Roberto Vidal

Irruption of the Trailer Jumbo in the Dredging Industry

Abstract

Since 1994 the dredging industry has seen a major change — the introduction of the "trailer jumbo" as it has come to be called. In that year the first trailing suction hopper dredger (trailer) with a hopper capacity of 17,000 m^3 was launched, marking a 40% increased in capacity with the next largest trailer. Since then eight more of these huge new trailing suction hopper dredgers have been built and the process is continuing. With these "trailer jumbos", dredging companies are leading the way in making gigantic infrastructure projects economically feasible.
If dredging in the 20th century can be divided into three epochs, the first would be the opening of the Panama Canal in the early part of the century; the second, the enlargement of the Suez Canal in the 1950s; and the third is the on-going land reclamation projects in Southeast Asia, which have been made feasible by the introduction of the Trailer Jumbos. This paper concerns itself with this last phenomenon.

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Introduction

Not even the most optimistic mind could have imagined what was to happen. It all began one day in 1994, when a trailing suction hopper dredger (a trailer) with a hopper capacity of 17,000 m^3 was launched in the dredging industry. At the time the largest hopper held 12,200 m^3. The new trailer's equipment capacity was 40% greater (Figure 1).

It did not seem to be the most appropriate time for such a great increase in capacity. The demand for dredging work was on the decline. The boom in activity resulting from the works in Hong Kong appeared to have peaked. The construction of the emblematic Chek Lap Kok Airport, which included 238 million cubic metres of dredging, seemed like a dream that would be difficult to repeat in the future of the dredging industry.

But once again the initiative of the dredging companies emerged as the driving force of change and development. In the following six years, eight more of these huge trailing suction hopper dredgers have been built. All together they cost the dredging companies over 870 million euros. And the process does not seem to be stopping.

Meanwhile, the market responded positively to these brave initiatives. At the same time as these large trailers were incorporated into the dredging industry, gigantic fill projects have been started around the world, especially in Southeast Asia.

Approximately 300 million cubic metres of material are being dredged and used for fill in the first three

Figure 1. In 1994 the Pearl River with a capacity of 17,000 m³, was launched. This is now viewed as the beginning of the era of Trailer Jumbos.

stages of the "Reclamation of Jurong Island & Tuas Extension" project in Singapore. The following stages 4.1 and 4.2 have already been awarded and involve 260 and 540 million cubic metres of material respectively. To date, the Jurong & Tuas Project represents four and a half times the volume dredged for the mythical Chek Lap Kok Project.

Dredging in Hong Kong has also recovered its level of activity. Important land reclamation jobs have been tendered and awarded such as the "New Hong Kong Disneyland at Penny´s Bay" project with 100 million cubic metres of dredging and fill and the Containers Terminal No. 9 project with similar volumes.

It is only with these new large sized trailing suction hopper dredgers, which are being called "Trailer Jumbos", that these gigantic infrastructure projects can be taken on under economically feasible conditions. These units are giving the most satisfactory response to the requirements of these projects.

There have been three essential moments for the international dredging industry in the twentieth century. The first was at the beginning of the century with the opening of the Panama Canal. The second was the enlargement of the Suez Canal in the 50's. And the third great moment is occurring today with the land reclamation projects in Southeast Asia. The economic growth rates foreseen for the next few years indicate that the moment will be a lasting one.

Without a doubt, the "trailer jumbos" are the great protagonists of this last essential moment in the dredging industry, and they are therefore certainly worthy of attention and analysis.

What is a Trailer Jumbo?

First, it is necessary to define what is understood by "Trailer Jumbo". It can be defined as a trailing suction hopper dredger with a hopper capacity over 16,000 m³. To give an idea of just how big this is as a dredger, trailing suction hopper dredgers, or trailers, have been classified here into four main groups by size of hopper:

- Small Trailers: up to 3,000 m³ hopper capacity
- Medium Trailers: between 3,000 m³ and 8,000 m³
- Large Trailers: between 8,000 m³ and 16,000 m³
- Trailer Jumbos: over 16,000 m³ hopper capacity

Although with some risk of inaccuracy because of the large number of trailers that exist, Figure 2 compares the basic dimensions of the average type of dredger from each of the above groups.The dimensions considered are length, beam, depth and draught with maximum load. The maximum and average dredging depths are also given.

Table I shows these characteristics. As mentioned, there is a wide variety of individual characteristics amongst the different dredgers within each group. Although they are only estimated averages, Figure 2 serves to visually place the dredgers within the different groups.

Table I. Basic data of average Trailers.

