Dredge Crawler Technology

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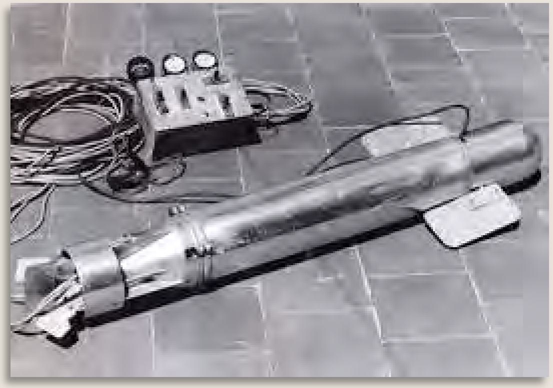
WODCON XXI

Miami, Florida, USA
June 13 –17, 2016

The technology innovator.

INTRODUCTION

- The first attempt to make a programmed underwater vehicle was a torpedo developed by Luppis-Whitehead in Austria in 1864.
- First tethered ROV, named POODLE was developed by Dimitri Rebikoff in 1953.



- The United States Navy funded most of the early ROV technology in the 1960s resulting in the so-called 'Cable-controlled Underwater Recovery Vehicle'.
- The real introduction of ROV technology came from the wide commercialization of offshore oil and gas exploration and operation.
- Nowadays ROV's perform numerous tasks in many fields. A typical example of a crawler is the subsea mining crawler built for De Beers Marine.

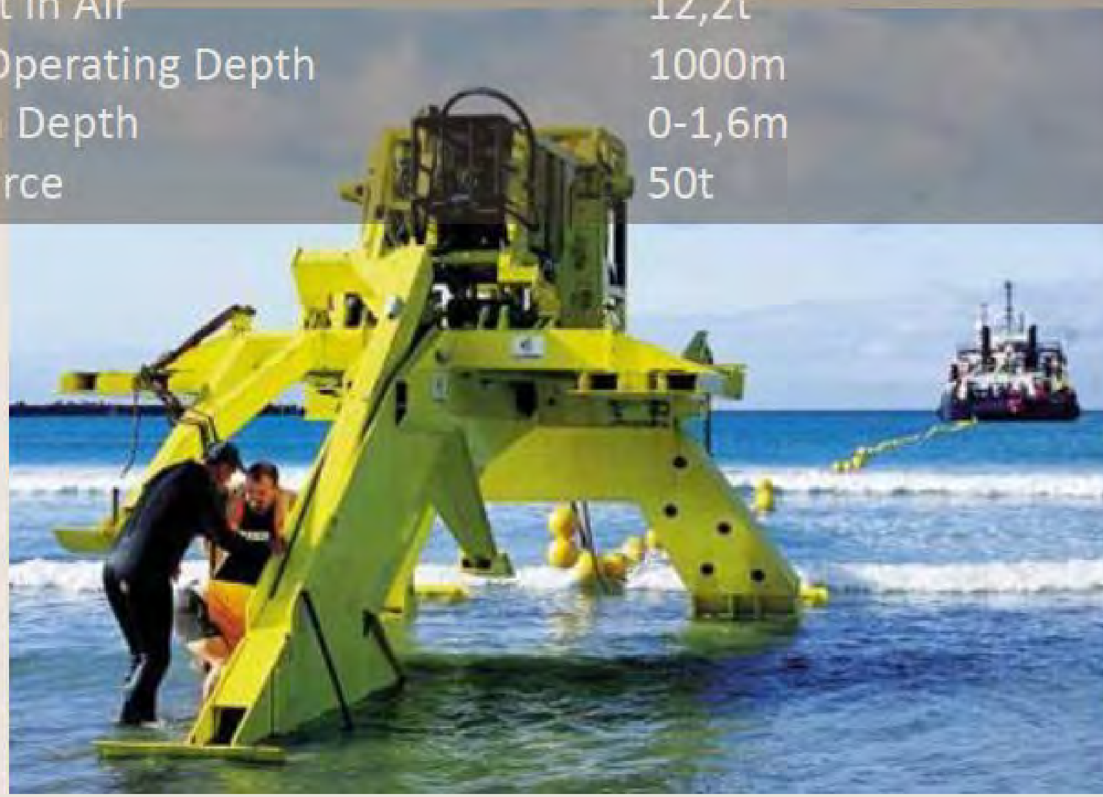
IHC Subsea Vehicles

Small plough

Sea Stallion 2

Main Specifications:

Weight in Air	12,2t
Max. Operating Depth	1000m
Trench Depth	0-1,6m
Tow force	50t

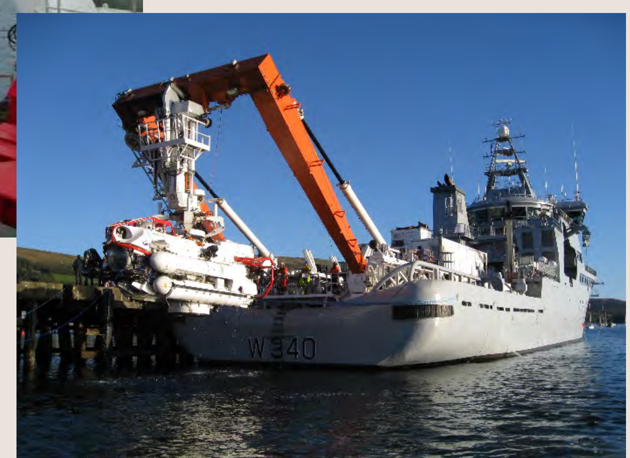


Big plough


Engineering Business Ltd
PL3
Saipem
PL3, multi pass
Main Specifications:
Weight in Air 205t
Max. Operating Depth 1000m
Trench Depth 0-2,5m
Tow force 400t
Product diameter 1220mm

