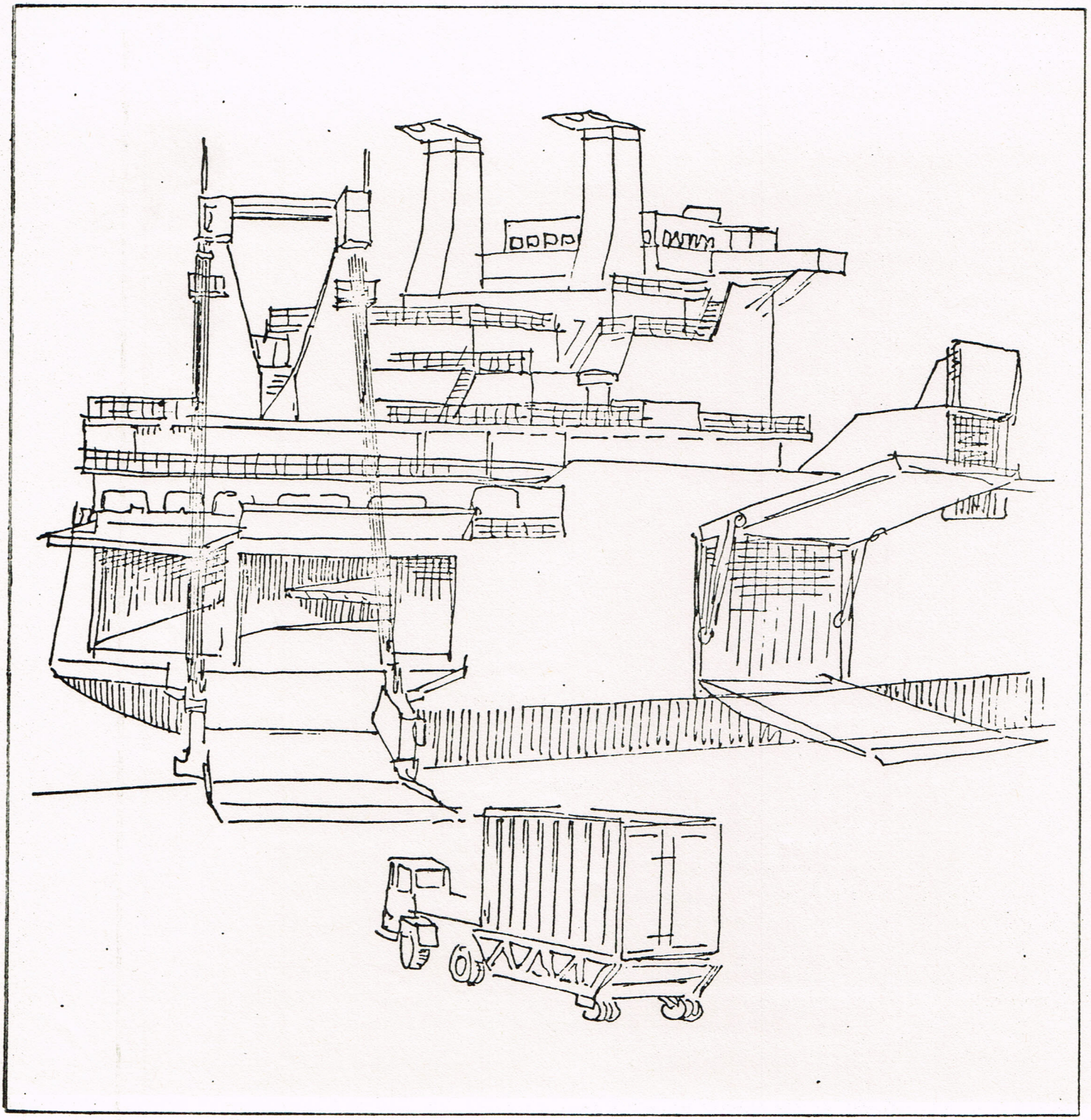
NAVIRE CARGO GEAR

DEVELOPMENTS IN CARGO ACCESS EQUIPMENT FOR RO-RO VESSELS

BJÖRN ANDERSSON
MANAGER R&D
NCG INTERNATIONAL



DEVELOPMENTS IN CARGO ACCESS EQUIPMENT FOR RO-RO VESSELS

Gentlemen,

Asked to prepare a retrospective overview and a future look into developments in CAE for Ro-Ro vessels is indeed no easy task.

Much has been written and much has been said about Ro-Ro vessels and their cargo access equipment during the past 30 years. However, summing up developments in CAE, I believe one has to pay appropriate attention to the development of the vessels themselves.

Identifying the genuine "first" Ro-Ro ship can become rather difficult. Brittish Rail used to claim (not without protest from others) that the first seagoing drive on/drive off vessel was the channel ferry "Dinard" converted in 1947. The "Dinard" was a former rail ferry and this give us the cue to mention the long history of railway Ro-Ro transports - a stream of "wheeled cargo" - developments which is as old as the rail roads themselves. It is only very recently that tendencies to merge with the "rubber-tyred" Ro-Ro technology has been shown.

The first large oceangoing Ro-Ro vessel built as such from the keel, was probably the "Comet" completed in 1958 by Sun Shipbuilding Company. She had a capacity of over 300 vehicles on a deck space of 60.000 ft^2. The "Comet" was equipped with large side ports and ship-to-quay ramps.

The "Comet" was antedated, however, by ships such as the "Carib Queen" - a conversion and probably the first real Ro-Ro to run in Transatlantic service, though that was not her regular trade. The "Carib Queen" was a stern-loader moreover, with doors lowering onto the quay to form twin access ramps and portable internal ramps for moving cargo between the lower and upper decks. The capacity of the "Carib Queen" is given as 92 trailers, 20 vans, 100 cars and 500 tons of general cargo.

The original correct solution of taking trailers and to some extent railway waggons to sea had before the Ro-Ro technology was known, naturally many shortcomings, economical as well as practical. With the Ro-Ro era, the mari-

time world saw very soon coastal as well as oceangoing ships correspondingly equipped.

Besides road trailers, pallets, self supporting units, flats, cars and other rolling stock went by ships proving the Ro-Ro system's flexibility and efficiency. But the big questionmark was economy, when bringing the wheels during comparative long sealegs. The original inventor of trailers at sea was caught economically in the situation but saw an economical improvement by specializing his trailers and separate the vans from the wheels. The vans or, as would be the new name, the containers had to be standardized for several reasons.

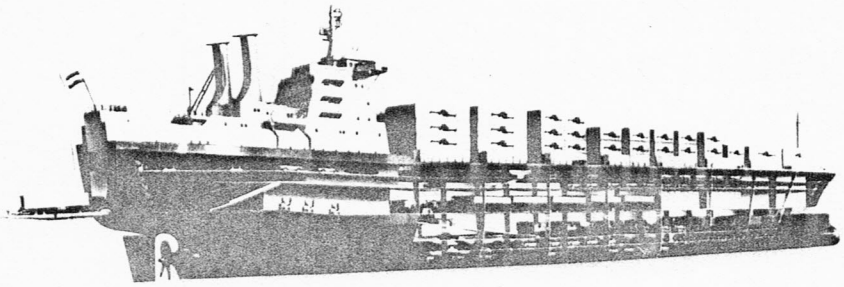
It is interesting to note here a difference of opinion between pioneer British and US Ro-Ro operators, on a question which still occupies the minds of freight economists.

The Atlantic Steam Navigation Company had been very careful to avoid getting involved in the ownership and operation of the rolling equipment. The operators of the "Carbi Queen" on the other hand preferred to use their own trailers and containers despite the capital outlay thus involved.

The mid-sixties can be said being the period when the real cargo-on-wheel era started. Along with the container came myriads of problems for the shipowners. The container standardization came to a halt when the ISO standard was put into effect. But the real harm was also at that time done to the integrated transportation. The ISO standard containers are not now and will not be and economical optimal shore equipment neither on roads nor on railway.