Group	Hopper Capacity	Length	Breadth	Depth	Draft Dredging	DWT	Total Installed Power	Normal Dredging Depth	Dredging Depth With Extended Pipe	Group Maximum Dredging Depth
	(m³)	(m)	(m)	(m)	(m)	(t)	(HP)	(m)	(m)	(m)
SMALL	1,500	75	13	5.5	4.5	1,700	4,500	–20	–25	–45
MEDIUM	6,000	100	19	9.5	8.0	9,000	14,700	–25	–35	–50
LARGE	10,000	135	23	10.5	9.0	16,500	17,200	–35	–50	–78
JUMBO	20,000	160	30	13.0	11.0	30,000	35,000	–60	–100	–131

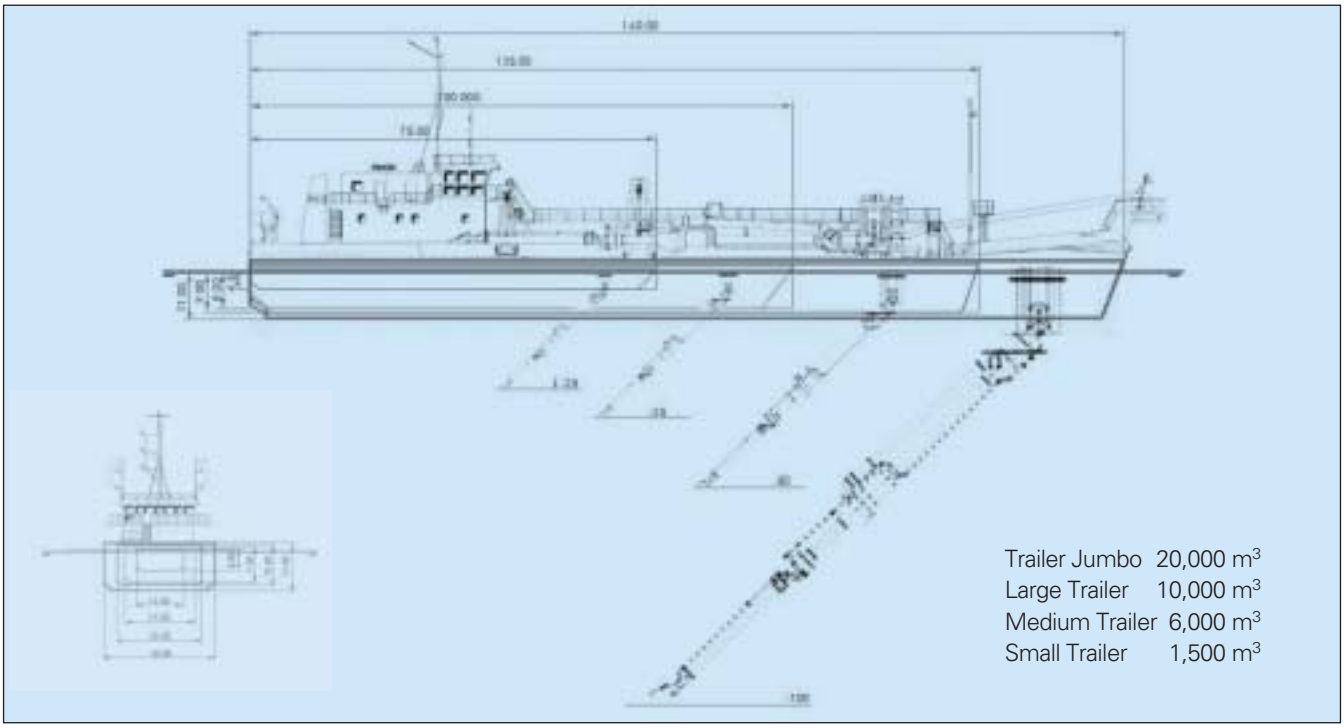


Figure 2. Basic dimensions (metres) of average trailers.

The Arrival of the Jumbos in the Fleet of Trailers

The arrival of the Jumbos in the dredging fleet had an enormous multiplying impact on the total hopper volume available on the market, especially in the large trailers group. It is well known that this type of dredger is ideal for extensive land reclamation projects located far from where the material is dredged.

Actually, in 1993 there were 18 units in the large trailer group, that is, with hoppers over 8,000 m3. The total combined capacity of this group was 164,200 m3. Both of these aspects are reflected in Figure 3, that indicates the number of trailers existing in 1993 in each size group

Figure 4 shows the total hopper capacity of each group. The capacities have been calculated by adding the volume of the hoppers of all the dredgers within each group.

From that year to the end of 2000, 41 new units have been added to the dredging fleet. Figure 5 shows the distribution of the sizes built, four large trailers and nine trailer jumbos.

Figure 6 gives the total combined hopper volume of the new trailers that have been built. It will be noted that the Jumbos represent only 22% of the units built but provide 58% of the 333,100 m3 combined hopper volume incorporated on the market.

