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A BRIEF SURVEY ON DREDGES

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by

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INTRODUCTION

This paper is intended to familiarize the reader with the different types of dredges, their functions, and some design problems. Upon an initial investigation of dredges, you will soon realize the vast variety of craft, differing in construction and purpose. Also, you will find that little useful information about them can be applied to design problems. Dredge building, like much of shipbuilding, is still an art.

However, there is much that a naval architect can learn from a study of dredges. Unlike most ships, dredges are designed solely for function (especially the hull). As a result of this singleness in design considerations, almost all dredges have poor course-keeping characteristics and poor resistance unless devices such as twin screws, bow thrusters, and extra large skegs are added to correct these deficiencies.

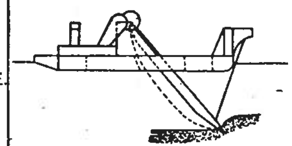
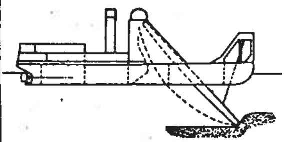
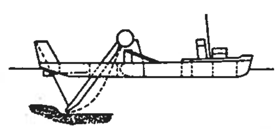
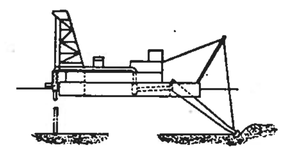
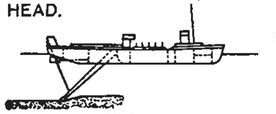
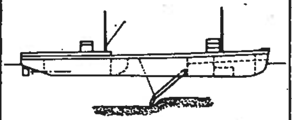
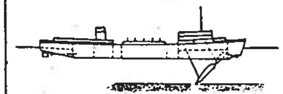
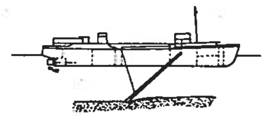
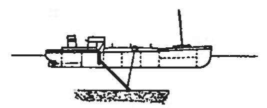
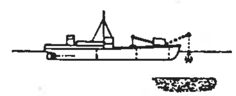
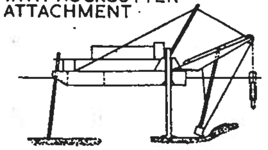
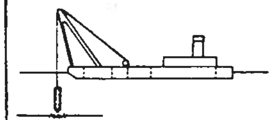
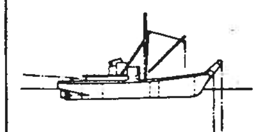
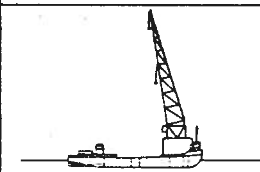
Ironically, with all our technological advances, we still have not learned how to dig a hole in the channel floor economically and fast. An average suction dredge of 250-400 feet costs about $14 million to build. Dredge costs vary with purpose, size, capacity, and the distance to the location.

In the first part of this paper I will introduce the different types of dredges. In the second part, I will elaborate on some specific new designs, notably the *McFarland,* the U.S. Army Corps of Engineers' newest and most versatile dredge.

PART I

DESCRIPTIONS AND DESIGN CONSIDERATIONS

TABLE I

	TYPE.	OUTLINE SKETCH.
A	NON-PROPELLING MULTI-BUCKET DREDGE.	
B	SELF-PROPELLING BOW WELL MULTI-BUCKET DREDGE.	
C	SELF-PROPELLING STERN WELL MULTI-BUCKET HOPPER DREDGE.	
D	NON-PROPELLING CUTTER SUCTION DREDGE.	
E	SELF-PROPELLING STERN WELL TRAILING SUCTION HOPPER DREDGE.	SUCTION FRAME CAN ALSO BE FITTED WITH ROTARY CUTTER HEAD. 
F	SELF-PROPELLING CENTRE WELL TRAILING SUCTION HOPPER DREDGE.	
G	SELF-PROPELLING BOW WELL TRAILING SUCTION HOPPER DREDGE.	
H	SELF-PROPELLING SIDE SUCTION TRAILING HOPPER DREDGE.	
I	SELF-PROPELLING SIDE SUCTION HOLE DIGGER HOPPER DREDGE	
J	SELF-PROPELLING GRAB HOPPER DREDGE	
K	SELF-PROPELLING MULTI-GRAB HOPPER DREDGE.	
L	NON-PROPELLING DIPPER DREDGE	WITH ROCKCUTTER ATTACHMENT 
M	NON-PROPELLING ROCKBREAKER.	
N	SELF-PROPELLING HOPPER BARGE.	
O	SALVAGE & GENERAL PURPOSE CRAFT.	
P	SELF-PROPELLING FLOATING CRANE.	

From Reference 1

TYPES OF DREDGES*

NONPROPELLING MULTIBUCKET DREDGE (A)

Bucket dredges may be used for all types of soil. Work is restricted to protected areas because swells can cause damage by the rising and falling of the hanging bucket line bumping against the ground beneath the dredge. For a diagram of this dredge, see Table 1, Figure A. The size of the bucket dredge is determined usually by the voyage from builder to operator. The beam, freeboard, and range of stability are determined by the delivery voyage conditions when the dredge is under tow and at sea. Sometimes this distance can be over 10,000 miles, for example, a dredge built in England for use in Australia.