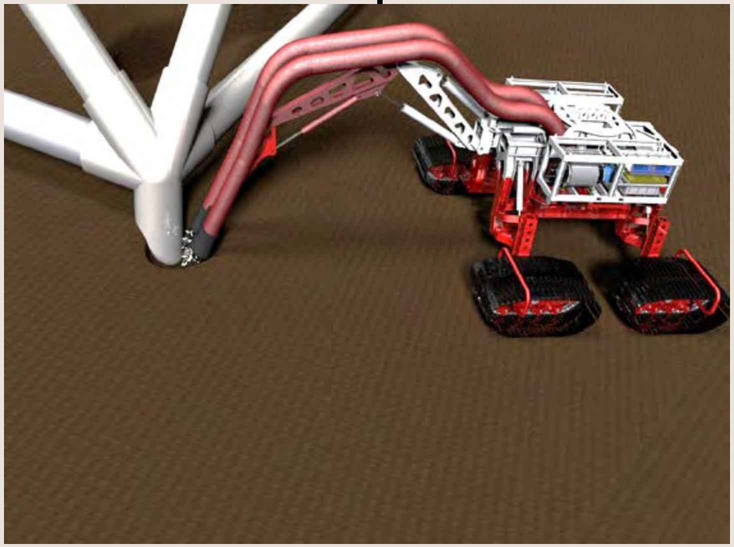
TYPES OF OPERATION

Deep Sea Mining



Subsea installations

Excavation operations



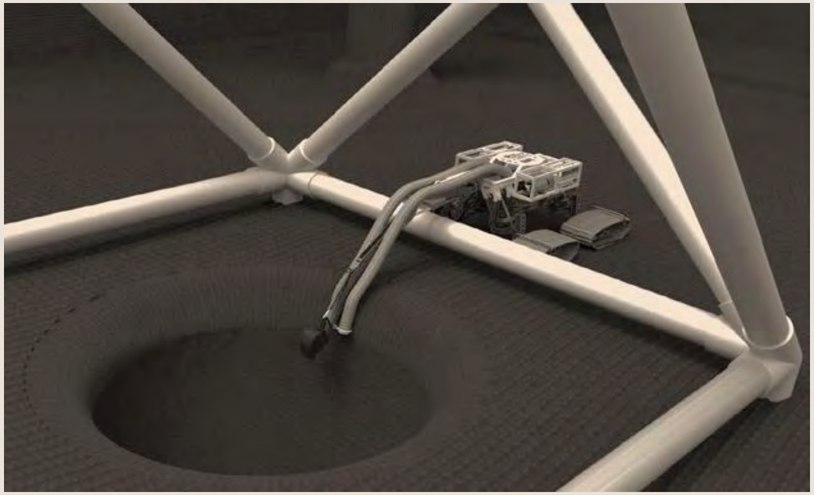
Seabed preparations / seabed leveling

- **Boulder / debris removal**

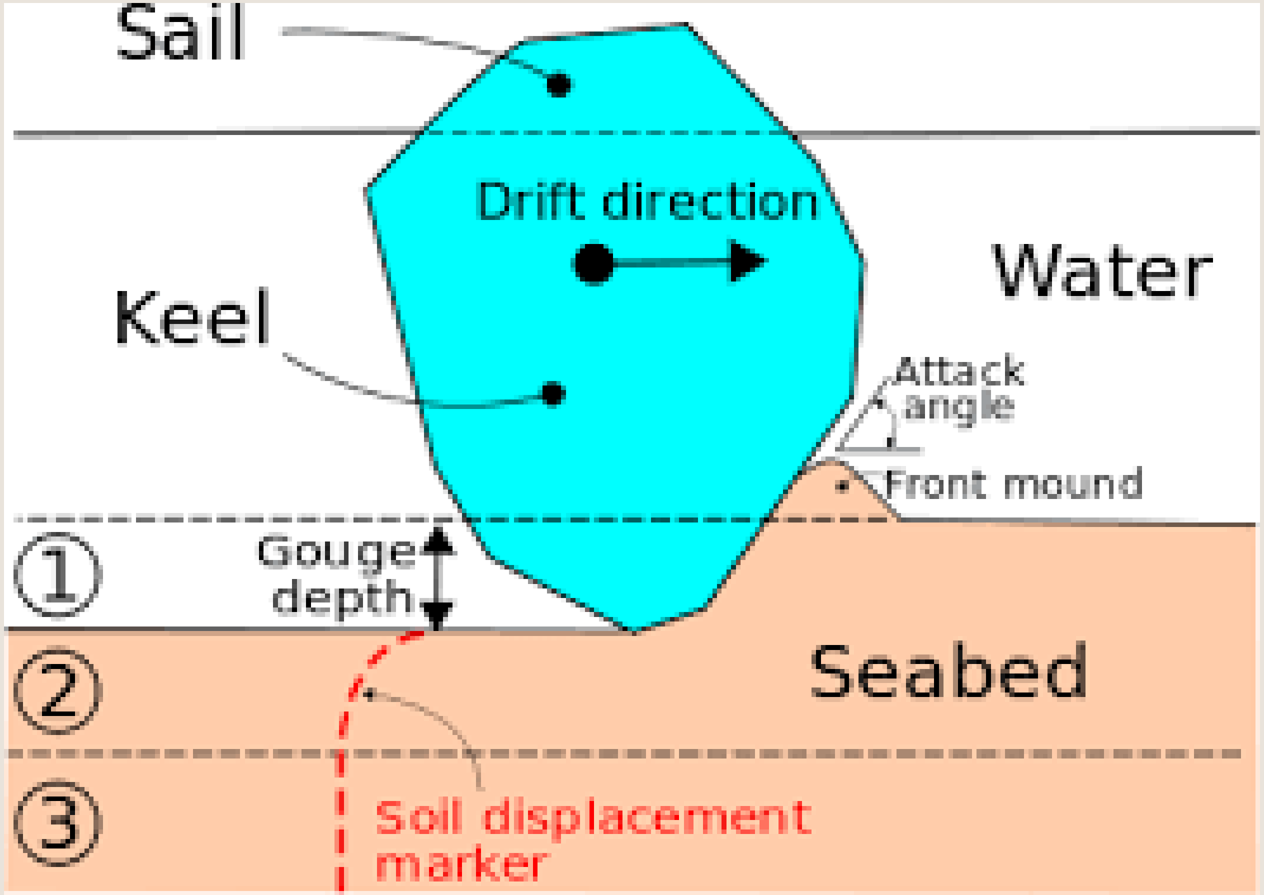
Boulder / Debris removal

Decommissioning

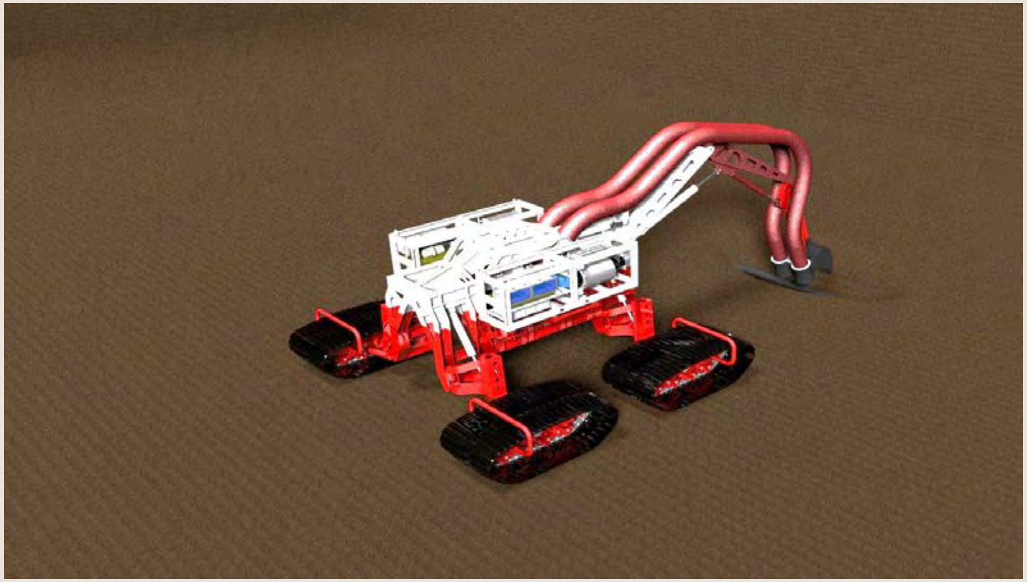
- Legislation governing the decommissioning of ageing offshore infrastructure, particularly Oil & Gas assets, is becoming more stringent with differing levels of acceptance across the globe. North Sea installations must