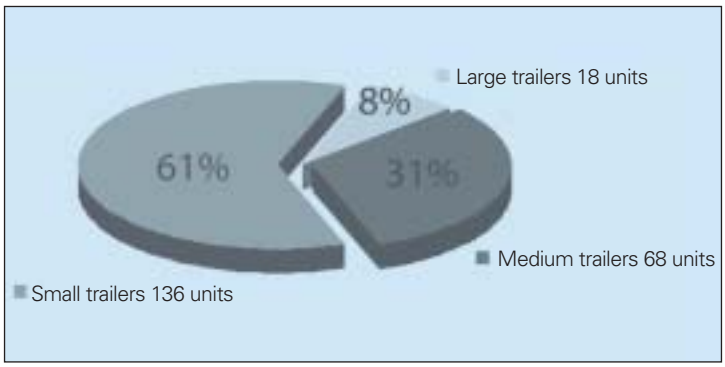
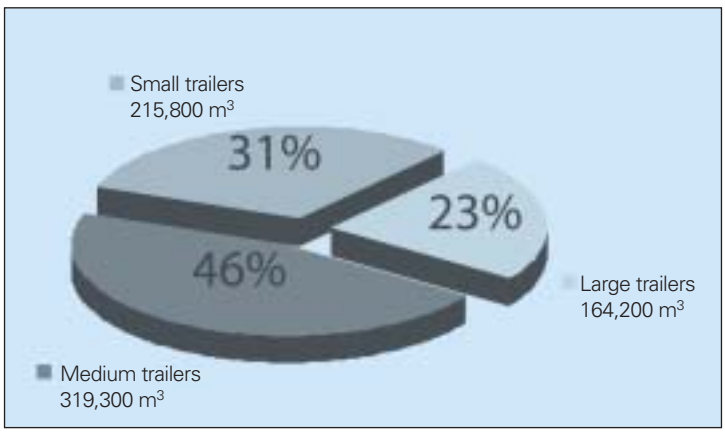


Figure 3. The number of trailers in 1993 in units and percentages.

Figure 4. Total hopper capacity (m3) of each group of trailers in 1993.



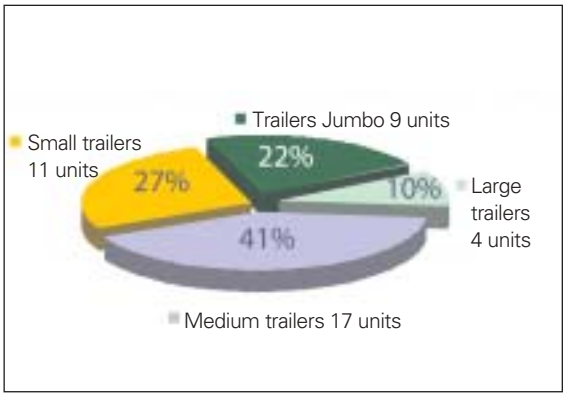
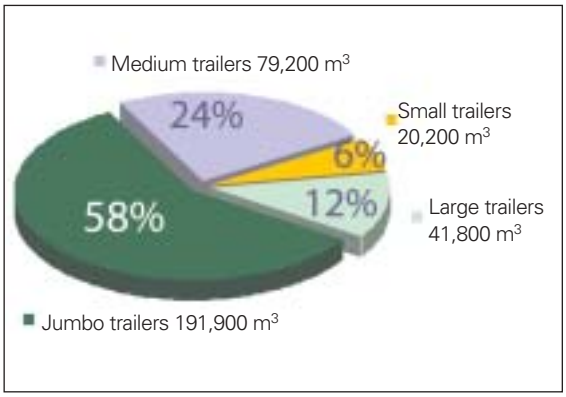


Figure 5. New trailer construction between 1993 and 2000.

Figure 6. Total hopper volume added between 1993 and 2000.



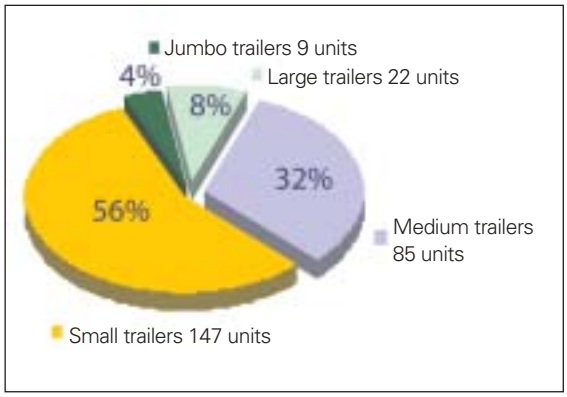
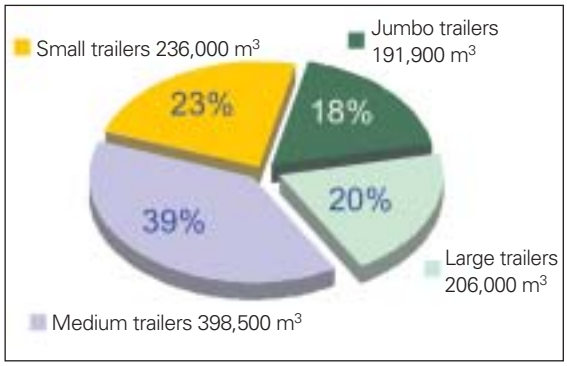


