a 15 m square area of bare shale rock was found onshore and surface blasted with 200 kg of explosive. The result indicated that this surface blasting should shatter the seabed rock sufficiently to be removed by dredger. The Tender was priced accordingly and it proved to be the correct and most economical method.

1965 In JV, construct 1,700 m long new Little Belt Bridge crossing the Little Belt



strait between mainland Jutland and the island of Funen in Denmark. Works for the 6-lane motorway suspension bridge included foundations, two 118 m high reinforced and prestressed concrete towers, total 900 m long approach viaducts and anchor blocks for the suspension cables (excluding steel deck by others). The tower foundation was a concrete caisson 56 m by 22 m by 21 m high with rounded ends on 32 m long concrete piles driven mostly underwater in the 20 m depth of water to within 1-2 m above the sea bed.

1965 Design and construct civil and M&E works for tanker berths up to 100,000 dwt at Leixoes Oil Terminal in Portugal. Works included dredging 600,000 m^3 of sand/silt using CN-owned dredger boat 'Kaptain Nielsen', named after the joint founder.

1966 Construct Funil hydroelectric power plant on the River Paraiba in Brazil,

with double curved arch concrete dam 85 m high with crest length 385 m. Other works included intakes, spillway, power house, tailrace and switchyard, making this the largest ever project for CN-Brazil.

1967 Detailed design and construction of two LNG storage tanks in Barcelona, Spain. Tanks were 45 m dia. by 39 m high with inner shell of prestressed concrete panels, outer shell and roof of carbon steel plates 8 mm thick, concrete domed roof supporting outer shell roof, all supported on concrete foundation on preloaded sand fill.

1967 Construct 12.9 km long, dual 2-lane carriageway for Hamilton By-Pass road in Scotland, including eight major/minor bridges, major bridge over the River Avon

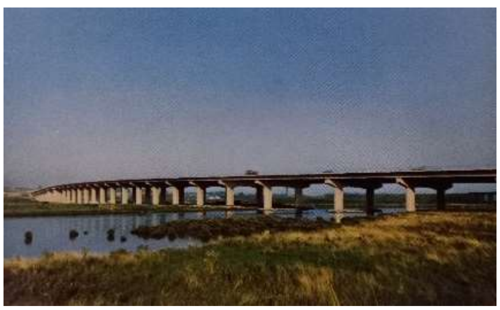
and 4.2 million m^3 of excavation.

1968 Design and construct slipway at Saldanha Bay Harbour for vessels of 1,200 tons, making this the largest slipway in South Africa.

1968 Construct Microwave Tower 268 m high at Hillbrow, Johannesburg in South Africa. Construction history was made by using precast elements for the three-floored concrete superstructure at the top of the tower.

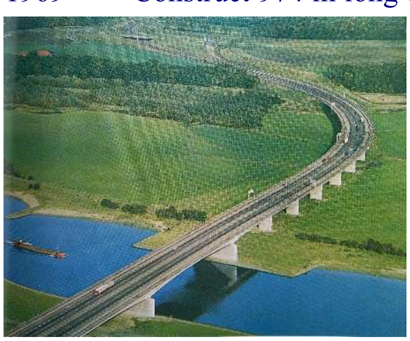
1968 Establish copper mine at Bidjovagga far north of the Polar Circle in Norway, including drilling and blasting a vertical mine shaft 319 m deep, section 4.7 m by 3.2 m, with a series of 10 m long tunnel headings at various levels.

1968 Construct 971 m long, 34.2 m wide, dual 3-lane motorway Weaver Viaduct in England, crossing two navigable waterways with 34 spans, mostly on a circular curve in plan, made up of precast post-tensioned concrete beams.



1969 After a previous contractor aborted their contract due to a number of deaths of their diving personnel, pull from shore and lay in seabed trench 3.2 km long by 1,219 mm dia. submarine effluent outfall pipeline in Durban, South Africa in depths of water of nearly 60 m. Specialist deep sea divers were brought from the UK.

1969 Construct 974 m long by 34.7 m wide motorway bridge curved in plan over the Rhine River in a particularly scenic part of Holland. The twelve spans were made up of two independent prestressed concrete double box girders using the free-cantilever method.