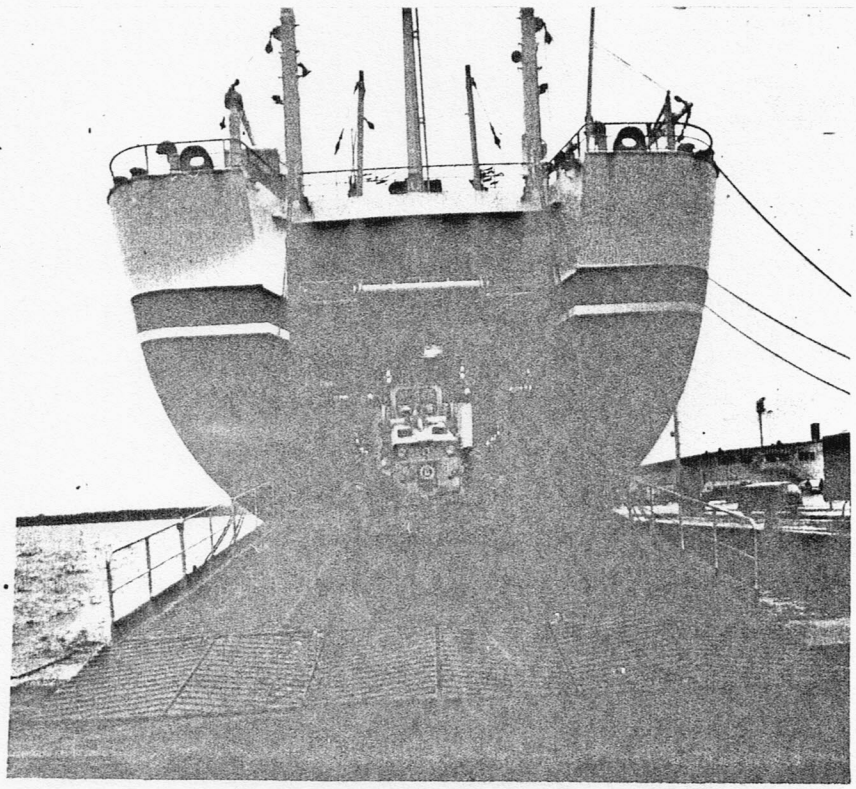
But what did the shipowners do facing the problems of trying to find a workable economic alternative in the face of two incompatibles; an apparently inevitable container revolution and a world where - sadly to say - neither all cargoes nor all ports are adapted to ISO-modules.

The ACL- ships



The Atlantic Container Line was 1966 preparing to demonstrate thet inter-continental Ro-Ro shipping could not only be made to work but might even prove to be the optimum solution. The 4 ACL ships delivered from shipyards in Sweden, Germany and France were of 16.100 dwt with a Lpp of 183 m and a moulded breadth of 27.4 m. Each ship has a capacity of 525 20' containers or 43.000 m^3 of cargo volume for trailors, cars and palletized cargo in holds.

The ship is equipped with a stern ramp of size 17x7m combined with a jack-knife stern door covering a clear opening 6.5 x 6.5 m.
Access to main deck is provided by the stern ramp.
A fixed driveway to D-deck is covered by a 2 section 50 m long ramp cover operated by hydraulic cylinders and winches. Quite a huge trailer access at this time.
6 side doors of size 4 x 4 m provide possibility of truck-to-truck loading.

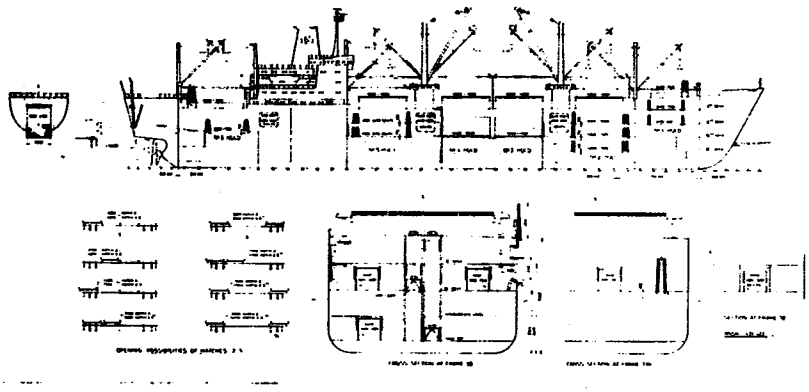


Small internal driveways provide access to tween decks where cars are carried.
Containers on W-deck are handled by shore based cranes. Access to holds are

also possible from 2 flush lift-away hatches in W-deck.

All the 4 ships of this "first" generation ACL ships will during 1975-1976 be lengthened to carry 818 20' containers at 21.000 dwt.

Finnflow

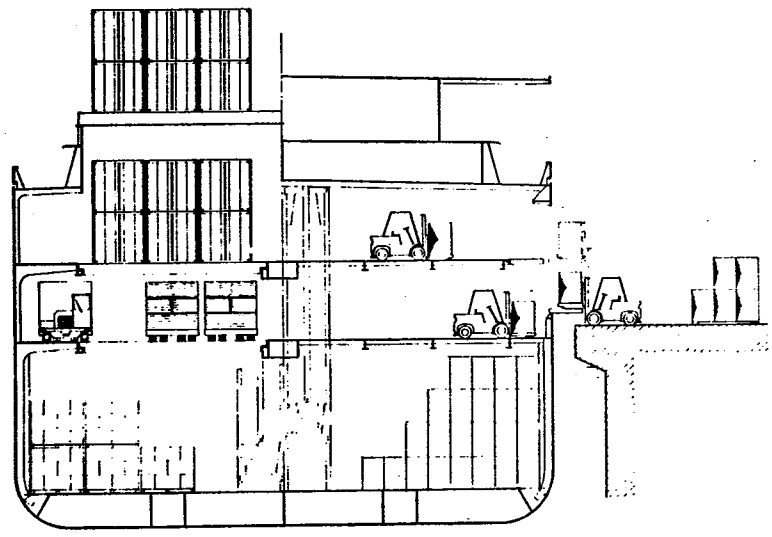


Another combination of lift on/lift off, side loading and Ro-Ro, the so called Finnflow system,was developed for a number of ships delivered by Rheinstahl Nordseewerke to Finnish owner Finnlines Ltd during 1971.

Being a 14.000 dwt ship, for the North Atlantic Trade, she can carry either 52 40 tons trailers of size 9.2 x 2.5 in holds and 132 20' container on W-deck alternatively 469 20' containers all over.

Six hatches on W-deck of side-rolling and high stowing folding type and in tween decks all of folding type permit almots direct spotting of cargo by ships derricks.

Second alternative of truck-to-truck loading is via 6 hydraulically operated upward moving sideports of size 4.8 x 4.8 each having a 5 ton loading platform which can mechanically be located in various heights. The system is supported by 2 3.5 tons wire operated elevators.