Figure 7. Number of trailers and percentage of trailer sizes in 2000.

Figure 8. Total hopper capacity of the fleet in 2000, in cubic metres and percentages.



The configuration of the fleet of trailers in 2000 is shown in Figures 7 and 8 — the first representing the number of units existing in each group, and the second, their combined capacities.

The total combined hopper volume existing in 1993 increased by 333,100 m3, of which 191,900 m3 corresponds to the Jumbos. While the total number of trailers only grew by a bare 18% in the mentioned period, the total capacity of the Fleet is 48% greater, having increased from 699,300 m3 to 1,032,400 m3 .

These aspects can also be seen in Figure 9 that compares the fleets of trailers in 1993 and 2000.

The fleet's capacity for large reclamation projects, that is, the trailers with hopper capacities over 8,000 m3, has grown spectacularly during these last six years. In fact, the addition of 13 trailer units to the 18 that existed in 1993 has multiplied the total capacity by 2.4, that is, from 164,200 to 397,900 m3. And this tremendous jump in capacity was mainly a result of the appearance of the Jumbos.

Figure 10 shows the innovation in large trailers as a result of the trailer Jumbos. This graph considers the larger sized dredgers that includes large size trailers and Jumbos. The trailers under construction or with firm order have also been included. There is a column for each dredger, all of which are listed in the margin. The nominal hopper capacity of each dredger is established on the Y-axis.

A distinction is also made between the trailers built before and after 1994. It is amazing to observe several facts:

- The first is the spectacular increase in the hopper volume of the first Trailer Jumbo that was built in 1994, Dredger no. 11 in the graph, in relation to the largest one that existed at the time, no. 17 in the graph.
- The second is the abrupt change in the growth tendency curve for the hopper volume in 1994.
- The last is the new change that occurred in 2000 with the construction and commissioning of a 33,000 m3 trailer. It seems that the era of the "Mega Trailers" is coming into sight.

The Fleet of Trailer Jumbos

Today, there are nine Jumbo trailers in operation. They are mentioned in Table II that also shows their most important general characteristics (Figures 11 and 12).