be removed and recycled including the removal of foundations to in excess of 3m below seabed level.

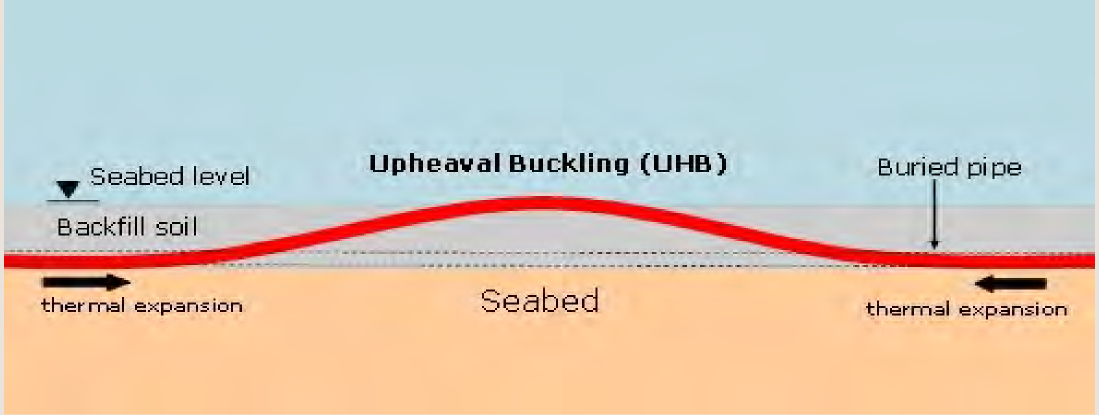


Creation of mudline cellars to protect delicate subsea infrastructure from Ice Scour or foreign object damage



Remediation works





Subsea crawlers

IHC Designed a multi-tool platform for conducting a variety of operations from excavation to lifting, cutting and mulching.

IHC Hi-Traq Crawler

beea 2014 WINNER
british engineering excellence awards

The automated self-levelling system provides a stable, level operational platform.