1969 Lay 16 km of submarine steel pipeline, 813 mm dia., from marine drilling platform to an oil refinery onshore in Brazil.

1969 Construct 2 million tons/year pelletizing plant at Tubarao, Brazil for Vale, one of the largest iron ore exporting companies in the world, including all civil work and erection/installation of steelwork and M&E equipment. The iron ore and extraction process produces a considerable amount of fines and 'blue dust' which previously was not suitable as feed for blast furnaces. The pelletizing plant converts the fines/dust into 10-20 mm dia. pellets which are highly suitable as blast furnace feed.

In 1971, construct a second pelletizing plant with a capacity of 3 million tons/year, and design and construct Ore Pier No. 2, in 26 m deep water, at Tubarao for 350,000 dwt ore carriers to export pellets and iron ore, which is transported 570 km by rail to the Port. Ore Pier No.1 was designed and built by CN in 1962.

1971 Structural design and construction of maize and wheat silos and mill buildings 93 m by 80 m by 79 m high containing 63 hexagonal bins with a total capacity of 54,000 tons at Randfontein, South Africa.

1972 Construct a 1.7 km long railroad trestle from a new marine terminal at Sepetiba, Brazil to Guaiba Island, where iron ore was to be stored. The 55 by 31 m long span trestle, with prefabricated steel superstructure lifted onto each span, was supported on concrete piers and 1.0 m dia. tubular steel piles up to 62 m long. To drive the piles without splicing, an especially high, floating pile-driver "Ramlift" was designed and constructed in-house. It was also used to lift into position the 31 m long, 75-ton, precast concrete beams.

1974 Design and construct TEBIG Oil Terminal at Angra dos Reis in Brazil to accommodate 500,000 dwt tankers. The approach and distribution bridge was 1,205 m long. The water depth at low tide was 25 m and tubular steel piles were 1.0 m dia. and up to 70 m long. A feature was blasting 1,500 m^3 of rock by placing explosives on the surface of the rock seabed, without any drilling (as used at Table Bay Harbour in 1963).

1974 Design and construct enlargement of Naval Harbour at Simonstown, South Africa comprising new outer tidal basin, new inner basin and expansion of ship repair yard (constructed by CN in 1971) using140 concrete caissons each 16 m by 8 m by 9.5-15.5 m high.

1975 Construct four oil jetties for loading 120,000-300,000 dwt tankers with liquid petroleum gas at Sullom Voe, Scotland. The total berthing face was 1.8 km long and included 14 berthing and 21 mooring dolphins with interconnecting walkways.

1975 At Kilroot Power Station at Belfast in Northern Ireland, propose alternative design for cooling water discharge from two bored tunnels to immersed tube, the first such tunnel in the UK, including the first elements to be sunk in the open sea. The rectangular tunnel 6.9 m wide by 3.5 m high was 462 m long with two 2.6 m square openings.

1976 Design and supervise construction of 1.7 km and 1.6 km long Faro bridges,

the longer of which was a cable-stayed bridge (first such type in Denmark) connecting Denmark and Germany.

1976 Install, fit/weld in place 2,500 tons of steel structure and pipes up to 810 mm

dia. inside/outside of 130 m high concrete TCP-2 oil platform at Andelsnes, Norway for the Frigg Oilfield in the North Sea,

1977 After having difficulties with another contractor, CN was engaged to urgently recuperate 450 m and lay 600 m length of new pipeline onto the seabed to complete a temporary outfall before opening of the factory, and then to lay a permanent 2.5 km long by 508 mm dia. fibre-reinforced polyester submarine outfall pipe in a dredged trench at Durban, South Africa.

1977 Design and construct 2,200 m length of container berths at Botany Bay, Sydney, Australia, made up of 350 prefabricated concrete counterfort units of cruciform shape, 6 m long by 18 m high, each weighing up to 360 tons. The units were placed in a dredged trench on a stone bed prepared by a hydraulic stone-spreader specially developed in-house

1977 Lay sea outfall 1,500 m long to dispose of treated water from a sewage treatment plant in Copenhagen, Denmark, comprising two concrete pipes 1.8 m dia. in a 5 m deep trench. A special pipe-laying system was developed to join the 1.5 m long pipes into a 30 m long string carried by a 32 m long strongback with buoyancy tank, launch from a gantry crane, tow and sink in position and then join to the previous section by diver-operated hydraulic jacks.