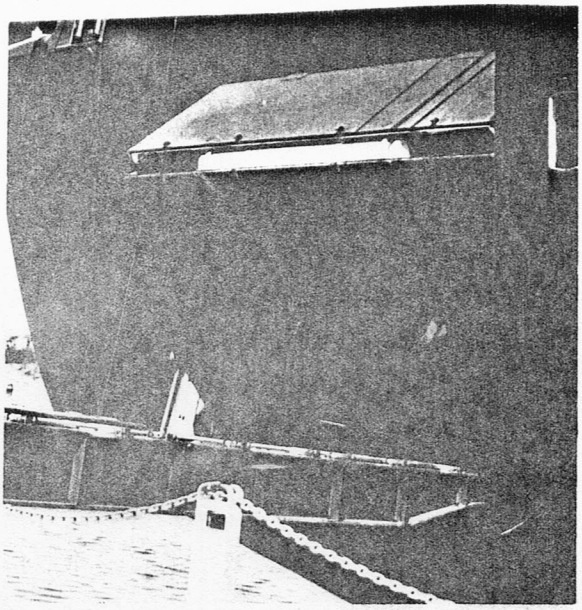


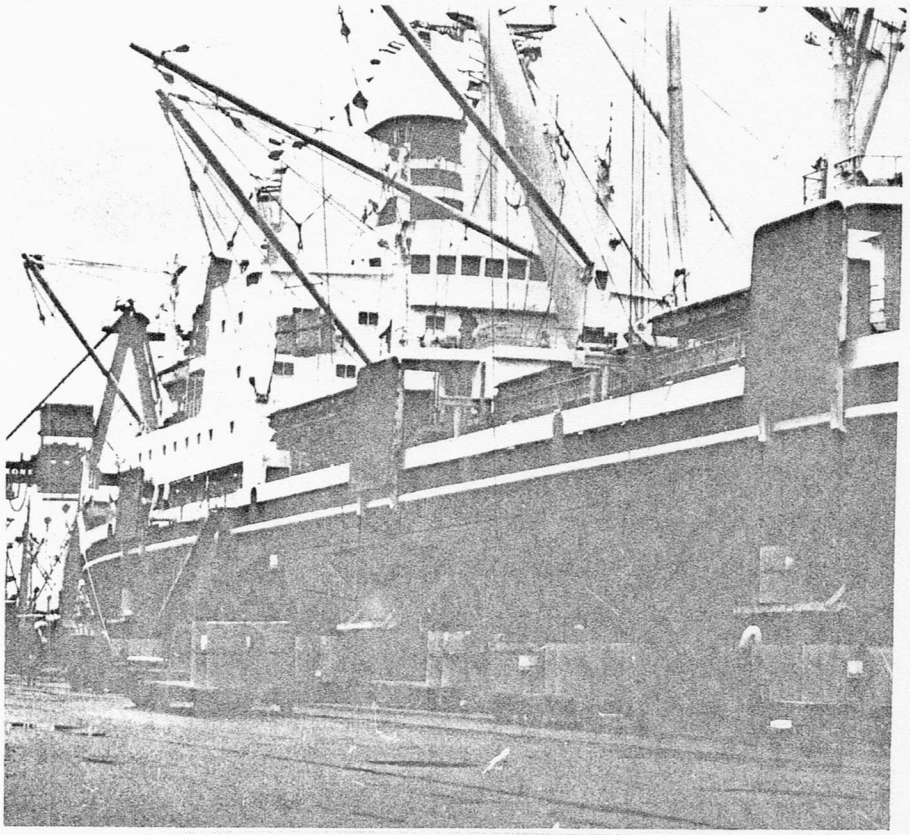
Access between holds using either side- or Ro-Ro loading is achieved by in total 5 sliding bulkhead doors of size 3 x 2.5 m.

The third alternative of loading is the Ro-Ro. A 12 m long and 6.5 m wide straight aft wire operated stern ramp offers possibility to load trailers, carrying cargo, containers, pallets or heavy vehicles. Inside the stern ramp a jack-knife WT stern door is mounted.

Principle particulars:

Lpp	152.9 m
Breadth moulded	25.4 m
Draught	7.315 m
Displacement	23.490 tons
Deadweight	14.260 tons
Speed	20 knots





As can be noted from above 2 types of ships, access to holds is permitted via the stern through a stern ramp of ordinary dimensions, via side doors/platforms able to handle loose cargo, paper rolls etc. and via lift on/lift off by means of ships or shore based derriks. Both systems are carrying trailers or containers on main deck with direct access via the stern ramp and containers on W-deck handled by the lift on/lift off princip.

PAD and Scan-Austral ships

With the development of the PAD and Scanaustral ships access to all decks for trailers and containers using the Ro-Ro technology was provided.

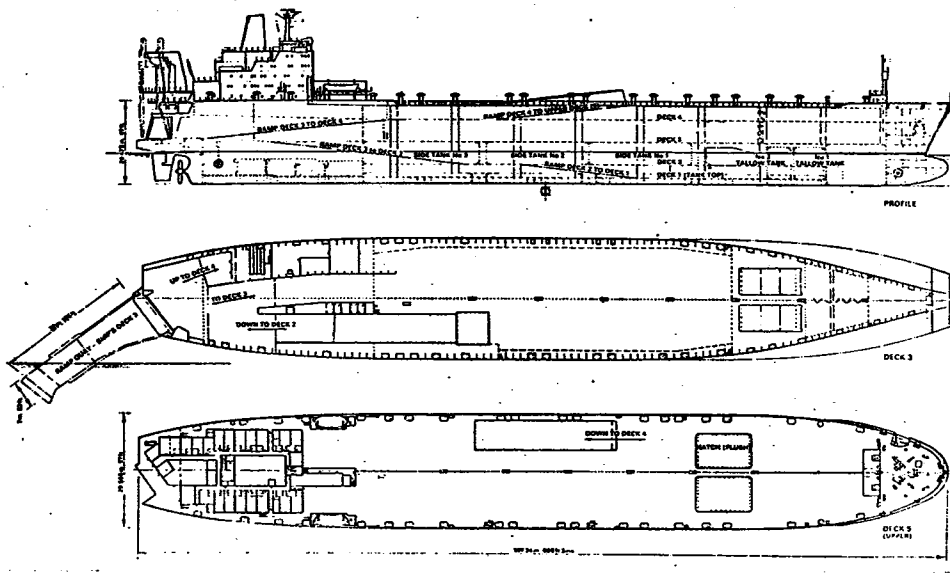
This era marks the real take off for intercontinental Ro-Ro shipping.

The PAD and Scanaustral ships were developed to load and unload from any port without established quays or equipment. The ships can berth in the conventional way alongside marginal quays with tidal differences of quite considerable values. (+ 2.15 m and -5.5 m in relation to main deck).

While the development of previous stern and side door ramps for pallet and trailer loading and fork lift truck working fulfilled most of the demands of normal Ro-Ro operations, none of these designs can be said to have produced a truly "Go-Anywhere" Ro-Ro vessel since they still depended largely on some of facilities normally found in ports.

The ships have the following principal particulars:

Lpp 199.01 m
Breadth moulded 28.65 m
Deadweight 20.225 tons
Loading capacity:
1.800.000 ft^3 equal to
1.200 20' containers



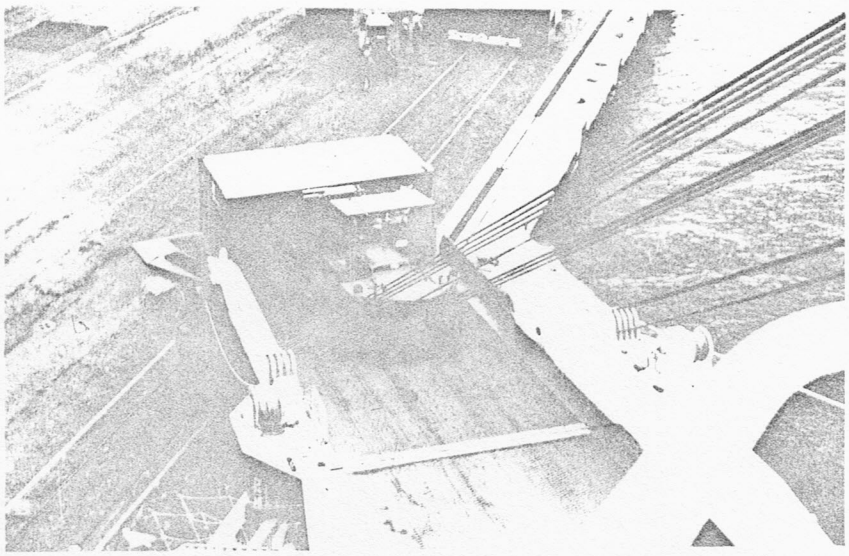
The heart in this system is the huge quarter ramp, a 36 m long x 7 m wide 150 tons heavy driveway enabling 65 tons fork lift trucks of loading 20' containers transverse. The ramp consists of 3 sections, folded around section 1 in stowed position.