IHC

beea 2014 WINNER
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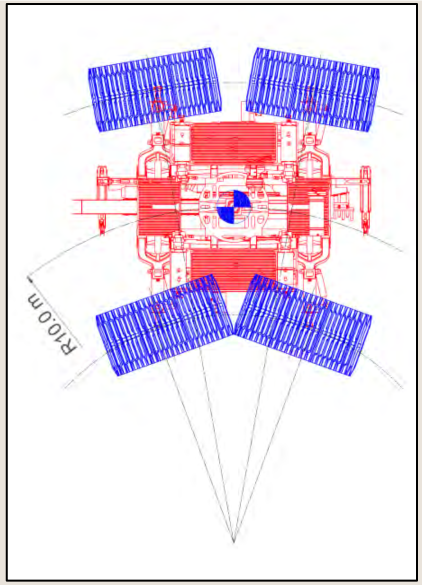
Wagon Steering

- R10.0 m turning during trenching
- Constant high traction whilst cornering
- Always creates a vertical trench



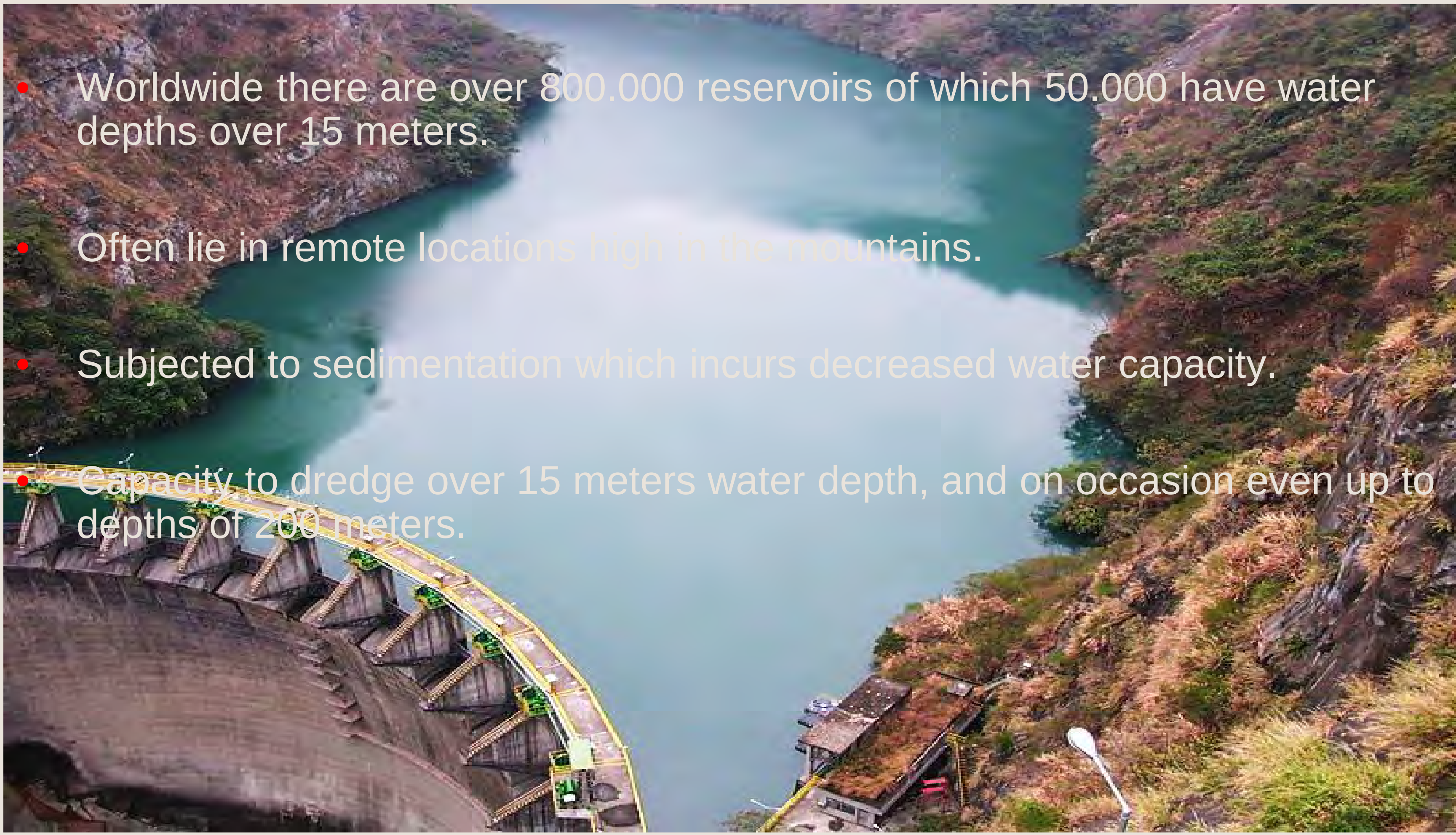
Maintenance Dredging (small scale)

- Ports and Marinas.
- Reservoirs and basins.
- Special projects like small backwaters, water locks, underneath floating docks, sand pits, environmental dredging etc.