1977 Detailed design and supervision of Saudi Arabia–Bahrain Causeway comprising five bridges (total 12 km long), 10 km long dual 4-lane causeway structures and 52 km of approach roads with 12 interchanges.

1978 Turnkey final design and construction of Terminal for Wheat and Soybeans

at Rio Grande, Brazil with an initial capacity of 11 million tons/year. This huge project included berthing facilities to receive grain by river transport (410 m pier for two bulk carriers with 2 shiploaders and 612 m wharf for six barges), silo complex and workhouse (132,000 tons capacity, 100 bins 7.6 m dia. by 35 m high, workhouse 60 m high), storage sheds (2 sheds each 76,000 tons capacity, 280 m by 70 m by 15 m high, in precast concrete), unloading facilities for trucks and railcars, railway and road connections, extensive conveyor system of conveyor belts for internal distribution and erection of all M&E equipment. Contract period was only 36 months.

1978 Turnkey construction of 2,000 tons/day Portland Cement Factory at Cantagalo in Brazil including 1,150 tons of structural steelwork and 9,200 tons of M&E equipment supplied by specialist cement maker F.L. Smidth.

1979 Construct Aughinish marine terminal in Ireland with 1,145 m long approach

and jetty head for import of bauxite and export of alumina. Unusually, work was carried out on a cost-reimbursable basis due to variations in soil conditions, including a sink hole along part of the line of the jetty.

1979 Construct civil works for expansion of iron ore mining installations from 2.5 million tons to 10.0 million tons/year at Casa de Pedra in Brazil. Most unusually, iron ore was used as aggregate, making the concrete almost twice as heavy as normal concrete, resulting in considerable increase in wear and tear of the concrete handling equipment.

1980	Construct one of the largest steel mills in Brazil at Planalto de Carapina, including erection of structural steelwork and M&E equipment, and port facilities for coal handling and export of steel products, with initial capacity 3 million tons/year.

1980	Supply, transport and erect first German research station at Atka Iceport in Antarctica, comprising two 8 m dia., 50 m long tubes and a 8 m long connecting tube

made of corrugated steel sheets. One tube carried 12 containerised highly-insulated buildings and the other construction materials. Extensions to the station were made in 1982-84 and an additional Neumeyer Polar Research Station was added in 1991. In 1984, additional buildings were provided for the Indian research station.

1980	Design and construct ship slipways at Angra dos Reis in Brazil. The slipways 350 m long by 70 m wide were the largest in South America.

1981	Installation of production/utility systems in two offshore oil drilling platforms in Brazil, including erection and testing of equipment, piping systems, electric / instrumentation systems and initial production tests.

1981	Construct coal export facility at Hay Point in Australia, one of the largest

such facilities in the world. The approach jetty was 3.7 km long with 157 spans complete with 490 m long wharf, 7 berthing and 4 mooring dolphins, 400 ton by 50 m high shiploader, complete conveyor systems, all M&E installations and 700 tubular piles 1.2 m dia. all fabricated from steel plate at site.

1981	Part-design and construct marine terminal for aluminium plant at Maranhao in Brazil. The berth incorporated 9 reinforced concrete caissons 18.1 m dia. by 20.1 m high built in two stages. First constructed onshore on a steel platform up to 4.7m, then launched via slipway, anchored and slipformed up to full height 20.1 m.

1982	Advise on marine planning and construction of 18 km long submarine 400 KV cable crossing the Strait of Belle Isle between Labrador and Newfoundland in Canada.

1982 Design and construct 648 m long East Wharf at Tanjung Berhala in Malaysia to serve nearby iron and steel mill. Substructure was made up of 30

slipformed concrete caissons each 22.5 m long by 14.0 m wide by 18 m high weighing 2,450 tons. A temporary marine lift was used for caisson construction.

Also construct LPG Jetty at nearby Tanjung Sulong for 4,000 – 40,000 ton tankers, comprising approach trestle 291 m long, central loading platform and single berth of 4 breasting dolphins and 4 mooring dolphins.