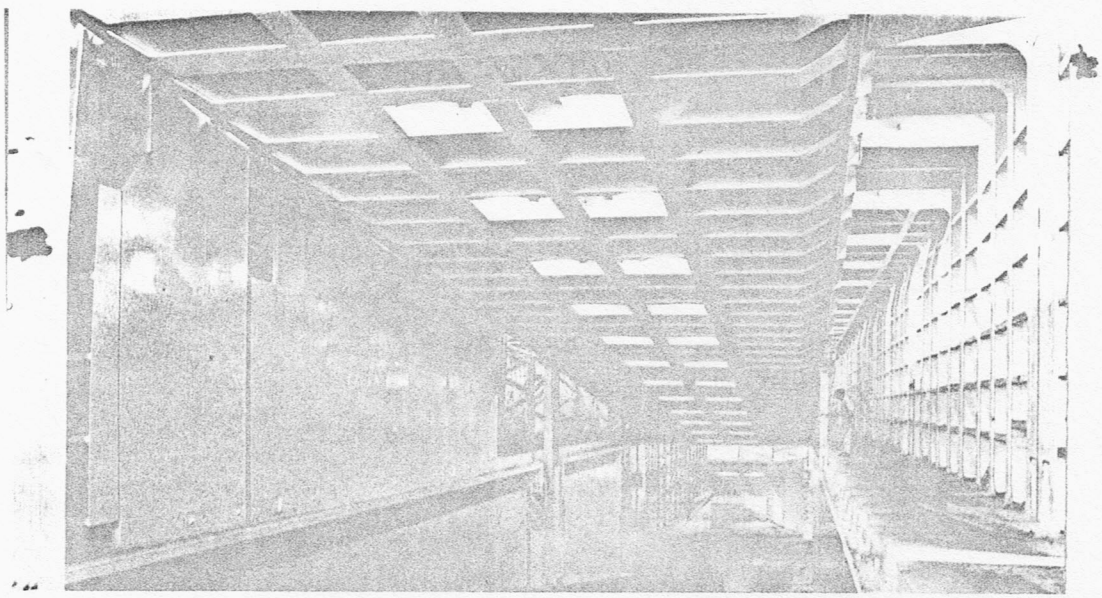
An extensive hydraulic system limits the wharf pressure to 2 t/m^2 and keeps continuously control of slope on the driveway during loading and due to tidal variations.

The PAD and Scanaustral ships feature in my opinion the true sound solution on intercontinental transportintegration as well as acceptable port operating costs and speed.

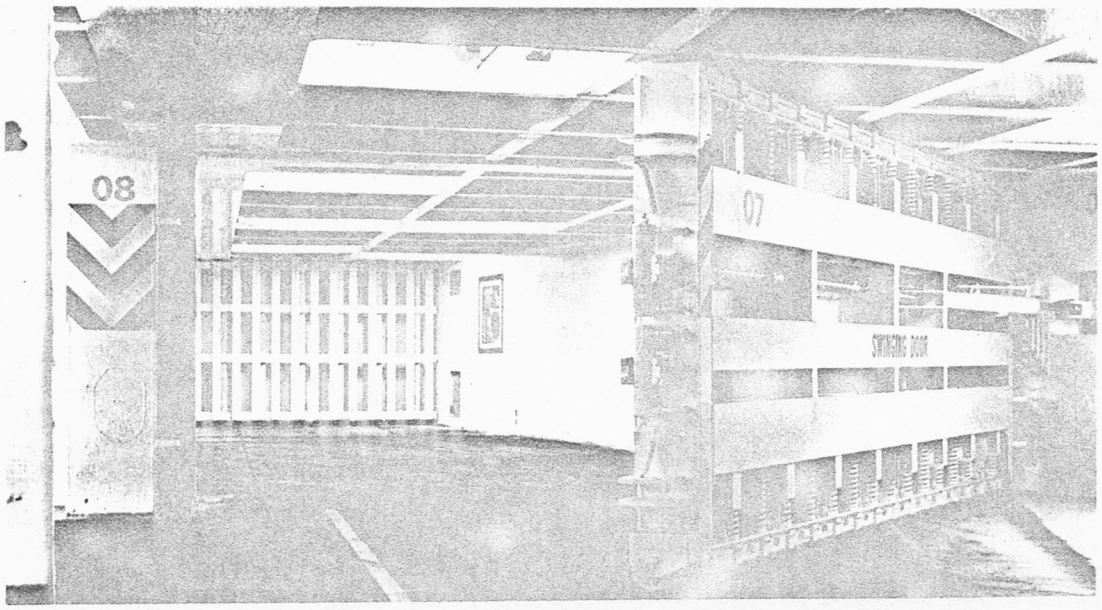
Since 1970 when the PAD Line took the first ship in delivery, the M/S Paralla from Eriksberg Shipyard, a number of approximately 30 ships have been equipped with identical quarter ramps. The development costs of more than US $ 500.000 have been more than justified.

Inside these ships, access to main deck is obtained from the quarter ramp directly. Access to other decks is made by fixed internal driveways built into the ship. In B-deck (main deck) and C-deck 2 ramp covers 52 m x 7 m resp. 32 m x 7 m are fitted above the driveways. These ramp covers are hydraulically operated.





A number of WT bulkhead doors are fitted in the bulkhead between tank top and W-deck so designed that the clear opening is the same as the full tween deck height.



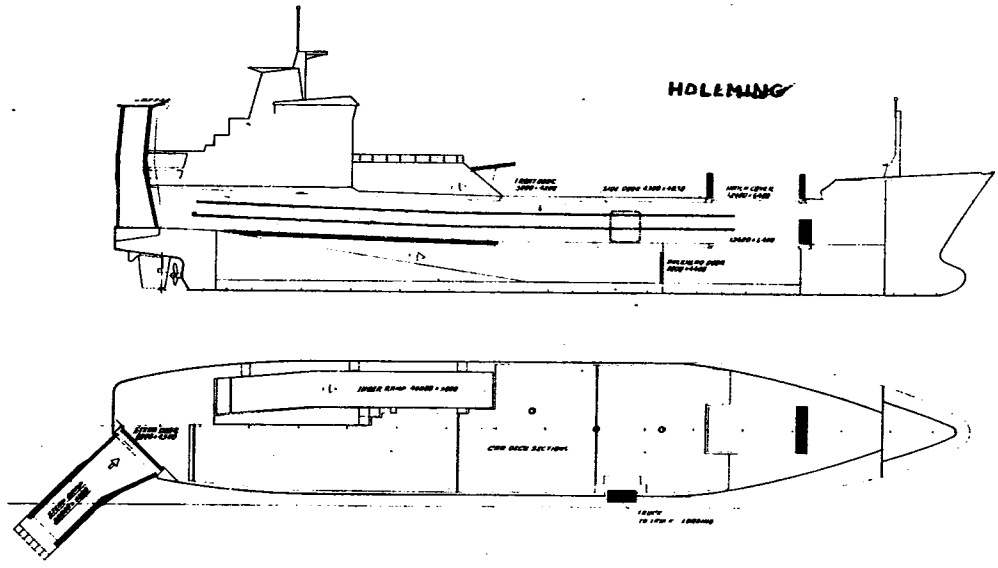
A casing door in the recess from A-deck to W-deck gives access to the W-deck.

The PAD and Scanaustral type of vessels of more than 20.000 dwt represent the oceangoing Ro-Ro's. They are operating between Europe and Australian harbours and the US west coast.

Hollming type Ro-Ro vessels

Medium sized Ro-Ro's for continental use have been developed in sizes of 4.000 - 6.000 dwt.

A serie of 5.000 dwt Ro-Ro ships for USSR from Hollming Yard in Finland represents such a design.



Instead of having a full scale quarter ramp (in fact not possible for such a small vessel and not necessary because of no tidal variations) the vessel is equipped with a 20.8 x 5.0 m quarter ramp stowed in one piece. The driveway consists of 3 sections linked together in that way that certain inclination between sections can be obtained.

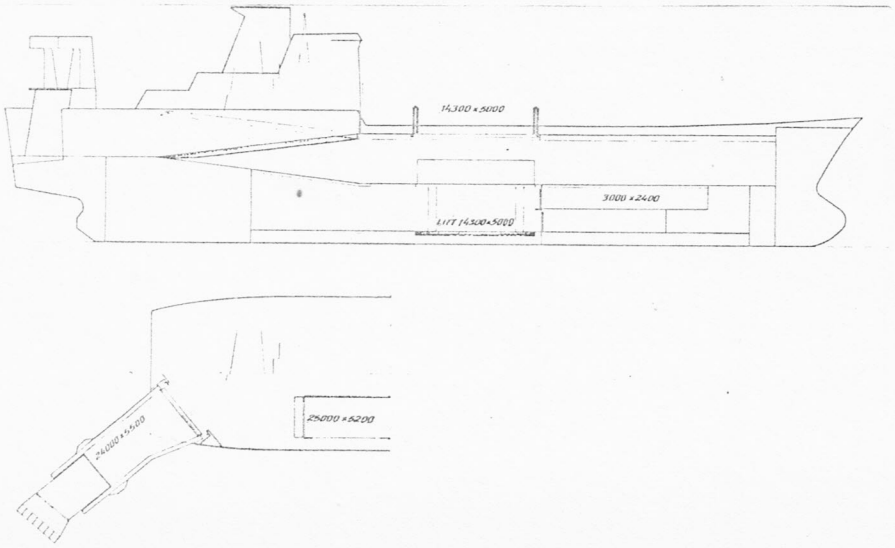
What is more interesting is the way access to W-deck and tank top is obtained. A fixed driveway down to tank top is covered by a WT hinged hydraulically hoistable ramp cover of size 40 x 5 m. In closed position the ramp cover works as a part of the main deck.