Ports And Marinas

- Ports and marinas continuously require maintenance dredging.
- For example, the port of Rotterdam needs 14.5 million cubic meters of silt dredging on an annual basis.
- Marinas are sheltered areas, but also need dredging due to tidal movement of sediment or even seabed movement from storms.
- The difference between dredging a port or a marina can be found in volume and dredging depth.

Reservoirs and Basins



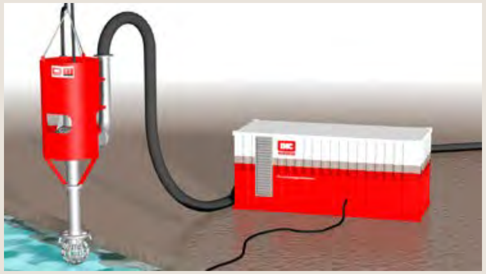
- Worldwide there are over 800.000 reservoirs of which 50.000 have water depths over 15 meters.
- Often lie in remote locations high in the mountains.
- Subjected to sedimentation which incurs decreased water capacity.
- Capacity to dredge over 15 meters water depth, and on occasion even up to depths of 200 meters.

Special Projects

- Dredging under floating structures like floating docks.
- Dredging in crowded areas like inner cities, where large construction activities are not disirable.
- Environmental clean-up or contaminated spot dredging.

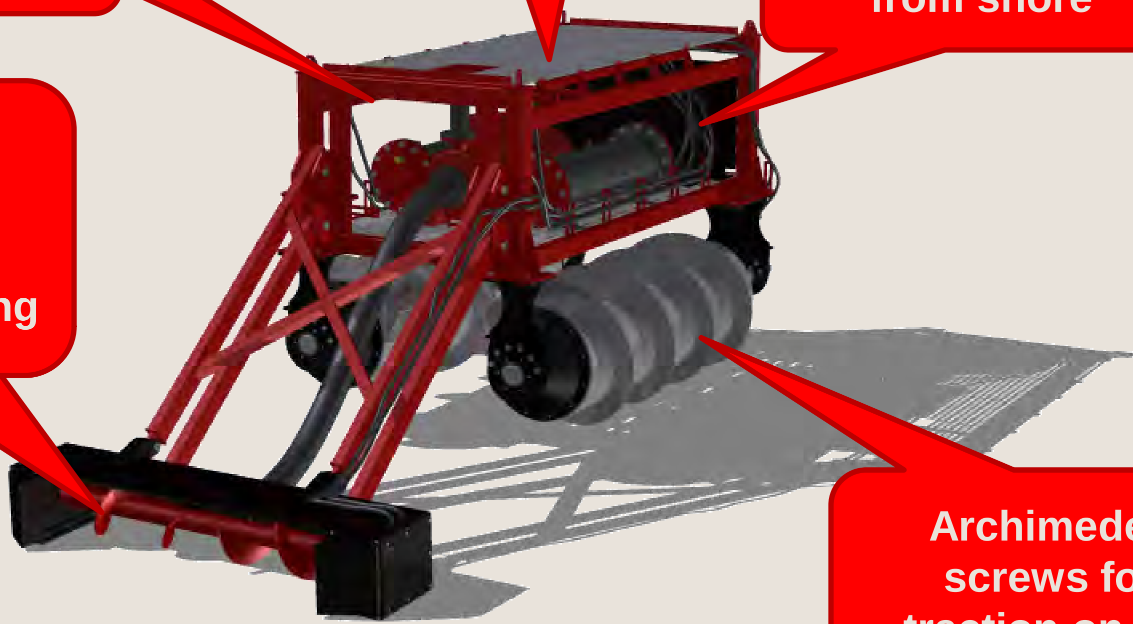
Equipment Requirements

- Easy transportation and mobilization to remote areas, even in mountains.
- Dredging in up to 200 meters water depth.
- Move in and on soft soils.
- Accurate.
- Changing type of dredge tools
- Capable of dredging in up to 200 meters water depth.