1982 After failure by another contractor to anchor an oil spillage boom with concrete blocks at Nigg oil terminal in Scotland, install 25 newly-designed expanding anchors driven into the sea bed with an experimental underwater piling hammer. Anchor flukes at the base are opened by a small underwater explosive charge. The operation proved to be a success.

1982 Develop a more efficient and time-saving electronic pile positioning system POSEIDON (Piledriver Orientation Simplified by Electronic Instrumentation and Displays for Offshore Navigation). Three reflectors are placed at unmanned reference points on shore. Three Geodimeters (range 5 km plus) placed on the piling barge continuously measure the distances which are linked to the computer system. A monitor graphically displays the actual pile position relative to the target position, as well as the orientation of the piling barge. This enables the winch operator to quickly manoeuver the barge into the correct position. Target pile position and rake and details of the reflector stations etc. are preset in the computer. The system was introduced on the Laem Chabang Gas Separation Plant project in Thailand. Thai surveyors estimated that the time used to position a pile using the conventional method would be about 2 hours. The new system was able to position a pile in 30-45 minutes.

1983 Lay 42 km, mostly 300 mm dia. welded steel pipelines for natural gas main distribution in North Zealand, Denmark at an average rate of 1.6 km a week, including twenty thrust-bore road crossings.

1984 Construct Ameria pumping station, part of the Greater Cairo Waste Water project in Egypt, 40 m dia. and 30 m below the ground and the water table level,

making it among the largest of its type in the world. Ground freezing was used to excavate the interconnecting tunnel section between the bottom of the pumping station and the distribution chamber.

1985 Design and construct 2,650 m long Undersea Cable Tunnel at Pulau Seraya in Singapore. The tunnel segments 6.5 m wide by 3.7 m high were joined together by prestressing cables to form 100 m long units and were built on two temporary syncrolift-type elevating platforms before being sunk in 23 m of water.

View inside the tunnel

1988 Design and construct all waterside foundations and grade decks (platforms)

for Phase 1 of Europe's largest development at Canary Wharf in London's Docklands. The heavily-reinforced grade decks built over 9 m of water, which provide support/foundations for six mid-rise buildings, consist of a reinforced concrete grillage on 1.0 m dia. tubular steel piles with the areas between the main beams typically infilled with prestressed, precast inverted T-(bridge) beams with an in-situ concrete topping.

A further contract within the development was to construct advance works for the new Jubilee Line Extension for London Underground. This entailed driving 4,700 tons of steel sheet piles to allow excavation 8 m below water level to form a 12,000 m^2 dry site.

1989 Dornoch Firth Bridge in Scotland, 892 m long, 15 span, prestressed concrete box girder, one of the longest bridges in Europe built by 'cast-and-push' method. Box girder units 21 m long weighing 14,000 tons were built at one end of the bridge and then 600-ton jacks pushed the deck out sliding over PTFE bearings on top of the piers. The launch nose section was of light steel composition to reduce cantilever moments,

1991 Complete restoration, while fully occupied, of 1879 Grade II listed Local Government Offices building with distinctive clock tower and dome, at Birmingham, England. The work included restoration of the clock mechanisms by a specialist, who had manufactured the original clock 114 years earlier,

1992 An alternative design for new quay walls and entrance lock for Sutton Harbour at Plymouth, England reduced the planned volume of concrete from 19,000 m^3 to 6,000 m^3 and rebar from 150 tons to 80 tons.

1993 Construct 1.2 km long, 30 deep water berths for the latest 6,000 teu container ships at West Port Klang in Malaysia. To avoid joining the 3,600 No. 500-800 mm dia. hollow prestressed concrete piles, over 50 m long, during driving, piles were assembled onshore and then floated out to two Ramlift piling barges. This method increased the average piling rate from three to eight piles a day.

Ramlift VIII ready to drive a concrete pile

1994 Construct 1 km long Lavernock Long Sea Outfall in the UK. Instead of the tender design 'bottom-tow' pulling method to lay the pipe, CN elected to lay the 1,892 mm dia. steel pipe in the 6 m deep trench, in 25 m of water, using a land-based launch technique by pushing the pipe progressively outwards from the shore as it was assembled.

1994 Construct Weston-Super-Mare Primary Distributor Road in England. Work completed 5 months earlier than the planned 18 months.