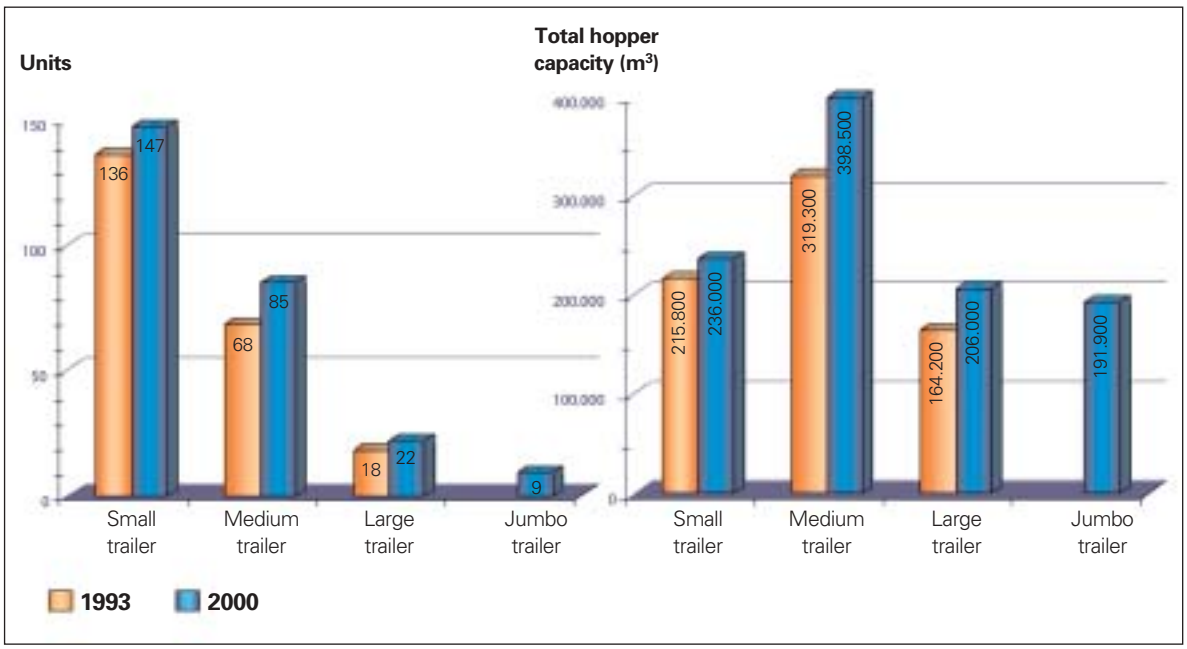


Figure 9. Trailers in 1993 and 2000, compared by units and by hopper capacity.

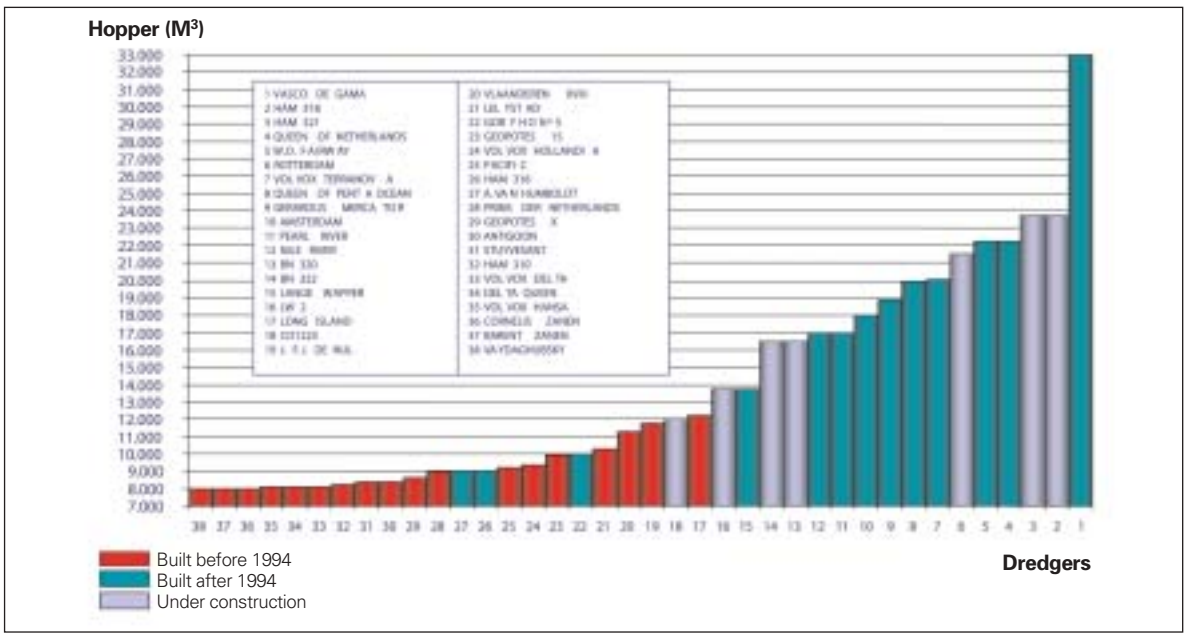


Figure 10. Chart of large and jumbo trailers in 2000.

Table III indicates the most significant specifications of the five trailers that are currently under construction or for which there is a firm order. It may very well be that when this article is published, some of them will have already been delivered (see Figures 13 and 14).

This data brings to light the three main characteristics that distinguish these units in dredging work:

1. The Jumbos have a tremendous load capacity, between 24,000 and 58,000 dwt. To this characteristic must be added the great engine power that allows them perform the dredging and unloading activities quickly and to navigate at great speed, between 15.5 and 17.3 knots. These virtues make the Jumbos irreplaceable for jobs for which large amounts of material must be transported from an extraction point located at great distance from the final delivery site (between 30 and 100 miles).
2. The Jumbos have increased the possibilities of dredging in deep waters. In fact, they are all capable of dredging in depths of at least 60 metres. Most can work at 105 metres, the current limit

Table II. General characteristics of Jumbos.