It can also reversed be hoisted and form then a driveway to W-deck through a recess ending up with a casing door. The vessel can also be converted to carry cars. The main deck cargo volume is then covered by 2 hanging car decks (1800 m^2) which normally are stowed below W-deck. Direct access to these decks are obtained from the quarter ramp.

Besides what is mentioned, the vessel also feature a side door and 1 hatch cover each in W-deck and main deck.

Ro-Ro vessels of this size will very often feature elevators connecting main deck, lower hold as well as W-deck, eliminating the dead loading space, which in fact an internal driveway create.

The elevators can be of different designs. One solution is a single platform operated by wire falls or hydraulic cylinders.



The platform, normally placed in main deck serves the lower hold. Normal dimensions for loose cargo or paper rolls are 6 x 2 m with maximum capacity of 5 - 10 tons.

A variation of the single platform elevator is the so called "Scissor lift", which operates as as a scissor with a built in hydraulic link system. Such elevators is considered to have a faster speed than ordinary operated platform elevators. A disadvantage is the rather big stowage height of up to 1200 m/m which has to be recessed into the tank top.

Dimensions of single platforms and scissor lifts for trailer use, do very often amount to 15 x 3 m with lifting capacity of 40 - 60 tons.

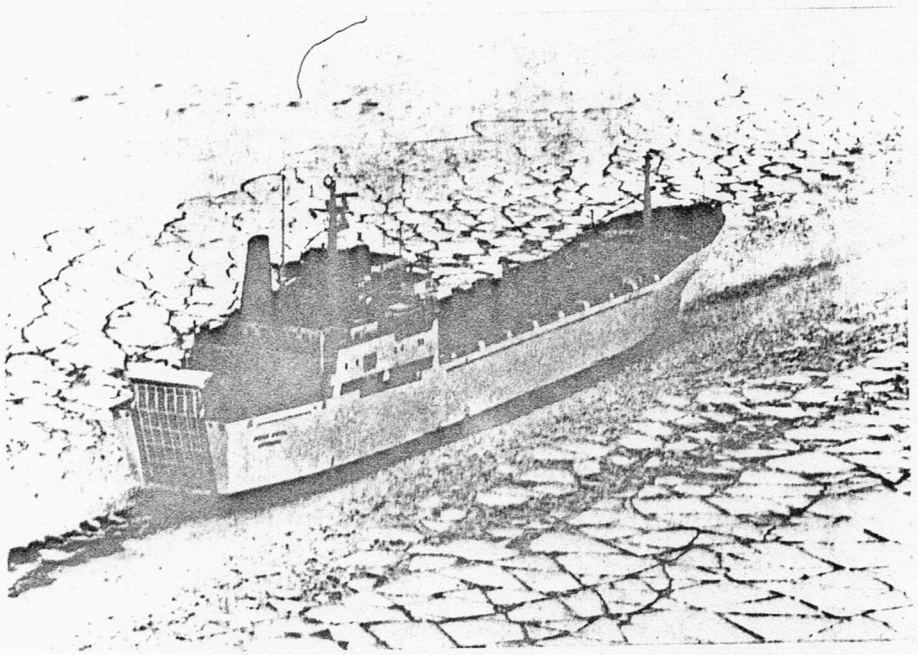
A remarkable high efficient elevator is the double platform design which features as the word says 2 platforms connected by means of hanging stays or pillars. With the double platform design access to 3 decks will be obtained using the intermediate deck as loading/unloading level. Such an elevator increase the loading capability while it never works "empty".

The use of elevators in Ro-Ro vessels can be justified on mediumsized ships where the internal driveways "kill" certain cargo space. However, on certain Ro-Ro vessels of oceangoing size, such as the newbuildings No 60, 61 at Whyalla Shipyard in Australia the double platform elevators can also be seen.

Conventional Ro-Ro access vessels

As a complement to the quarter ramp on medium and small size Ro-Ro vessels the straight aft stern ramp might be considered.

It does not create any heeling moment of the ship, as well as interfere with a conventional hull design of the stern. It can be designed with the same width but can only be of limited length and serve in ports with limited tidal conditions. Such a ramp will never become longer than 20 m.



Cargo handling equipment

Parallell to the development of CAE giving possibility to support bigger and bigger unit loads, the development of cargo handling equipment has of course gone in the same way.

It existsa variety of semi trailers, towing vehicles, mafi-trailers, all aiming to carry as much load as possible.

The following table give you an understanding of which sizes and loads that exist today.

Type of unit	Max length	Max breadth	No of wheels	Max wheelload	Max axleload	Load	Total weight
1. Selfmoving					Boggie 16 tons		
a) Trailer (semi)	20 m	2,5 m	8	4,5 tons	Axle 8 tons	20 tons	36 tons
2. Loading vehicles							
a) Fork lift trucks	9 m	4,5 m	8	7,5 tons	50 tons	25 tons	56 tons
b) Straddle carrier	6,2 m	3,5 m	4	10 tons	20 tons	23 tons	40 tons
c) Side loader	8 m	3,5 m	8	6,5-9,5 tons	40 tons	25 tons	60 tons
3. Trailers	20 m	8,5 m	4-96	2-4,5 tons	5-25 tons	10-150 tons	20-180 tons
4. Towing vehicle			8	4,5 tons	18 tons		37 tons

Such cargo carrying elements require normally a slope of ramps and driveways of not less than 1:6 and not more than 1:10. In average the slope has to be 1:8 which of course determine the length of corresponding CAE structure.

