How did dredging start?
A simple question that leads to a complex answer. The origins of dredging go back to the need to determine nautical access as well as the need for flood control. Dredging has existed at least as far back as the Romans. It started with shovelling out a ditch to make it wider and moved on to digging out a meandering river with horse-drawn bucket dredgers to make it more accessible to small boats as they transported goods from one town to another. Fast forwarding to the late 20th century, dredging has evolved and become even more complex, and more necessary as the backbone of economic growth.

Dredging machines are involved in port development, urban expansion, beach replenishment, coastal protection, flood protection, energy exploration and production, mining and environmental remediation and improvement. The magnitude of earth-movings and the kinds of machinery demanded by these activities have caused a surge of research and development and resulted in highly specialised, innovative equipment dedicated to specific projects.

Why is Dredging Equipment so specialised?
Each dredging project has its own unique demands. The cost-efficiency of a project is determined by the matching of the site-specific conditions (hydrometeor, soil, ...) with the characteristic of the dredger. A particular project is influenced by the quantity and type of soil or rock that is present, where it is located and where it may have to be relocated or placed. Weather conditions and the accessibility of the site, such as its depth or width, and environmental issues such as marine habitats, their flora and fauna and contamination must be considered. No single type of dredger is suited for every project.

Two major breakthroughs in power technology allowed for the expansion and specialisation of dredgers: the invention of steam-powered engines in the 19th century and the post-World War II introduction of diesel engines in the marine world.

What are some types of dedicated Dredging Equipment?
Dredging equipment can be classified into several broad categories based on the mode of excavation and how they operate. These include hydraulic dredgers, mechanical dredgers, hydraulic/mechanical combinations, hydrodynamic dredgers and environmental dredgers that have been developed or adapted from standard equipment into dedicated or purpose-built machines. Within all these classifications a distinction can be made between self-propelled and stationary equipment.

What are the most common types of dredgers used today?
Trailing Suction Hopper Dredgers (TSHDs), Cutter Suction Dredgers (CSDs) and Backhoe Dredgers (BHDs) are probably the most common workhorses of the industry. Recently assembled data from 2010 identifies a total of 1481 vessels as active internationally, comprising 604 TSHDs, 565 CSDs, and 311 BHDs.

Since the early 1960s, dredging vessels have evolved to be more powerful, with greater tonnage-carrying capacity and the ability to achieve greater dredging depths. These developments go parallel with ever more environmental-friendly work methods. All this progress is a response to the increased demand of the projects and their economies. In addition to the huge increase in the number of newly built ships, technology advances have also been generated, reflecting the enormous advances that have been made worldwide in technology, such as in GPS, echo-sounders, position and control sensors and other highly accurate means of excavating and computer-controlled operations.

What are Hydraulic/Mechanical Dredgers?
Cutter Suction Dredgers are the most common vessels in this category. Cutters (CSDs) have the ability to dredge nearly all kinds of soils (sand, clay, rock), but since they operate in “quasi-stationary” mode, they are particularly vulnerable when working in shipping channels and also
sensitive to wave conditions and rough seas. The larger and most modern CSDs, however, are generally self-propelled. They can be mobilised over long distances to a project and also readily relocated during the project.

The working principle of the CSD is that it disintegrates or breaks the cohesion of the soil to be dredged mechanically by a rotating cutter head. When the material is loosened or pulverised, it is then sucked up and transported through a pipeline by centrifugal dredge pumps.

What are Hydraulic Dredgers?
Falling in the category of hydraulic dredgers are the Trailing Suction Hopper Dredger (TSHD), plain suction dredger, stationary hopper dredger, dustpan dredger and barge unloading dredger. These dredgers use hydraulic centrifugal pumps to provide the excavating force, and they use hydraulic transport to carry the solids or slurries from the digging site through pipelines to the discharge or placement site. Hydraulic dredgers may also pump into barges for later transport to a placement site. Of all of the above-mentioned types, the TSHD is the most commonly used dredger for larger projects.

What are the main characteristics of Trailing Suction Hopper Dredgers?
The main characteristics of TSHDs are that they are free sailing and self-propelled, seagoing or inland waterway vessels, which are stable and thus relatively insensitive to weather, waves and rough seas. They are also self-loading when trailing and self-unloading or – discharging, and thus also suitable for work in shipping channels. Generally speaking, they dredge “non-rock type” soils.

The dredging cycle of a TSHD begins with loading at the dredging or borrow area, then sailing (loaded) to the unloading area, unloading via bottom opening doors or by pumping and then sailing (empty) back to the dredging area. The carrying capacity in the hopper is restricted either by volume (hopper is full) or by weight (the maximum draught). Production may vary as a result of the soil characteristics and hydraulic conditions; available propulsion power, the size and weight of the draghead; the keel clearance when the ship is loaded; the dredging depth; and the pumping distance. Trailing suction hopper dredgers vary dramatically in size and the capacity of their hoppers.