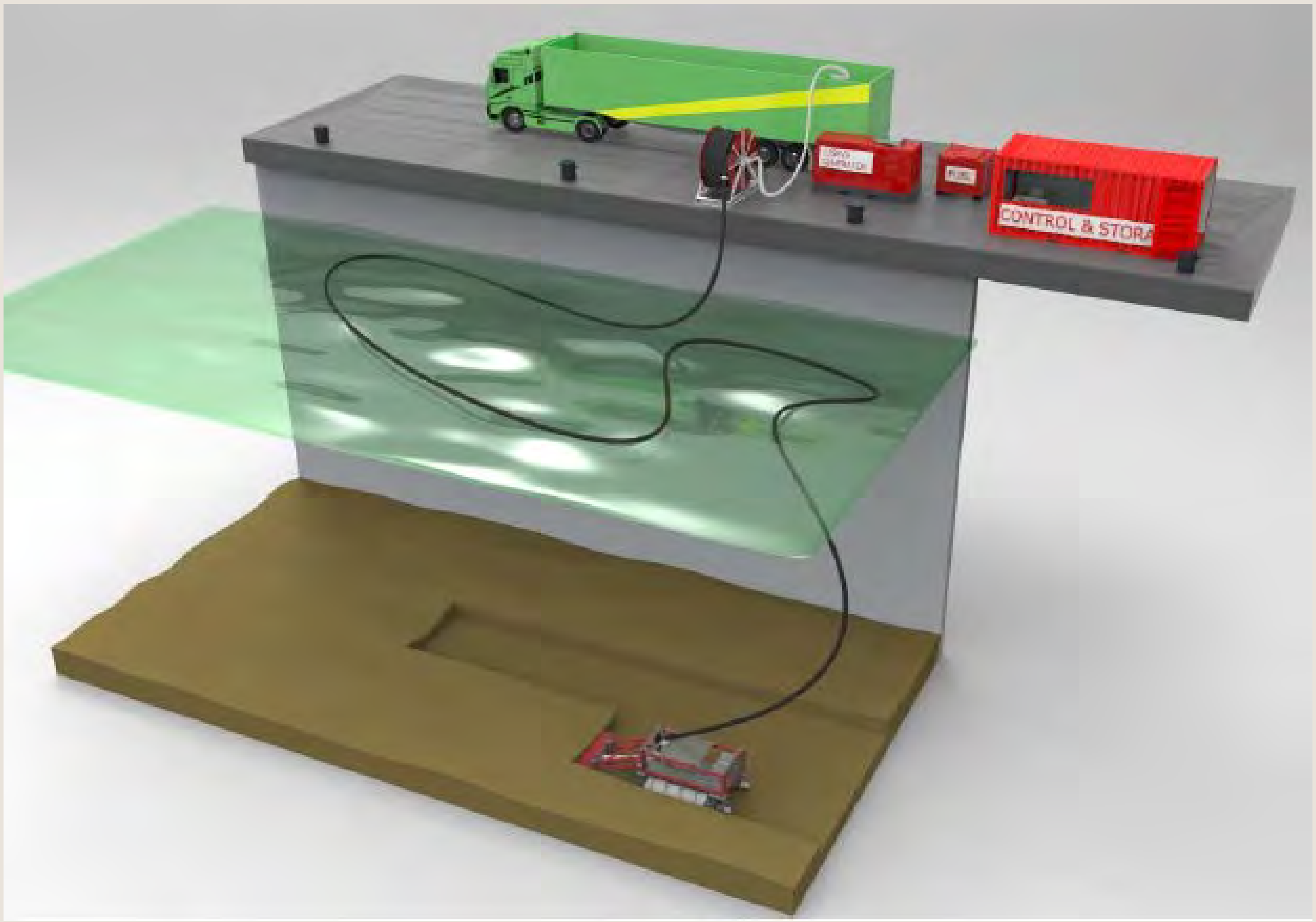


- Alternatives:
  - Submersible dredge pump
  - Grab dredger
    - Advantage: grab dredger can pick up large pieces of debris like tree trunks, which is not possible with a hydraulic solution.
    - Disadvantage: Not accurate dredging at these large water depths.
    - Long cycle times at larger depths.