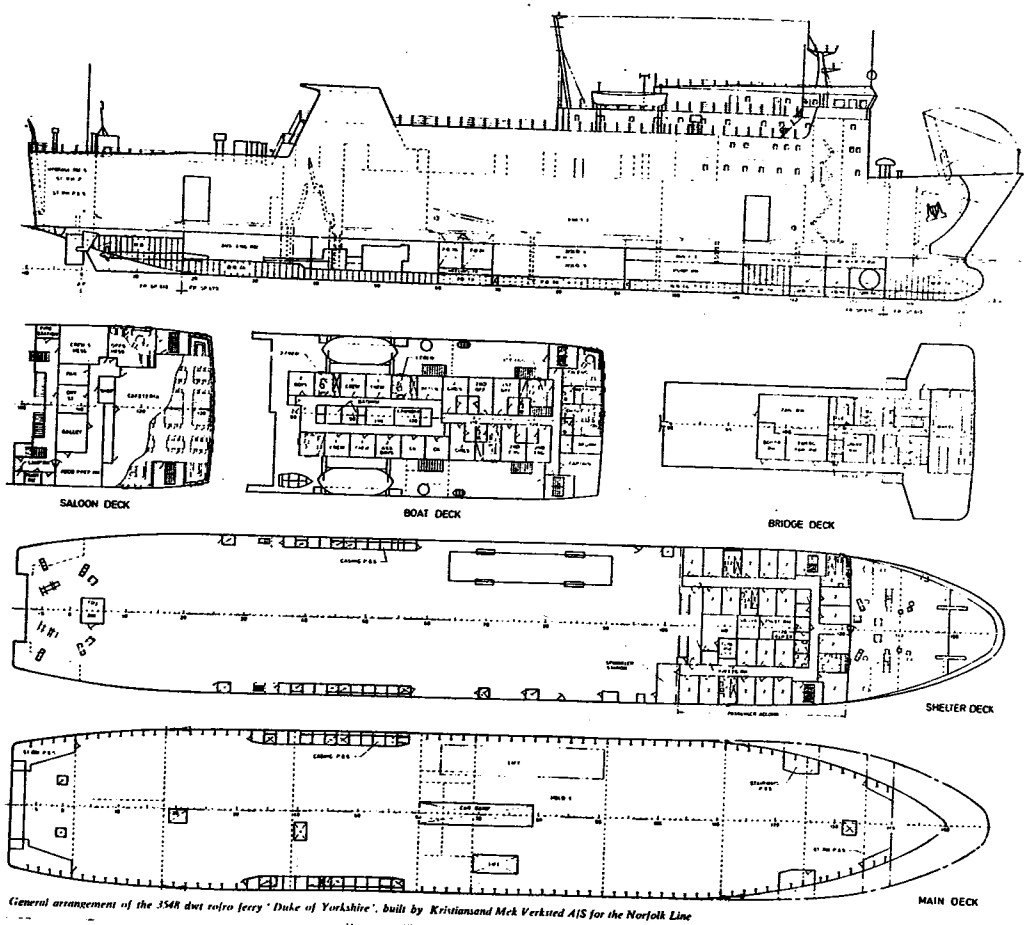
Ro-Ro ferries

The introduction of bow ramps created the "drive-through" ship which greatly decreased turn-round time. Earlier vessels (ferries and coastal size Ro-Ro's did suffer from manoeuvring constraints within the ships themselves due to comparative short sea legs. With the bow ramp, loading and discharging could

consequently be done simultaneously. This particular development also led to the introduction of the now familiar bow visor which was necessary to allow the bow door/ramp to be applied to seagoing ships.

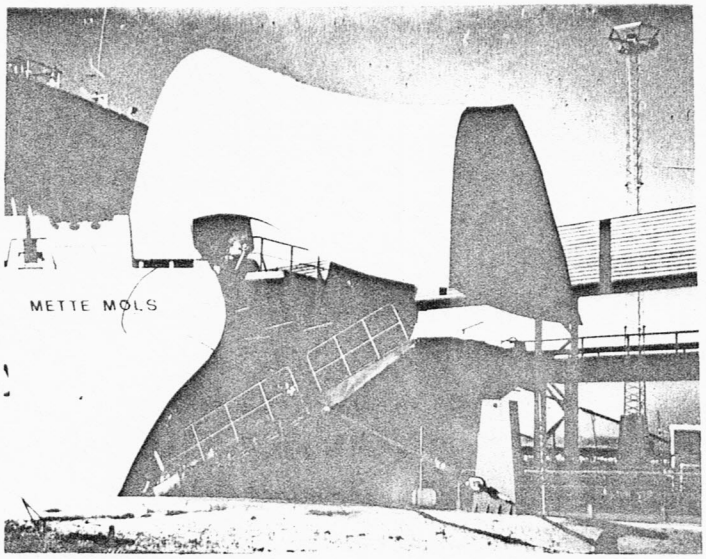
The original operating principle of raising the visor by hydraulic cylinders is still regularly used today. However, utilizing existing windlasses or mooring winches on forecastle deck is also coming into use.

The Ro-Ro ferry "Duke of Yorkshire" built in Norway 1974 for Norfolk Line represents the modern Ro-Ro ferry concept.



General arrangement of the 3548 dwt roro ferry 'Duke of Yorkshire', built by Kristiansand Mek Verksted AIS for the Norfolk Line

Cargo is carried on four decks, upper, main, tween and tank top. Access to lower and upper cargo spaces is provided by two elevators, one to tweendeck and tank top of size 5 x 1,95 m with 5 tons capacity and one to upper deck of size 18,3 x 2,45 with capacity of 42 tonnes. All vehicles and containers are brought into main deck through the stern ramp or the bow ramp. The stern ramp of straight aft design has the dimensions of 9 x 7 m and can carry 55 tons load on a 2-axle trailer.

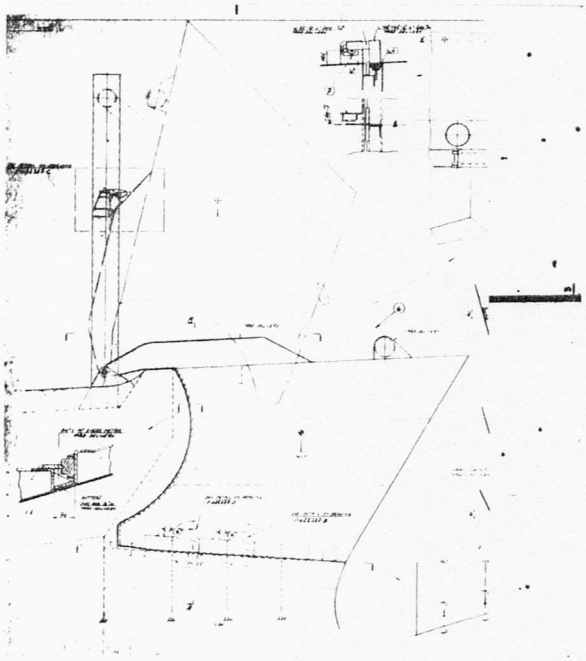


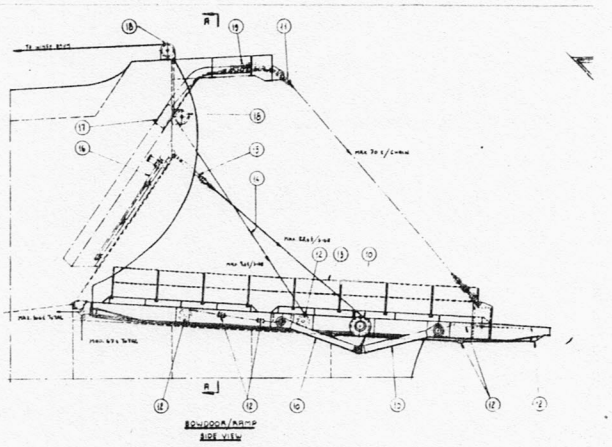
The bow access of the Ro-Ro ferry "Mette Mols" feature a similar bow visor with ramp/door. The cut-out on the hull structure, which the bow visor represents, will in general amount to about 50 - 80 tons in weight. They have to be carefully locked and secured to the hull structure taking into account huge dynimical forces caused by the ship's motion in sea.

The bow ramp extends 1,5 m beyond the bulb and has a breadth of 4 m able to carry a 15 tons 2-axle trailer. Inside stern and bow ramps WT doors are mounted. All equipment are operated by hydraulic power supply.

Multi purpose Ro-Ro vessels

Probably one of the biggest bow visors in the world will be the one on Whyalla newbuildings 60 and 61. The weight of this visor will amount to about 150 tons providing a through passage of clear opening 7,1 m in breadth and 4.75 m in height in the inclined collision bulkhead.





The visor is wire operated by means of the existing windlass. Inside the bow visor is a bow door/ramp in 2 sections installed. The one section works both as ramp and WT door. The total length of the ramp is 14,4 m protruding

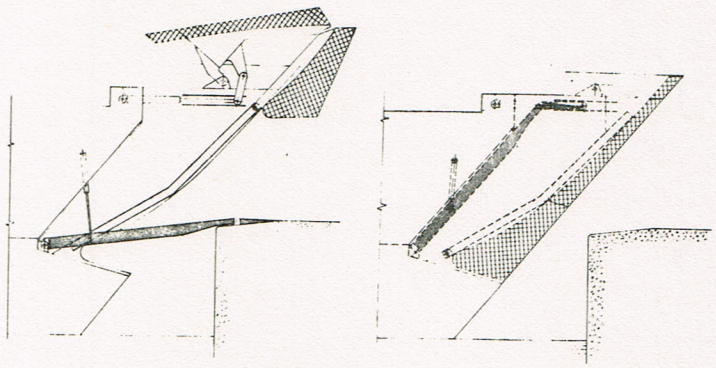
4.3 m beyond forward p.p. and having a driveway of 6.1 m. The ramp is operated by wire and folded in stowed position.

A forklift truck with 53 tons axle load and 13.5 tons wheelload can pass over the ramp.

The Whyalla newbuilding 60 will be a highly sofisticated Ro-Ro vessel featuring besides the bow access also a quarter ramp of PAD-type and 3 double platform elevators serving tank top and upper deck.