The bucket dredge is able, because of its arrangement with the buckets and conveyor going through a well in the center of the ship, to dredge the bottom directly beneath it. The ladder is nothing but the mechanism onto which the conveyor with the buckets attached is situated. It is adjusted for height by wire ropes hanging over the vessel's bow. Many ladder arrangements enable the dredge to work deeper than its maximum designed operating depth. During operation, these dredges are usually positioned by five

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*See Table 1 for schematic view of various types of dredges discussed.

or more anchors so that the bow swings in a steady motion for even and smooth dredging. The spoil is dropped through a chute to a barge alongside. When this type of dredge's operation is primarily going to be based close to a shore station, a limited amount of cargo capacity can be provided to enable the spoil to be pumped ashore; however, this is very rare. The use of barges enables the dredge to be on location at all times and in continuous operation. Mixing the spoil with sea water and pumping it ashore is the most economical method of cargo-handling and does away with the operation of barges, which must move along with the dredge and still stay out of the way of the anchor lines.

In spite of many precautions with slip gears, etc., it is possible, and common, for the hull of one of these dredges, in way of the ladder, to become damaged when the buckets hit a heavy or substantial object. For this reason a well-designed dredge usually has a cofferdam around the well near the ladder to prevent extensive flooding if damaged.

Multibucket (nonpropelling) dredges are usually box-shaped with longitudinal framing. They have large towing bollards and a swim end for towing ease. The hull is sometimes cut away a little in way of the ladder to enable the dredge to work close to piers. Winches are provided on board so that the crew can do most of the repairing of the bucket band, without wasting much time.

SELF-PROPELLING MULTIBUCKET DREDGE (B)

This type of dredge is difficult to justify economically in a system; however, as an independent unit it has had some success. Small ports not easily serviced by dredging may use this type of dredge. In this case it is usually equipped with a hopper for carrying the spoil to dumbing grounds closeby. Some private firms have used this type for seagoing, operating in small unserviced ports. Because of the operation in small ports, which are usually inaccessable to dredges of average size, this type of dredge is usually quite small, or at least an effort is made to keep the size small.

The self-propelling bucket dredge is usually of full form, providing for large cargo capacity and the equipment on board. It is also of slow speed, since the dumping grounds are close to the place of operation. The ladder well and trailing bucket design add a large amount of resistance to this craft. The study of well resistance for all types of dredges has been considerable, but as yet no systematic study has been made to determine proper configuration and size for least resistance. The location of the well for least resistance is still being discussed. Usually, however, if the dredge does not have a hopper, the well will be located at the bow.

If the vessel must work at sea, a stern well would be preferable since a bow well is difficult to handle in a head sea. The stern well, however, is difficult and expensive to construct, and therefore, a bow well generally is used in spite of its poor characteristics. The dimensions of the vessel with a bow well are usually set by delivery voyage conditions, since that will be the only time it will be at sea. With a hopper and stern well, cargo capacity usually determines the dimensions.

NONPROPELLING SUCTION DREDGE (D)

The basic operating principle of the suction dredge is to dislodge the soil and transport it by a current of water, excited by a pump. The upper edge of the suction tube is connected to the hull by flexible fittings, enabling it to move on the bottom as the ship moves, rolls, etc. A wire winch controls the suction head on the bottom to lift and drop it.

It is important that just the right quantities of soil and water are sucked up to make the operation economical. This is done by keeping the suction head at the right level on the bottom. If not enough soil is taken up, the process is uneconomical. If too much soil is taken up, the pipes may get clogged or the pump may stall.

The nonpropelled suction dredge moves forward by pulling on anchor lines and thus warps forward. They are only able to operate in soft or loose material. This type of drege usually has the suction tube hanging in a well, and discharges the spoil into a barge alongside or pumps the spoil ashore. The suction head and the ladder it is connected to cannot take bending moments caused by lateral movements of the ship because of their connections and construction. Therefore, the ship is kept steady by four anchors along its sides. With this arrangement it is possible for the dredge to operate in rough seas with barges coming alongside.

The basic hull form, like most stationary, or nonpropelled, dredges is box-shaped. The well for the suction pipe is short. The sides are also cut in way of the well to enable this dredge to work near docks, etc.

SELF-PROPELLED SUCTION DREDGE (E - H)

Most self-propelled suction dredges are of the trailing type, that is, they drag the suction heads across the bottom. They can have a stern well, center well, or partial bow well. The stern well type can be arranged so that the trailing mouthpiece can be removed and a cutter head installed. The vessel is then moored by anchors, as in previous nonpropelled cases, for the cutting operations. In this state the vessel can dig hard materials and cut beneath itself. However, hard material would damage the hopper, and under such conditions barges must be used to carry the spoil. Sometimes special doors are constructed to hold hard material, but they are quite expensive. Also, special pipelines can carry the material.

This type of dredge can be equipped with two side suction pipes, which eliminates the well and permits a decrease in the size of the vessel while maintaining the given cargo capacity. Most self-propelled suction dredges have hoppers; however, they might be dry hoppers, where the spoil must be pumped out.

Suction dredges with wells generally have poor maneuverability, and therefore, they usually have twin screws and twin rudders. With this configuration they have good seakeeping qualities at low speeds. With the trailing suction pipes at the side there is little difficulty in keeping a straight course. The suction pipe can be made to stow inboard and the mouthpiece can be made to be placed near midlength to reduce the effect of pitching on the mouthpiece. For work near piers the trailing suction side dredge is quite suitable.