1994 In JV with a local construction company, design and construct Preveza-Aktion crossing in Greece, a 909 m long by10.6 m wide by 6 m high, immersed tube tunnel in 27 m of water. The tunnel had to be designed to resist earthquakes and, as it had to be founded on soils with a tendency for liquefaction during earthquakes, extensive ground improvements were necessary. This comprised installing 0.6 m dia. stone columns on a 1.8 m square grid along the entire length of the tunnel to a depth of 15 m below the base of the tunnel segments, It was the first European Union-funded project in Greece and the first civil engineering contract to be awarded to a British contractor. The complexities of the ground conditions severely disrupted and delayed progress, to the extent that the resulting adverse effect on cash flow of CN-UK was a factor leading to the closure of the branch in November 2000. The project was completed in February 2002, nearly 4 years late.

Tunnel elements under construction prior to launching

It should be noted that negative cash flow on the Preveza project was not the sole, or the major factor, causing the cash flow crisis and the closure of CN-UK. Rather, it was the tipping point leading to the closure. In the UK, it was normal for contractors to make claims for additional time/cost from day one and, due to tight tender margins, claim recovery represented a major part, if not all, of the final profit margin. Until settled and paid, the assessed claim recovery is referred to as 'uncertified value' ("UCV"). Costs of the claims have been incurred, which means that this uncertified value is negative cash flow locked up until the claims are settled. By far, the major part of the total UCV was locked up in UK contracts, increasing from a sustainable level in 1996 to four times that level by year 2000, which was not sustainable for any length of time. The UCV was largely recovered over a period of several years after closure, in order to repay bank loans and other creditors and, of course, to pay legal expenses.

It is said that '*cash flow is the lifeblood of the construction business'*. The downfall of CN-UK and the loss of CN-Brazil is testament to the truth of that statement!

To date, Christiani & Nielsen has operated in 73 countries (listed on the next page) and been active in a maximum of 29 countries in any one year (1963). Structures left in all seven continents of the world are tangible evidence of innovative and technical excellence during the course of 118 years of civil engineering.

Within a few short years after formation in 1904, the partnership of a young civil engineer and a naval officer expanded at an explosive rate into undoubtedly the largest and most geographically spread civil engineering and contracting organisation in the world (and remained as such for several decades) grounded on its unsurpassed technical capabilities.

The history of Christiani & Nielsen is truly unique and, certainly, no construction company will ever replicate its past achievements.

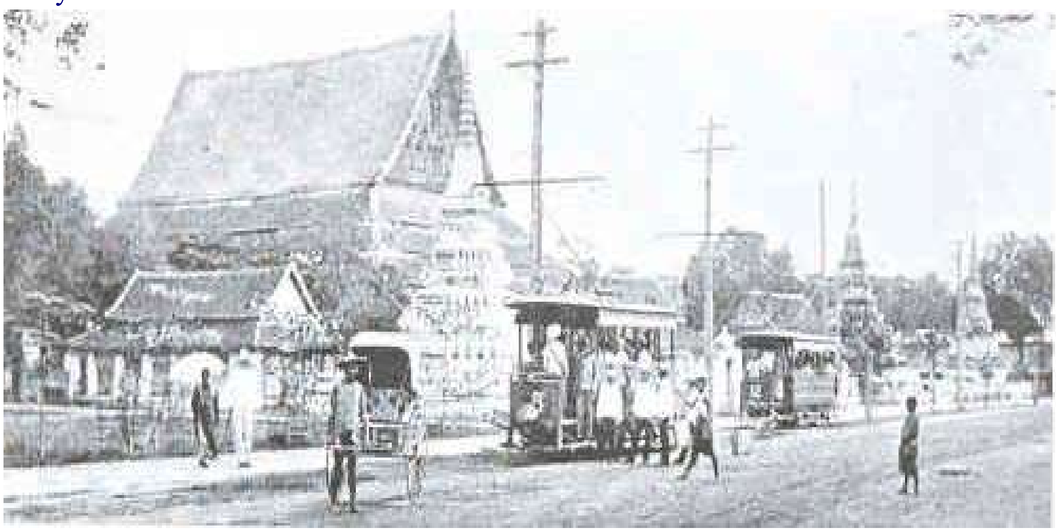
As this chapter closes on the past, so a new chapter opens with Christiani & Nielsen in Thailand carrying into the future the fine reputation and traditions built up throughout the world over more than a century.