What are Hydraulic Dredgers are there?
Another type of hydraulic dredger is the Suction Dredger (SD). Amongst the SDs are the plain suction dredger; the stationary hopper dredger, the dustpan dredger and the barge unloading dredger. In the case of the SD, dredging is done by the suction of free running material like sand, and jet water is used for dislodging and fluidising material. A deep suction pit is necessary. In the case of a stationary dredger, the suction arm does not swing, but only intermittently moves forward.
**What are Mechanical Dredgers?**
Mechanical dredgers are in essence similar to dry land excavators. They include Grab or Clamshell Dredgers, Backhoes and Bucket Ladder Dredgers. They usually have no hoppers but discharge into barges which then bring the sediment to the appropriate disposal site. Occasionally a Grab Dredger will have its own hopper within the vessel hold, and will have to travel to the placement site to discharge its cargo as does a TSHD.

**What are the characteristics of a Grab Dredger?**
A Grab Dredger (GB) can be attached to a normal grab-crane on a pontoon or on specially built pontoon (with spuds) with fixed grab-crane on rotating table. Small GBs are often used for areas that are difficult to access, in shallow waters, and also for construction works for shore and bank protection. Material dredged by a grab is loaded into barges and transported to deposit sites. They are suitable for non-rock types of soil and for debris and vegetation, but they are generally unsuitable for creating an even bed.

**What are the features of the Backhoe or Hydraulic Excavator?**
A normal Backhoe (BHD) is located on a flat-top pontoon or, for larger sizes, a specially built pontoon (with spuds) with fixed excavator is attached to a rotating table. A reasonable cutting force can be generated making the BHD suitable for “non-rock” type soils with stones, blasted rock and for precision dredging. The dredged material is then loaded into barges for transport to a disposal site. It is also possible to fit different types of Buckets, Sticks and Booms on the arm of a Backhoe, and to position them with spuds. The advantages of the hydraulic excavator is that whilst the Bucket or Backhoe is less suitable for strong rocks or large boulders, it is suited to precision dredging along quaywalls, slope dredging, and the removal of debris or vegetation.

**What are some other types of Mechanical Dredging Equipment?**
There are a few other types of mechanical dredgers that are used less frequently: The Bucket Ladder Dredger (BLD), the dipper dredger, the rock breaker and the plough or bottom leveller. The Bucket Ladder Dredger was once the mainstay of the dredging fleet, but has long been outpaced by newer TSHDs and CSDs. Still, the BLD is reasonably economical for mixed materials. It works by a revolving chain of buckets, swings even as a Cutter Suction Dredger, with no spuds, but rather position-fixed by wires. At the highest point of the chain the buckets turn upside down to discharge the dredged material into barges.

The dipper dredger is rather like a powered shovel and is mounted on a barge. The shovel empties through the bottom as it discharges into a barge. Dippers come in all sizes. They are particularly suited for dredging boulders and stiff clays.
Rock breakers use hydraulic power to crack rock and can assist other dredgers in removing extremely hard spots. The broken rock is then removed by the other dredger. The plough or bottom leveller assists the TSHD with the removal of ridges and high spots and of soft material from small harbours. It is an inexpensive, low production method as it is not self-propelled but towed by a tugboat.

**What is a Hydrodynamic Dredger?**
Hydronamic dredgers mobilise material underwater and then use the bed slopes natural water currents and density gradients at the dredging site to move the material to a different location. They may be mechanical or hydraulic.

One such hydrodynamic dredger is the Water Injection Dredger (WID). The WID has been used successfully for maintenance dredging. It uses water pressure to fluidise the bottom material to be removed, creating dense fluid slurry. The slurry is then transported from the excavation site by currents, either induced by the density gradient between the slurry and the water, or by naturally occurring currents, such as from tides. This is a relatively low-cost technique whose use is limited to silts unconsolidated clays and fine sands. It is less suited for environmentally sensitive areas as one has no real control over the deposit location.

**What are Environmental Dredgers?**
Environmental improvements to dredging techniques have become increasingly important over the last 25 years. For instance, new or modified dredging techniques try to minimise turbulence and turbidity to causes less disturbance to marine flora and fauna. One example of this is the “green valve” system developed for TSHDs, which reduces turbidity caused by overflow during the dredging process.

Environmental dredging tries to optimise the precision with which operations are done, for instance, to execute accurate thin layers so that there is less dredged material to be disposed of, especially if the dredged material is contaminated. For this purpose special Environmental Dredgers have been developed, which are primarily modifications of CSDs, BHDs, and GDs.

**What other types of Dredging Equipment are in use?**
Large dredging vessels are also supported by a variety of water-based equipment, such as previously mentioned barges, work boats and launches, anchor pontoons, floating line pontoons and booster pumping stations. Other equipment includes multicats and survey launches, floating pipeline pontoons and rubber floating pipelines, conveyor belts for transport as well some land-based equipment.

**How do you match the proper dredging equipment to the job?**
The choice of equipment depends on the type of soil conditions, the transport options, the configuration of the dredging area, including pre- and post-dredge water depths and placement requirements as regards environmental and other considerations. Because of the wide variety of tools – vessel sizes, diesel engine power and hopper capacity – clients, often assisted by expert consultants, can best seek the advice of the dredging companies themselves to help find reasonable, economical solutions, within the framework of competitive bidding processes.

**For further reading and information**
Construction and Survey Accuracies (2001), Rotterdam Public Works.

This brochure is presented by the International Association of Dredging Companies whose members offer the highest quality and professionalism in dredging and maritime construction. The information presented here is part of an on-going effort to support clients and others in understanding the fundamental principles of dredging and maritime construction.