HOLE-DIGGER SUCTION DREDGE (I)

This type of dredge is usually equipped with one or two side suction pipes. This is usually where the material is free-running, like sand. Here the dredge is anchored against the tide and the suction pipes lowered. The material is then pumped into the hopper, leaving a hole in the sea floor. The tidal currents against the bottom eventually fill in the hole, but in so doing the sea level of the whole area is lowered. The process is repeated at intervals along the channel, and in due course, the depth is increased.

Twin screws and twin rudders are not that important on this type of vessel, but can be very useful if operating in narrow, busy waterways. In all types the suction pipes have flexible connectors. Beam-draft ratios for these vessels are high. Due to the considerable free surface in the loaded condition, GM must be high in order for the dredge to maintain stability with cargo. The speed of this type of dredge ranges from 9 to 11 knots when not digging.

GRAB DREDGE (J)

Grab dredges are designed for operations in bottoms that are composed of silt or mud. The single grab type is little more than a land crane on a floating platform. Usually, a single crane is at the bow and the hoppers are aft. Hopper capacity for this type of dredge ranges from 250 to 350 cubic yards. This small dredge is used in dock areas and close to walls, bulkheads, etc., where the problem is more one of access than quantity of material to be dredged. The multiple grab dredges usually have hopper capacities in the range of 1,000 to 2,000 cubic yards. This size is used in wet docks and harbors.

Today most of these cranes are powered by both main propulsion and by direct-drive diesels, or diesel-electric. The craft is either anchored in position or wires are tied to the shore while dredging. The beam-draft ratios and GM of these craft are the same as for most suction dredges, with alloawances for cranes hanging over the sides. Heeling can be critical since not only the weight over the side but also the suction effect creates a moment. The grab dredge, like most, can also be nonpropelled and can either empty its spoil into a barge or dump its load ashore. In many cases where a limited area near shore has to be dredged, a special land-based crane is used.

DIPPER DREDGE (L)

The dipper dredge is one of the few dredge types that was developed in the United States. It is nonpropelled and is designed to dredge heavy material. The dimensions are determined by dredging depth, crew size, and bucket size. Buckets range from 1 to 15 cubic yards. The dredging power is concentrated on the digging edge of one bucket.

The dipper dredge is unique in its method of remaining on position. Basically, it has three spuds that extend from the ship to the bottom and lift the ship up. Thus, the ship actually is lifted by the spuds, not the water. These spuds have automatic controls that change their height so that it can compensate for the rise and fall of the water level. The dredge moves by putting the bucket on the bottom in front of the vessel and pulling itself. The stern spud acts as a rudder. When in position, the spuds then lift the dredge up. When off the spuds and floating, these dredges have considerable trim by the head.

This type of dredge can also have rock-cutter attachments added. The hull, like most nonpropelled dredges, is box-like for easy construction and welding. It has a swim end and large towing bollards. Most dipper dredges empty into barges along side. Even though they have intermittent operation due to the bucket, they can do a great deal of dredging in a short time because of the large bucket capacity. In many cases dimensions are fixed by stability criteria in delivery voyage.

ROCK-BREAKER DREDGES (M)

There are two methods of breaking rocks--by explosives or hammering; the rock-breaker dredges are designed to do both. For explosives, they use a drilling bit to place the charges in the rock. For hammering, they have a chisel-shaped cutter that weighs 6 to 22 1/2 tons that is dropped to the bottom. This type of dredge is positioned, and then held in position by means of anchors. The cutter is dropped through a heavy steel tube, and in some of the new dredges it can work in depths over 60 feet.

The size of the dredge is fixed by the size of the cutter and shears, so that ample stability can be maintained and trim will not be excessive during operation. Stability on voyage conditions is, again, probably the main factor in determining dimensions.

SELF-PROPELLED HOPPER DREDGE (K, C, E - I)

The hopper dredge is one that has its own cargo tanks and does not need barges to cart the spoil away. The spoil is pumped from the bottom to hoppers in the ship, which can open from the bottom to dump the cargo. These dredges usually are developed to have some speed since the time used in going to the dumping grounds is wasted dredging time. Thus, in many cases some sacrifice on cargo capacity for hull form takes place. This vessel is particularly well-suited for maintenance work, which takes a long time.

In the center of the vessel is a box keelson onto which are hinged the doors at the bottom of the hoppers. On the older dredges, all doors can be operated at the same time using winching and chain arrangements; today, hydraulic controls make simultaneous operation possible. The suction pipe is controlled by a wire from the deck.

On this type of dredge, it is not possible to bring the pipe and mouthpiece on board, and it is not really necessary, since the craft is in continuous operation. However, the mouthpiece and suction pipe are stored next to the hull when under way and are often protected by a sponson or fairwater on the shell plating.

The vessel's hull is shaped like a small freighter's, or a small tanker's. Many hopper dredges built today are actually T2 conversions. The oil tanks can be converted easily to hoppers by adding hopper sides and doors. The dimensions of new designs are set by hopper capacity, draft limitations, speed, and the type of machinery. The beam, for stability purposes, is influenced by the type of cargo. A problem in construction and operation arises if the valve doors used in the hoppers are not appropriate for the cargo carried. Obviously, if they are inappropriate, severe damage can result.

Within the classification of self-propelled hopper dredges there are many different types of dredges. This type of dredge has more possibilities of unloading schemes than any other: Cargo can be stored in the hoppers and taken out to sea and dumped; the dredge can be connected to a pipeline and pump its cargo ashore; or it can have a sidecast boom and discharge into the water a few hundred feet out of the channel. Most dredges do not have the capability of doing all of these things, except the *McFarland*, the U.S. Army Corps of Engineers' newest dredge. Because of its unique features, some time will be spent later in discussing this ship.