One of the strongest requirements from the owner was to have as much operation as possible by electric power supply. Therefore all CAE except the quarter ramp will be operated by electric winches and secured by cleats operated by electric ball screw actuators.

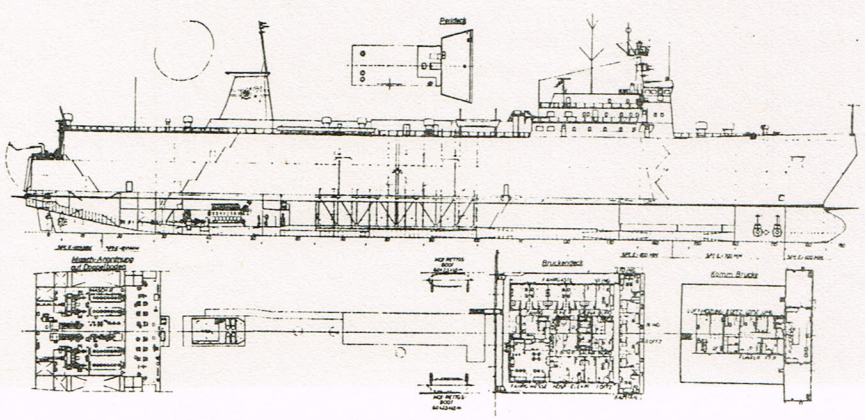
A different shape of bow visor is the one developed for the Finnish gas-turbine powered ferry "Finn-jet". It is a 2-section visor resulting in minimum cut out in the hull and consequently decreased power to open.



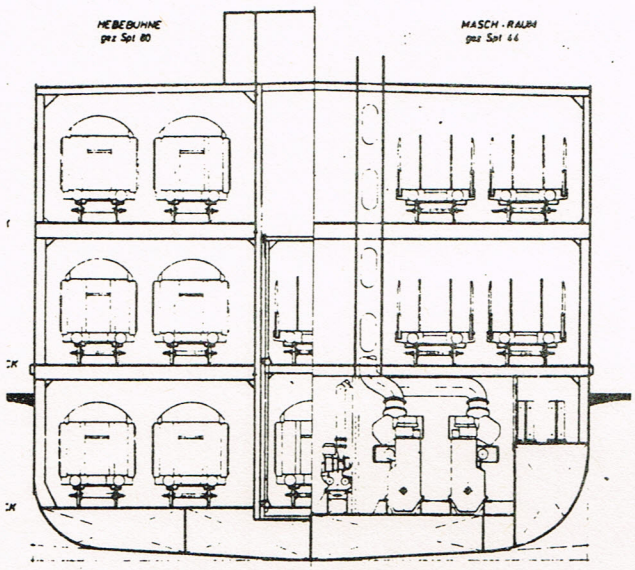
Bow arrangement, developed by Navire Cargo Gear for Finnlines' gas-turbined "Finn-Jet" ferry.

Railway Ro-Ro vessels

Starting this paper with the railferry "Dinard" I will also end the look back with an-up to date railway Ro-Ro vessel.

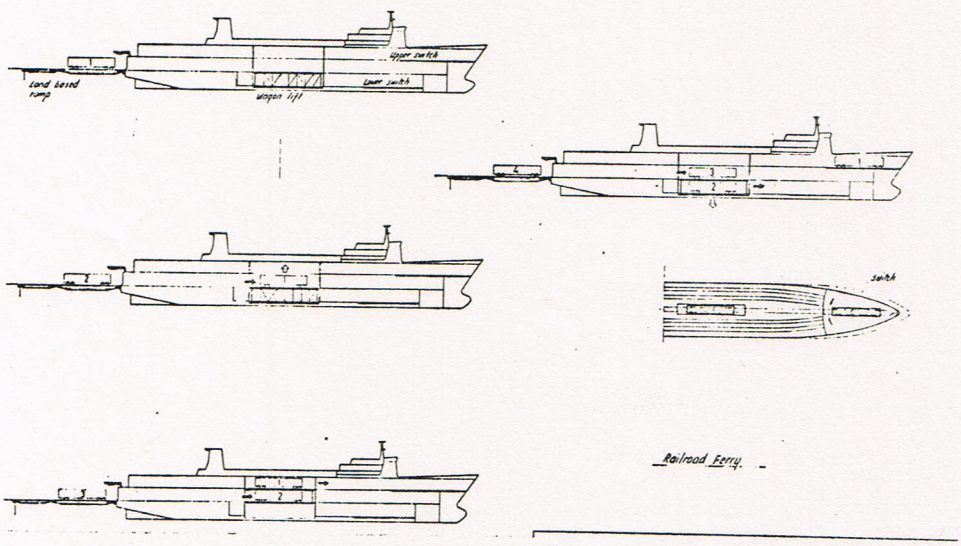


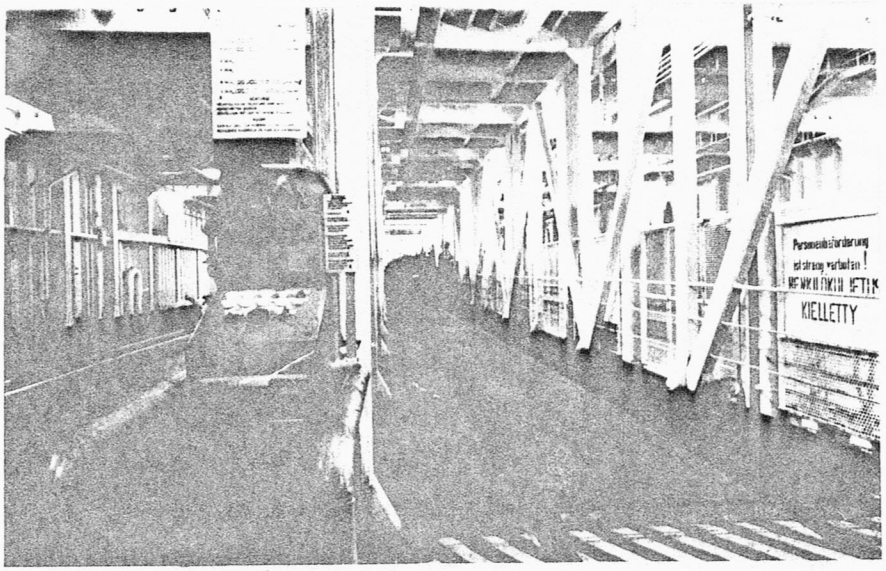
The vessel "Railship 1" serving Germany and Finland was delivered 1975 by Rickmers Verft in Germany. Her Lpp of 139.2 m and her moulded breadth of 21.6 m with a deadweight of 7.100 tons makes her the biggest ship of this type in the world. She can carry 60 waggons of length 20 m or 37 waggons of length 27 m on 3 decks.



Five rails in each deck are interconnected by rail switches and a double platform elevator.

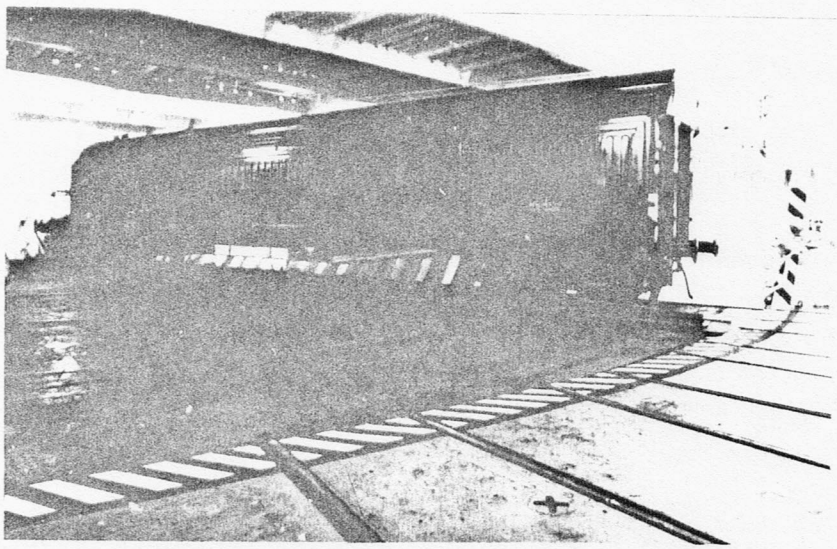
The main deck serves as the entrance deck and access to main deck is provided by a stern door of size 12.6 x 5.0 m and a shore based ramp.