	Pearl River	Amsterdam	WD Fairway	Gerardus Mercator	Queen of the Netherlands	Volvox Terranova	Queen of Penta-Ocean	Nile River	Vasco da Gama
Year built	1994	1996	1997	1997	1998	1998	1999	1999	2000
Builder	IHC	De Merwede	Verolme Scheep.	IHC	Verolme Scheep.	IHC	IHC	IHC	Krupp/ Thyssen
Hopper capacity	17,000	18,000	23,347	18,876	23,347	20,016	20,000	17,000	34,350
Top coaming (cm)									
Lightweight (tons)	10,112	1,606	15,950	13,782	16,512	12,686		10,700	20,485
dwt (tns)	24,746	24,420	32,068	28,263	31,506	30,234	31,521	24,250	58,000
Max.dredging Depth (m)	60	75	120	112	120	105	60	110	131
Length (m)	144	159	172	152	172	164	167	144	200
Breadth (m)	28	28	32	29	32	29	31	28	36
Draught loaded (m)	10.4	10.4	11.5	11.5	11.5	11.2	10.5	10.4	14.0
Speed loaded (knots)	16.0	15.5	16.8	15.8	16.9	17.3	16.0	16.0	16.5
Total installed Diesel capacity (kw)	19,061	23,320	27,567	21,992	27,567	29,563	27,030	21,116	37,060
Pump-room situation	stern	bow	bow	stern	bow	stern	stern	stern	stern
Suction pipe diameter (mm)	1,200	1,100	1,200	1,200	1,200	1,200	1,200	1,200	1,400
Discharge pipe diameter (mm)	1,100	1,000	1,200	1,100	1,200	1,100	1,100	1,100	1,100

being 131 metres. This technical characteristic opens new horizons to the dredging world. Material can be extracted at great depths since this can be done in economically feasible conditions. It must also be pointed out that these dredgers that can work at greater depths cause a smaller impact on the environment than those that work in shallower waters.

3. Finally, the dimensions and ranges of these dredgers make them appropriate for working in the more severe wave, wind and current conditions than the largest of the dredgers of the previous generation. What's more, the Jumbos have been progressively fit with other technical innovations over time that have made it possible to maintain the spirit of continuous improvement that prevails in the dredging industry.

Innovations

Noteworthy amongst these innovations are:

- The incorporation of new, powerful dredging pumps that are needed to dredge at great depths and pump at great distances in a minimum time.
- The improvements in the hopper's overflow systems such as the flooded overflow installation that helps the dredged material to settle in the hopper.
- Direct reuse of the water from the overflow to feed the jet pumps of the draghead, improving the concentration of the dredged mix and reducing the loss from overflow.
- The improvement in the design of the dragheads, with the installation of high pressure jet systems of up to 6 kg/cm^2. These improvements make it possible to dredge more compact materials than the previous equipment could dredge with considerably more efficiency.
- As a result of the possibility of sand-dumping with the fall pipe, the material can be dumped at great depth in an exact spot only a short distance above the sea bed. This characteristic is very advantageous when, for example, marine outfall trenches must be covered or when material must be dumped on the bed without dispersing it or causing turbidity.
- The general improvements in the electronic, computer and communications systems in the

Figure 11. Queen of the Netherlands (23,347 m³), launched in 1998, was part of the wave of jumbos built in the late 1990s. (Photo First)

Figure 12. Right, With a capacity of 34,350 m³, the Vasco da Gama is one of the largest and newest dredging vessels afloat.

automation of the dredgers and in monitoring the operations have given the dredging processes much greater precision and higher quality.

- The incorporation of the multibeam survey equipment on the suction pipe of the dredgers whereby the dredger itself does the control and follow-up soundings on the work at the same time as the dredging operations are being carried out.

Design Characteristics

When designing this type of ship, there are some design elements that have to be adjusted in accordance with the characteristics of the dredging work that the ship will have to carry out.

Table III. General characteristics of Jumbos under construction

	HAM 318	Rotterdam	BN 320	BN 322	HAM 321
Year built	2001	2001	2001	2002	2003
Builder	IHC	Van der Giessen	AESA	AESA	IHC
Hopper capacity Top coaming (cm)	23,700	21,500	16,500	16,500	23,700
dwt (tns)	36,450	38,000	25,900	25,900	36,450
Max.dredging Depth (m)	120	120	48	48	120
Length (m)	176	185	149	149	176
Breadth (m)	32	31	28	28	32
Draught loaded (m)	12.0	11.3	11.0	11.0	12.0
Speed loaded (knots)	17.0	15.9	15.6	15.6	17.0
Total installed Diesel capacity (kw)	28,500	27,500	24,300	24,300	28,500
Suction pipe diameter (mm)	1,200	1,200	1,100	1,100	1,200
Discharge pipe diameter (mm)	1,200	1,000	1,000	1,000	1,200

Figure 13. The Rotterdam, the largest jumbo built so far, has recently been delivered.

Hull design

Three aspects of the hull design were studied referring to the main body, the bow and the stern.

In the first place, the increase in the block coefficients of the hull of the Jumbo in relation to those of the trailers of the previous generation of dredgers should be mentioned. The main characteristic sought when first conceiving the trailer Jumbo was to increase the profitability of transporting material.