Today, most large-size self-propelled hopper dredges are using booms (sidecasting). A notable example of this type is the *Zulia*,[2] built by D. K. Ludwig to enable his large tankers to go into Maracaibo Harbor. Here the sidecaster was chosen for a number of reasons. It can discharge outside the project area, since booms are well over 150 feet long and *Zulia*'s is 415 feet. The actual distance that the spoil is put back into the water is farther than the end of the boom since the spoil has a transverse velocity from the ship equal to about 25 feet/second. The major advantage of the sidecaster, however, is that it can dredge continuously and does not have to leave station. With a 180-degree working boom, the craft can dispose of its cargo to make best use of the currents carrying it farther away from the channel. The sidecaster can also have multiple pump and drag pipe assemblies for greater dredging capacity.

A number of difficulties and trick design problems are encountered by the naval architect when working on a sidecaster. In the case of the *Zulia* they were: stably mounting and counterweighting, with 1,000 tons, the revolving 415-foot boom containing a long tabular steel pipe which was 50 feet above sea water; fitting to the hull four 85-foot long, 36-inch diameter drag pipe assemblies; and fitting and finding room for all the machinery.[2] It has been said that a dredge is an incredible piece of construction, for if you took the volume of all its components and machinery, they would be much greater than the hull volume of the craft.

It is interesting to note that in 1960-1961 *Zulia*'s total annual production, all in new work, was 57 million cubic yards. This amount is equal to the entire U.S. Army Corps's fleet production for that same period. The cost of dredging with *Zulia* comes to approximately 15 cents/cubic yard. The reason for this is partly due to the continuous operation of a sidecaster. At present, the *Zulia* loses 5 to 7 minutes in turning, which is the same for most dredges; however, with the addition of a bow thruster even this short period of time can be reduced.

CLASSIFICATION SOCIETY RULES FOR SUCTION DREDGES

In this section only self-propelled suction dredges will be discussed. The majority of the world's dredges are classified with *Bureau Veritas* because of its convenience to The Netherlands, where most of the world's dredges are located. Thus, *Bureau Veritas* Rules should be indicative of the general trend in classification societies dealing with dredges.

There must be a keel plate the length of the vessel; if, however, it is cut in way of the hopper, a longitudinal girder must be fitted. All bottom plating under the hoppers must be increased by 20 percent. All of this is to insure proper strength in the cargo tanks and for longitudinal strength, since the hoppers are amidships and will be filled with a sand and water mixture of heavy density. The hopper sides must be as thick as the shell plating.

BRIEF DISCUSSION ON THE DESIGN OF SUCTION DREDGES

The most important relation in dredge design is the ratio of the weight carried divided by the displacement of the dredge. This ratio is usually plotted for constructed vessels, and using weight to be carried, the new hull weight can be determined. Most suction dredges are pontoon-shaped with block coefficients around 0.95.

The prinicpal dimensions are found from

$$\Delta = f\gamma LBTC_b$$

where

Δ = total displacement, including shell, in metric tons,

f = factor for shell thickness $\approx$ 1.008,

γ = specific weight of water (for FW, γ = 1.0, for SW, $\gamma \approx$ 1.026),

L = length in meters,

B = beam in meters,

T = draft in meters,

C_b= block coefficient.

and from length-beam and draft-beam ratios of vessels already built; the draft-depth ratio follows. Usually, barge-unloading suction dredges have a small draft since they operate close to the shore. Well length, in those vessels having wells, is determined by dredging depth. The starting point in most dredgê designs is the estimate of the item weights.

In hopper suction dredge design the first step is to determine the hopper capacity. Then, from curves of hopper capacity divided by length multiplied by beam multiplied by depth and length-beam, draft-beam, draft-depth ratios, determine the principal dimensions. When calculating the weight, the engine horsepower is first determined. The water in discharge holes under the doors is considered part of the weight and displacement, and block coefficient is calculated as if these holes were not present. One must be careful to insure that the vessel has the right length to hold everything and at a reasonable trim. The value of C_b is found from displacement, and then length, beam, and draft are to be checked to be sure that the vessel has a speed-length ratio appropriate for best propulsion. For propulsive power, the "Fench Formula" is used:

$$ihp = A_{\boxtimes} (V/"m")^3 ,$$

where

ihp = indicated horsepower,

$A_{\boxtimes}$ = area of main section below load waterline in m^2,

V = speed in knots,

"m" = a coefficient depending upon the location of the well.

Also, Taylor's Standard Series modified by Van Lammeren may be used. In all cases the final design is model tested to determine the exact horsepower needed. The propellers for a trailing suction dredge are designed in such a way as to give the right blend of efficiency in both cruising and dredging modes. In most new designs controllable pitch propellers are being used for this purpose.

PART II

BRIEF DISCUSSIONS OF SOME NEW DREDGES

TABLE 2[3]

DREDGE	LENGTH (ft)	BEAM (ft)	B/L
Essayons	500	72	.144
Goethals	461	68	.148
Comber Class	340	60	.176
Markham	316	62	.196
Harding	300	56	.187
McFarland	288	72	.250
Hains-Hoffman Class	212	40	.189
Pacific	168	38	.226

TABLE 3

(All units are metric.)