Christiani & Nielsen has operated in the following 73 countries (the countries active in 1963 are shaded)

Continent	Country	Continent	Country
Europe	Denmark	Africa	South Africa
	United Kingdom		Egypt
	Finland		Uganda
	Germany		Kenya
	France		Gambia
	Holland		Mozambique
	Norway		Tanzania
	Sweden		Namibia
	Belgium		Sudan
	Ireland		Ghana
	Spain		Mauritius
	Greece		Libya
	Portugal		Guinea
	Estonia		Botswana
	Guernsey		Algeria
	Gibraltar	Asia	Thailand
	Iceland		Malaysia
South America	Brazil		Vietnam
	Argentina		Myanmar
	Ecuador		Cambodia
	Paraguay		Laos
	Peru		Singapore
	Venezuela		Indonesia
	Trinidad & Tobago		Japan
	Bolivia		Turkey
	Columbia		India
	Uruguay		Russia
	Guatemala		Pakistan
	Nicaragua		Qatar
	Jamaica		Bahrain
	Curacao		Saudi Arabia
	Mexico		Dubai
North America	USA		Lebanon
	Canada	Australasia	Australia
	Greenland		New Zealand
Antarctica	Antarctica		Fiji
	South Georgia		

The Future

When Dr. Rudolf Christiani first visited Thailand (Siam) all those years ago in 1928, he saw the potential for development. It is unlikely that he would have envisaged the extent of development that has transformed Bangkok from a tiny centralised city of 38 square kilometres, with a population of 750,000, into a sprawling metropolis covering 1,570 square kilometres, with a population of 10 million or more, and transformed Thailand into an industrialised nation supported by modern infrastructure, and seen its population grow from 12 million to around 70 million today.



Bangkok in the early 1900's above and present day Bangkok below

As intended by Dr. Rudolf Christiani, the Company has played its part in full. Many of the projects completed throughout the country, since establishment 92 years ago in 1930, stand today as landmarks in the development of Thailand, including Klong Toey Port, the Democracy Monument, the Rama VI, Krungthep, Krungthon and Nonthaburi bridges spanning the Chao Phraya River and Ratchadamnoen Boxing Stadium, not to mention the vast number of other marine structures, power plants, roads, bridges, factories and other buildings still in daily use.

The Company is justifiably proud of its achievements in Thailand during the past 92 years, and the part it played in the 118 year history of Christiani & Nielsen worldwide, as it looks to face the many challenges ahead to build on these achievements in the future.

This book is dedicated to the Company's loyal and committed staff, and to the countless number of former employees who still have fond memories of their time spent with Christiani & Nielsen, both in Thailand and in many other parts of the world.

About the Writer

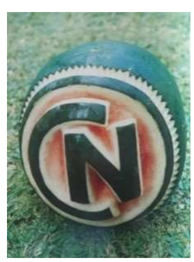
After graduating in civil engineering from Hatfield Polytechnic in the U.K., I began my career working overseas for various contractors/consultants in Zambia, Sultanate of Oman, Republic of South Africa, Saudi Arabia, Iran and Iraq. In February 1981, I started my current journey by joining CN-Brazil to work on a cement plant project in Trinidad & Tobago. After spending a year with CN-Thai on the Gas Separation Plant Jetty Project in Laem Chabang, interspersed with spells with CN-Malaysia, related to preparation of major contractual claims, in January 1985 I transferred as Commercial Manager to the CN-UK Greater Cairo Wastewater Project in Egypt.

Thereafter, in August 1990, I was posted as Commercial Manager (later as Commercial Director) back to CN-Thai, where I remain. I will retire at the end of 2022.

During my time here, I met and married a lovely Thai lady and we have been blessed with two children, a son and daughter.

Let's spread the story of CN back across the world, by copying this to friends and colleagues. Thank you.

Thai fruit carving



Footnote:
To explain the family photo (Message from the Writer), a photographic studio in our village asked to take some photos to help promote their business. Even though I was not so keen to 'dress up', I feel that the traditional Thai costumes reflect the period when the Company was formed 92 years ago.