This objective implied combining, on the one hand, a large load capacity and, on the other, a high operating speed both for extraction and unloading and for navigation. This second requirement made it necessary to fit the Jumbo dredgers with high powered engines in machinery, equipment and services. Consequently, the large load capacity and the weighty installed machinery implied an increase in the ship's total displacement. But at the same time, the ship's design required the least possible draught to allow dredging and above all dumping and pumping in shallow waters as this is necessary for land reclamation work.

Therefore, the significant increase in the ship's total weight had to be made compatible with a shallow draught.

As an excessive increase in the length and beam was not advisable in order to be able to work in confined areas, the final design of the Jumbo dredger has resulted in hulls with a high block coefficient.
These requirements also produced certain problems in the hull's hydrodynamic design, especially in the ship's stern. In fact, the low draught requirement made it necessary to define a propulsion unit based on propellers with relatively small diameters in relation to the ship's displacement. Otherwise, hydrodynamic vibrations would be produced in the ship's hull and cavitations in the propellers and nozzles. There would also be risk of the nozzles or rudders being damaged or breaking down.The solution of all of these problems has led to a hull design with a twin gondola escutcheon stern and without propeller shaft struts in the most recent Jumbos (Figure 15).

Finally, with respect to the bow, it was necessary to satisfy the need for a short length with respect to displacement. This requirement is based on the need to work in areas where the space for maneuvering is limited such as ports, marine basins, and os on.
The result is the bulbous bow that most of the Jumbos have but which was not very usual in dredgers built before they appeared.

The bulbous bow improves the hull's hydrodynamic behavior as well as the ship's overall maneuverability.

Location of the pump room

The location of the pump room is an aspect that has affected the design of the dredger.
As mentioned above, it was necessary to balance the need to take advantage of space to increase the volume of the hopper while maintaining the draught relatively low.

This led to considering the convenience of installing the pump room in the ship's bow in order to optimise and increase the dead weight / length and dead weight/draught ratios.