	Columbus	Franzius	Simson	Mittelgrund	Titan	Meyersledge	Geheimrat	Hafenbaudir.	Rudolf Schmidt & Johannes Gährs
	1892	1898	1905/6	1908	1913	1915	1939	1940/41	1959/60&1960/61
LBP(m)	60.6	63.8	50.0	57.5	62.0	56.2	62.0	91.0	104.0
BEAM(m)	10.0	10.6	10.0	10.8	11.75	10.2	12.0	15.15	18.0
DRAFT(m)	5.1	5.1	3.2	4.6	4.4	4.5	4.0	6.0	5.9
DEPTH(m)	5.25	5.25	4.0	4.8	5.2	4.8	4.7	7.2	8.0
CARGO $\nabla(m^3)$	800	1,000	400	735	1,000	650	700	2,000	2,800
PAYLOAD (tons)	1,200	1,800	520	1,140	1,300	1,120	1,000	4,000	4,200
$\Delta_{F.L.}$	2,460	2,700	1,185	2,340	2,500	2,130	2,300	6,610	8,325
MAX. DREDGED	18	18	14	16.5	17	18	18	21	21.5
NO. PIPES	1	1	1	1	1	1	1	1	2
LOCATION	Side	Side	Stern	Side	Stern	Side	Stern	Stern	
NO. PROPS.	1	1	2	1	1	1	1	1	2
$\vec{V}_{MAX}$(knots)	8	8	6.5	8	8	8	9	11	12.5
TYPE OF PROPULSION	Steam	Steam	Steam	Steam	Steam	Steam	Diesel-electric	Diesel-electric	Diesel-electric
POWER MN. ENGINE	600	800	760	790	1,800	650	1,170	3,000	4,800
NO. PUMPS	1	1	2	1	1	1	1	1	2

BRIEF DESCRIPTIONS OF SOME NEW DREDGES

SAND & GRAVEL DREDGE--*HOVINGHAM I* [4]

LBP	190 ft
BEAM	37 ft
DEPTH	14 ft 7 in.
DRAFT	12 ft
DEADWEIGHT. . .	1,100 tons
SEA SPEED	10 knots

This dredge is used for the reclaimation of sand and gravel in estuaries. There are a number of special features employed on this vessel: Cargo is loaded in only 1 1/2 hours, it can work in 4-knot currents, it can work in depths from 3 to 14 fathoms. It has its own discharge pumps (diesel-electric) on board and can discharge its cargo at the rate of 400 tons/hour. The framing is transverse, and it has a controllable-pitch propeller.

SEAGOING TRAILING SUCTION HOPPER DREDGE--*TEES BAY* [5]

LBP	310 ft
BEAM	52 ft 6 in.
SPEED	12 knots
PAYLOAD	5,200 tons
CREW.	32 men
AUTOMATED	

The *Tees Bay* can operate in depths of up to 70 feet while in a swell of 10 feet. It can take on its payload in approximately 2 hours.

AUTOMATED RUSSIAN DREDGE--*SEVERODVINSKI* [6]

LOA	269 ft 6 in.
BEAM	45 ft
DEPTH	17 ft
MAX. DRAFT	13 ft 9 in.
HOPPER CAPACITY . . .	1,547 cu yd
MAX. DREDGE DEPTH	50 ft
SERVICE SPEED	11.5 knots

This vessel is designed to operate in a severe arctic climate. It has the capability of opening the hopper doors and dumping its cargo or pumping it ashore. It is diesel-electric driven, and for crew comfort is soundproofed to a maximum of 60 db.

NATIONAL BULK CARRIER DESIGNS [2]

T2 CONVERSION

No hoppers
Sidecast boom extends 250 ft from side of ship

ZULIA

LOA	548 ft
LBP	525 ft
BEAM	95 ft
DEPTH	40 ft
DRAFT	26 ft 6 in.
GROSS TONNAGE	15,273 tons
CRUISING SPEED	13 knots
HORSEPOWER (PROPULSION)	11,000
OFFICERS AND CREW	96 men
NUMBER OF DREDGE PUMPS	4
DISCHARGE DIAMETER	32 in.
SUCTION DIAMETER	36 in.
TOTAL PUMPING POWER (4 PUMPS) . .	12,000
BOOM LENGTH	415 ft

TWO NEW GERMAN DREDGES[7]

VOLUME	2,800 cu m
SPEED	12 knots
DRAFT	5.9 m

These craft had a number of unique design conditions. They had to be able to operate continuously even during bad weather and in heavily trafficked waterways. This led to hinged suction pipe design with rubber hinges. The craft had to be able to operate both day and night. This necessitated a large crew size, a quiet ship, and a vibration-free hull. Remote-control operation was also found necessary for continuous dredging.

The dredge also had to be able to maneuver more frequently and faster than most dredges and other craft. This led to the installation of a bow thruster, twin screws, and diesel-electric power. To reduce repair and docking, high-speed motors were used for diesel-electric power and included good access, good layout, and an aesthetically appealing design.

In order to guarantee success, the dredge had to be able to operate in a minimum depth of water at night while maintaining the right location and depth. This was achieved by the use of several devices: bottom profile recorder, television pictures of suction head at location, measurement of the concentration of solids in the pipes, and a device using the Doppler effect to check that the ship's velocity above ground is right for efficient production. All motions and operations are controlled from the bridge.