Access between upper deck and tank top is provided by a double platform elevator of size 28 x 3.5 m with maximum lifting capacity 84 tons.

In upper deck and tank top rail switches are mounted to direct the waggons into 5 rails on each deck. The main deck rails are served directly by the shore based ramp.



At the moment Bulgarian and USSR owners have placed orders for another four railway Ro-Ro vessels built on the same princip as "Railship 1". The elevator capacity will however be increased to 170 tons.

The future

And what is then coming next in the Ro-Ro technology? What are the problems within the oceangoing Ro-Ro concept and what will the possible solutions look like.

It is evident that the Ro-Ro system is highly flexible in itself and in relation to its surrounding, which means that the potential for future develop-

ment is by far exceeding any other system where a world-through system is a must for success.

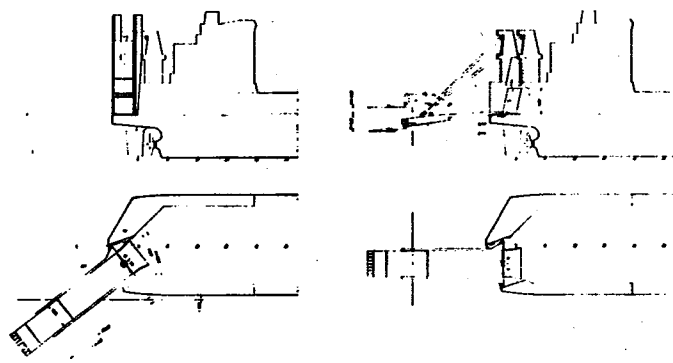
It is easily understood that all different types of cargos to go with one and the same ship presents many administrative and pshysical probelms. Nevertheless this is done today on various trades and regular scheduled traffic.

Each type of unit is basicly accepted onboard the Ro-Ro ships and even loose cargo stowed onboard. Achieved turnover per day is between 2000 tons and 7500 tons weight, which is pretty close to the best lift on/lift off containerships, cost per ton is very favourably. But it is essential that achieved results are improved drastically.

Always present is the desire to increase the cargo handling capacity. The increasing costs in terminals to prepare the Ro-Ro commodities for fast loading will call for a solution where cargo can be taken directly from the storage, the more in one go the better, into the ship.

Already today one can realize the need of taking heavy loads onboard the ship. For the PAD and Scan-Austral ships heavy loads have during some years been loaded via the quarter ramp, loads of up to 180 tons. Knowing that the ramps originally were designed for 65 tons trucks, quite small reinforcements have been made to accomodate such huge cargos.

A further development of the quarter ramp will most probably be a slewing ramp providing access to the ship both from PS and SB. For a couple of years such demands have been raised in shipping circles, however by analysing the manoeuvrability of the ship the requests have been turned down so far. Still, I believe, we will see such a design not far away.



The quarter ramp will most probably in the future also be widened to say 15 m, providing double traffic or handling 40' containers by fork lift trucks.

I believe that in the future super size units will be interesting to load onto the ship. Units of 100 - 1000 tons, in other words a complete cargo shed with the shape of a deck with cargo ready lashed and all.

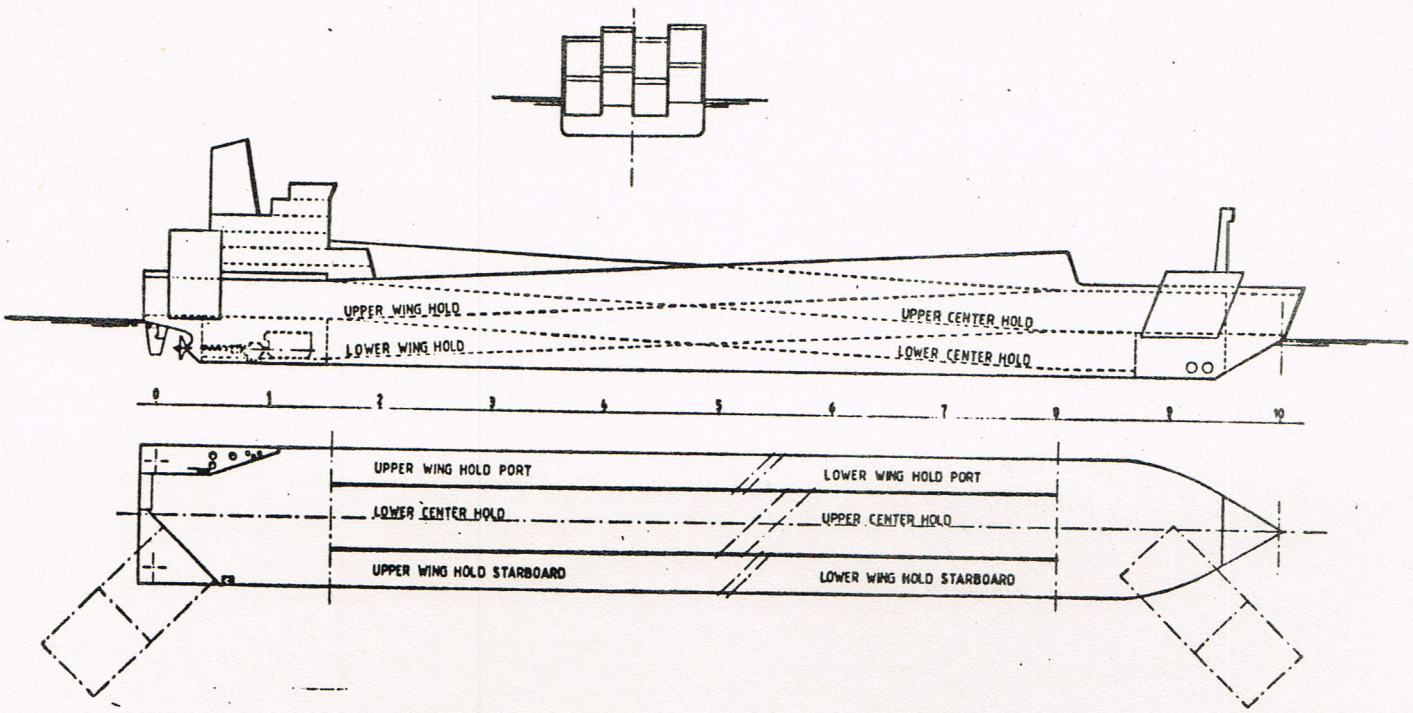
In this respect some interesting solutions have been presented lately. The so called LUF-system is today transporting four 20' containers or comparable sized flats with pulp or paper etc. within port terminals and onboard Ro-Ro ships.

Further developments of this system is aiming for handling eight 20-feet or siz 40-feet containers simultaneously. In other words approx 150 - 200 tons gross weight handled in one move. Ten moves an hour, 8000 tons in the forenoon! I say this is something. But we know how far different it is between theory and the moment of truth. But get cracking on constructing a rolling unit of say approx 500 W-tons payload or approx 1500 m^3 volume suitable for terminal movements and possible to roll or move onboard a ship would be a challenging idea.

How will the inside structure of the vessel look like? Is there any genius solution in arranging the interior ramps in a much more efficient manner than that seen today? Is there any technical solution to assisting the trucks or units to climb up the ramps faster or with less effort thereby minimising the exhaust fumes and shortening the cycle times?

Would <u>this</u> lay-out be the Ro-Ro vessel in 5 - 10 years and would there be a need of an alternative, say a standard "ro-Ro SD -14 vessel"?

The pioneers deserve all honour, but the superbly flexible and efficient Ro-Ro giants of today would not have been possible but for the technical developments gained over the past decade.



PRINCIPAL PARTICULARS:

LOA	220 M
Lpp	211 M
B	26 M
Dm	24 M
d	7 M

QUARTER RAMPS:

L	52 M
B	15 M
SLOPE	1:8
AXLE LOAD	50 TON
TOTAL LOAD	400 TON