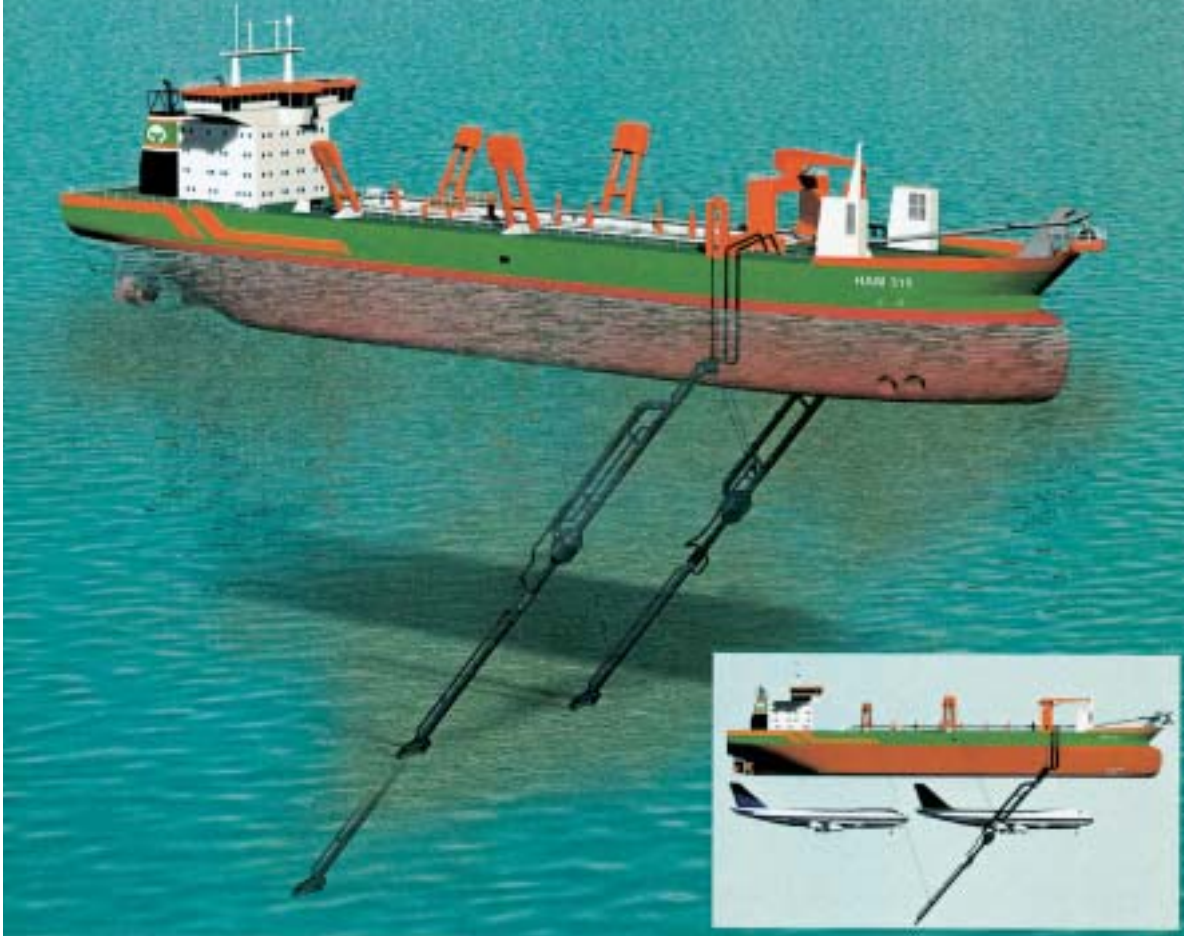


Figure 14. Drawing of one of the newest vessels commissioned, HAM 318.

To install the pump room in the bow required a diesel-electric drive for the pumps on board since the engine room was located in the stern. This drive has certain advantages such as a more progressive speed control for the pumps.

When the pump room is located in the stern of the dredger, the drive for the pumps is totally diesel in which case the need to use a gear- box makes it necessary to have only 2 or 3 operating speeds. The electric-diesel installations have lower efficiency than the fully diesel ones which means that they consume more fuel per power unit. This is a very important economic factor at this time when the cost of fuel is so high. But it has the advantage that they have a lower initial cost and less maintenance than a diesel drive.

As can be seen in Table II, neither of the two alternatives has prevailed although the individual dredging companies and ship designers seem to prefer one system or the other depending on what they are accustomed to working with.

Figure 15. Hull design of the Jumbos: twin gondola escutcheon stern, without propeller shaft struts.

Table IV. Comparison Jumbos/Bulkcarriers.

	Dwt tons	Length L m	Width B m	Depth D m	Draught dredging mark T m	Draught summer loan line Ts m	Total installed power P Kw	Propulsion free sailing Ps Kw	Speed loaded V Knots
Bulkcarrier	30,000	172.5	26.0	14.7		10.0	8,000	6,200	16
Jumbo	30,000	162.0	29.0	12.8	11.2	9.6	29,563	22,680	17
Bulkcarrier	58,000	200.0	32.0	17.5		12.4	12,000	9,900	16
Jumbo	58,000	200.0	36.2	19.0	14.0	13.5	37,060	29,400	17

The installed power

It is worth mentioning the great power installed to run the complex and numerous equipment of the trailer when compared with most other types of conventional ships with similar tonnage. To illustrate this fact, for comparative purposes only, let's consider the conventional ship that is most like a trailer. Because of the type of load it transports, the bulkcarrier has been chosen.

Table IV reflects the average characteristics of a Jumbo with 30,000 dwt and the same characteristics of a bulkcarrier with the same dead weight

Table IV also contains the characteristics of the Jumbo that currently has a greater dead weight. They are compared with those of a bulkcarrier of the same weight.

With respect to the total installed power, the difference is enormous: 29,563 Kw in the 30,000 dwt Jumbo and 8,000 Kw in the bulkcarrier of the same weight. The power/dwt ratio is 0.985 for the Jumbo and 0.267 for the bulkcarrier. These ratios demonstrate the importance of the equipment and machinery installed on the Jumbo in comparison with those of a conventional ship.

Conclusion: The Future of the Jumbos

To this point the impact of the trailer Jumbos on the dredging industry and its repercussion on the demand of infrastructure projects has been demonstrated. But what does the future hold for this type of dredger?

The forecast for the future seems to be optimistic. The contracts already awarded to dredging companies guarantee that these dredgers will be fully occupied for the next five years.

The importance of world trade continues to grow. In areas like Singapore, Hong Kong and South Korea, the economic growth in 2000 was over 8%, and long term projections continue to be positive.

Economic growth is often reflected in the movement of merchandise. And as long as marine traffic is the least expensive and most ecological means of transport – the latter being an aspect that is often forgotten – more wharves and deeper navigation channels will be required.

It will also be necessary to respond to the industrial development that will be produced by the economic growth. New locations in other less industrialised parts of the world will have to be found where the chemical and oil industries can be developed, such as is happening now in Jurong.

The possibility of moving airports from the cities out into the sea, as was done in Hong Kong, is being considered for other locations such as Amsterdam, Buenos Aires, Lisbon, Barcelona, to name a few, and some will certainly be realised.

The dredging industry is alert to all these phenomena. The five Jumbos currently under construction or firmly on order will undoubtedly be followed by others to meet the expectations for the future. Existing dredgers are presently being transformed to lengthen and increase the capacity of their hoppers. And so the era of the Mega Jumbo is about to dawn.