OUTLINE OF DESIGN--AUTOMATED HOPPER DREDGE *McFarland* [3,9]

Uses:

- a) maintenance of harbors
- b) realigning harbors and channels
- c) deepening harbors and channels

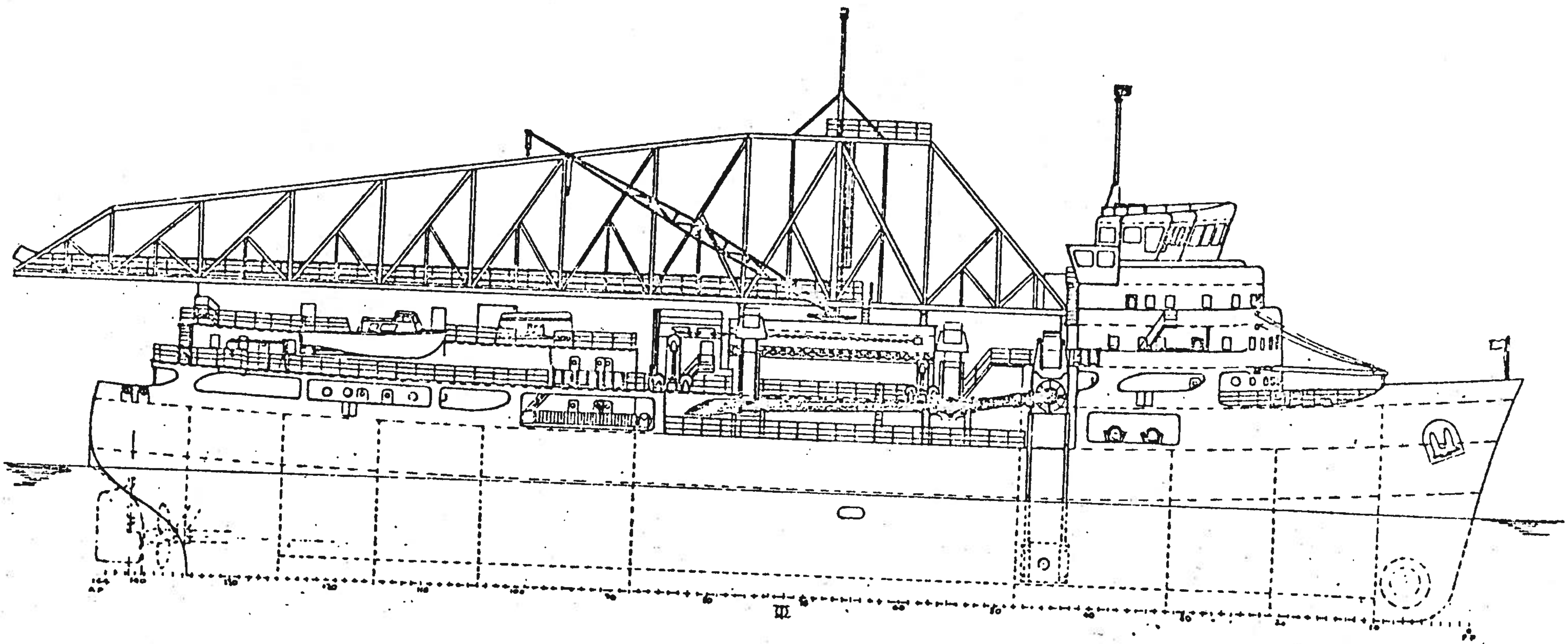

Figure 1

Outboard Profile
McFarland

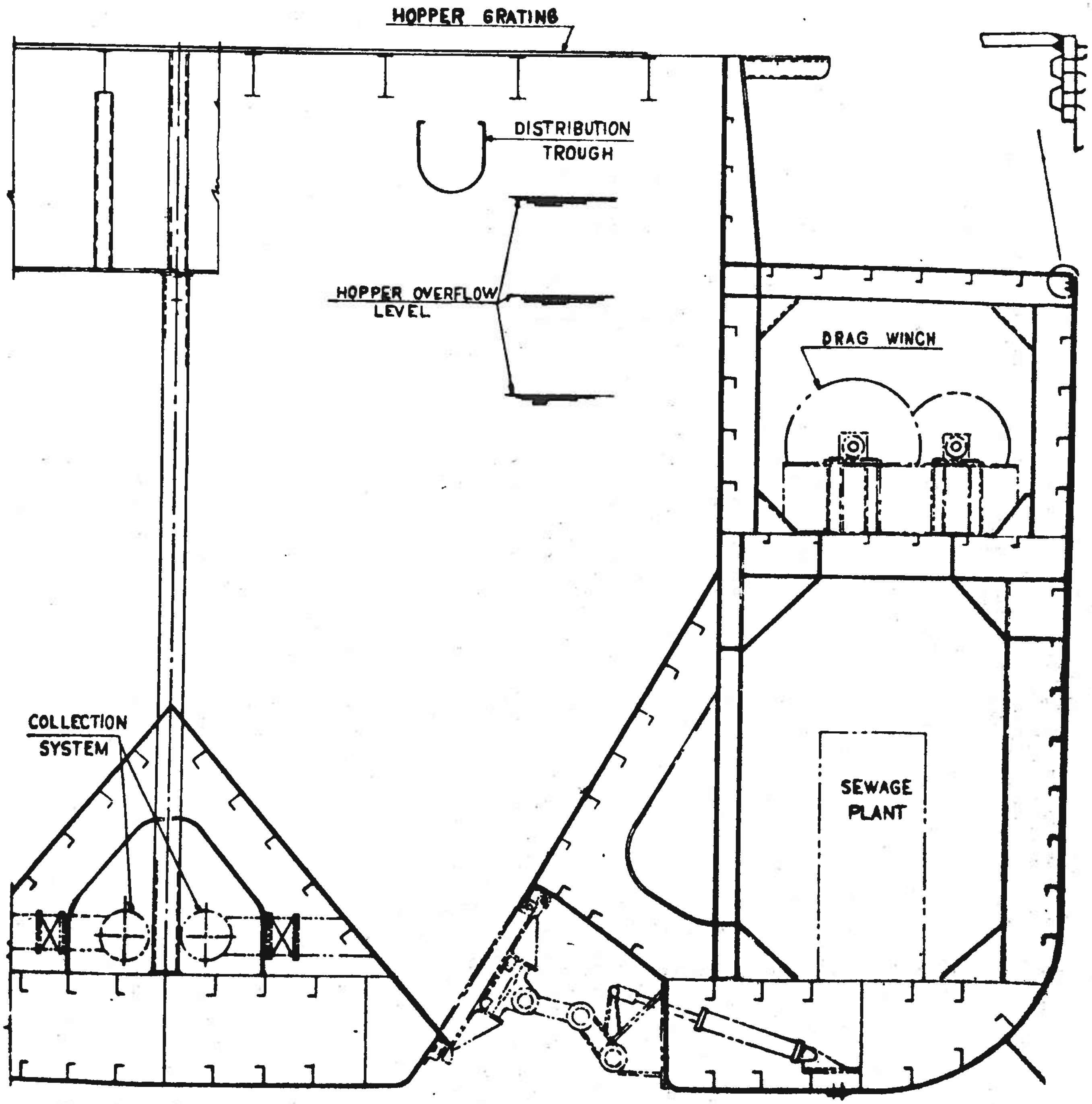

Figure 2
Section Through Hoppers

Three systems for disposal of spoil:

a) bottom dumping
b) direct pipeline discharge ashore
c) sidecasting

Advantages of self-propelled hopper dredges:

a) doesn't greatly interfere with harbor traffic
b) can work in harbor entrances and on ocean bars where swells would interfere with cutter-head dredges

Methods:

a) direct pumpout--dredge pumps through pipeline to disposal area ashore
b) sidecasting--pipe on boom connected to swivel on ship disposes of spoil outside limits of channel
c) bottom dumping--doors in bottom of hopper open to let spoil fill in areas

Structure--Highest standards:

a) two riveted seams--bilge and stringer
b) transverse framing--extra-heavy plates to resist corrosion, abrasion, and shocks of dredging
c) Eleven compartments--two-compartment ship with cross-flooding necessary only in forward fuel oil wing tanks

Propulsion:

a) four diesel engines
b) controllable-pitch propellers
c) two dual-input/single-output reduction gears to give plant electric-drive versatility

d) three diesel engines for dredge pumps (generators)

e) three diesel engines for auxiliary equipment and ships service (generators)

f) ten main diesels and emergency generator, total of 16,000 horsepower

Hull form:

a) beam . . . . 72 ft

length . . . . . 238 ft

range . . . . 8,000 miles

speed . . . . 4 knots, against wind & current

. . . . . 12 knots, free running

b) size limitation by Galveston harbor to LOA = 300 ft

c) wide beam needed for stable sidecasting platform

High degree of maneuverability:

a) twin rudders--semi-balanced located directly in propeller race and toed inward 4 degrees for improved steering. Area of each rudder is 136 ft^2.

b) hydro-electric steering gear for simultaneous operation of the two rudders

c) both rudders from 35 degrees hard over to 30 degrees on other side

1 pump . . . 28 sec

2 pumps. . . 14 sec

d) bow thruster for good maneuverability and to offset lateral reaction to sidecasting

e) directional stability by adding diagonal fins to stern tubes

f) place between hull and stern tubes plated over to increase lateral area

Crew:

a) 75 men

b) on board 24 hr/day--7 days/wk

c) crew changes by launch

Period of operation:

a) two weeks between refueling

NOTE ON BOW THRUSTER: It is 500 horsepower and is of value only in 0- to 6-knot range.

Methods of operation:

a) sidecasting--boom is 220 ft to the end connected to a turntable on top of hopper. When in the stowed condition, it extends 20 ft aft of the ship's stern. In operation, it reaches 136 ft to side of ship. Y-joint at the end distributes lateral thrust.

   total assembly . . . . 136 tons

   with counterweight . . 320 tons

   can be stowed to 90 degrees in 3 min

b) hopper--hoppers are composed of six sections with port and starboard dumping doors. They can open and close without protruding below the keel. All the doors have rubber seals. The operation of the doors is controlled from the pilot house. Each hopper is equipped with a jetting and washdown system.

c) dredge (side drag type)--enables the vessel to have great flexibility in vertical and horizontal motion, which is needed in narrow and congested waters. Maximum dredge depth is 55 ft at a 45-degree angle. The entire assembly is removed from the water when vessel is not dredging.

Noise proofing:

a) main diesels and gears enclosed in accoustical panels

b) special mountings for equipment, and insulated machinery spaces

c) engineer's control room is completely sound-proofed

Automated from pilothouse and easy communications to control areas.

The principal dimensions and physical characteristics of the dredge are as follows:

Length, including boom overhang	319 ft 8 in.
Length, overall (hull)	300 ft
Length, between perpendiculars	288 ft
Parallel midbody	86.42 ft (30% of LBP)
Beam, molded	72 ft
Breadth, overall	74 ft
Depth, to upper deck	33 ft
Draft, loaded	22 ft
Displacement, S.W. at 22-ft draft	9760 tons
Draft, when sidecasting	16 ft 9 in.
Shaft horsepower, twin screw, 2 @ 3000	6000 shp
Hopper capacity	3150 cu yd .

The disposition of weight on the dredge is approximately as follows:

Hull and outfit	4152 tons
Machinery	426 tons
Dredge equipment	1290 tons
Light ship	5868 tons
Fuel, water, etc.	842 tons
Hopper load	3050 tons
Total Displacement	9760 tons (at 22-ft draft, salt water).

The normal hopper load at full-load draft and with a full two-weeks supply of fuel and water on board is 3050 long tons. As fuel and water are consumed during operations, a corresponding additional hopper load can be carried without exceeding the loaded draft. This is accomplished by adjusting the overflow level in the hoppers to create a larger cubic capacity for the dredged material, up to the maximum available volume of 3150 cubic yards.

MODEL TESTS

During the design period, a program of model tests was undertaken to explore certain vital characteristics of the hull form and to determine the validity of earlier design assumptions concerning propulsion power requirements. The model tests were run at the Davidson Laboratory of the Stevens Institute of Technology.

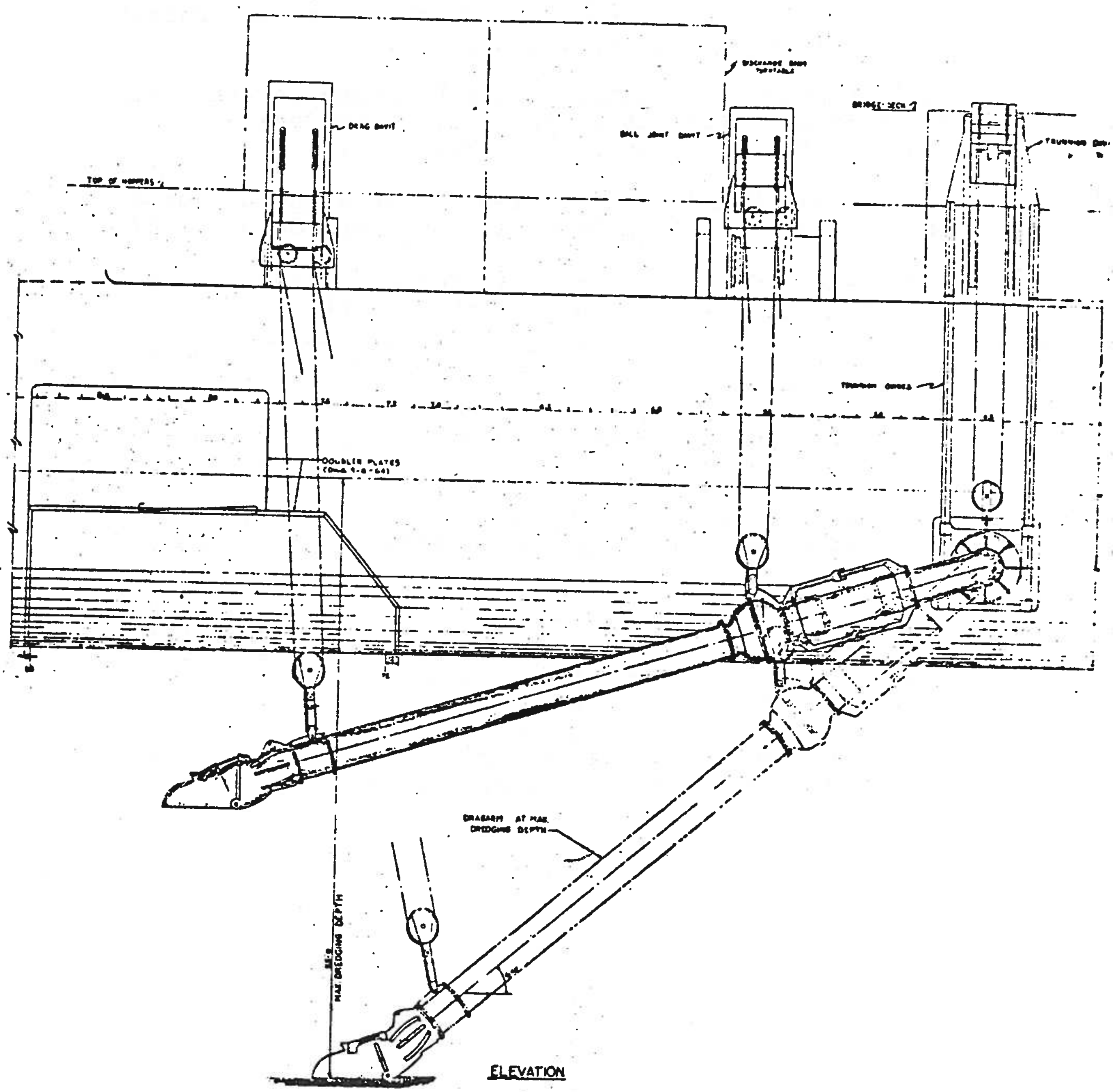

Figure 3

Suction Pipe and Mouthpiece

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