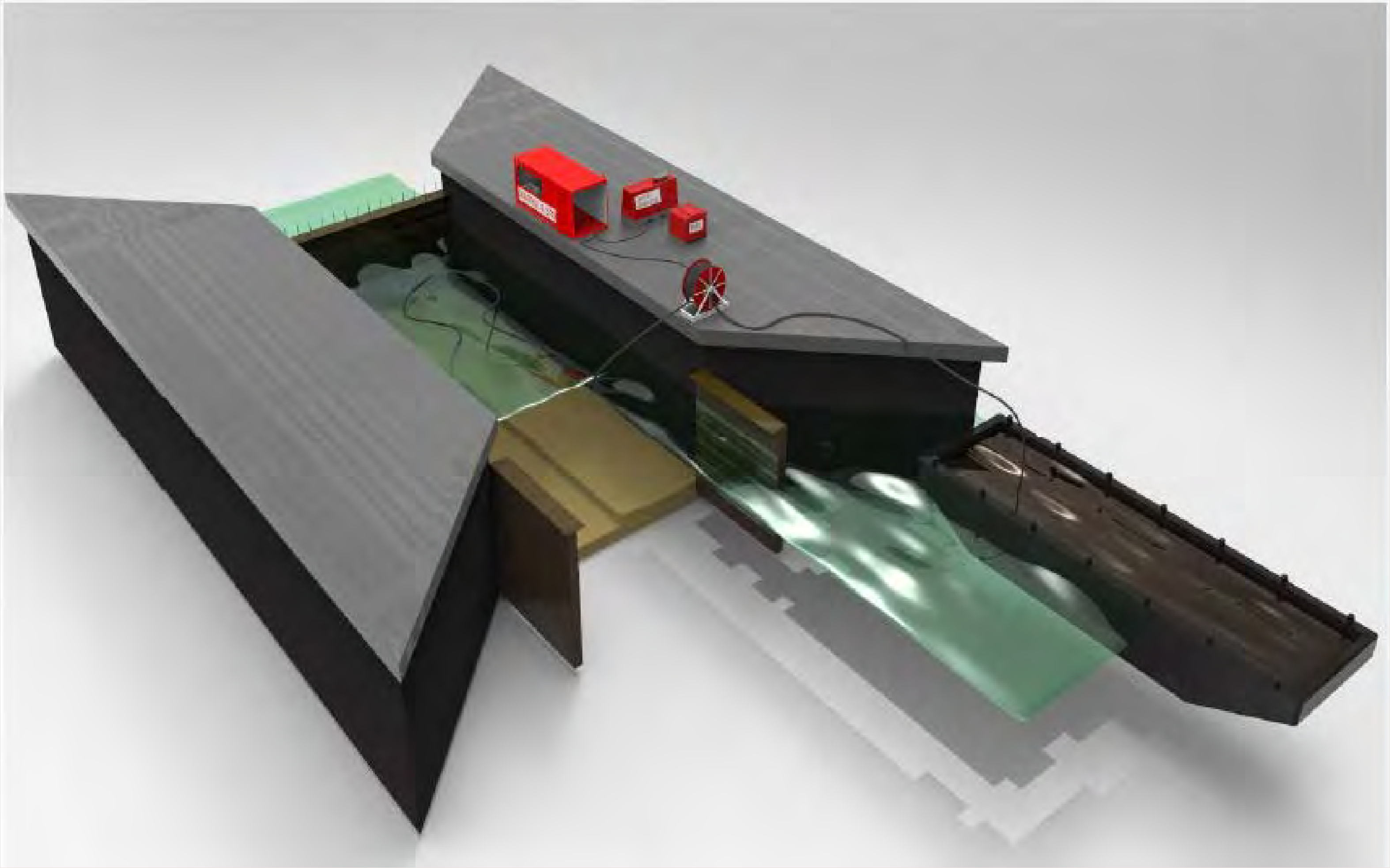
IHC Dredge Crawler "DredgeBot"



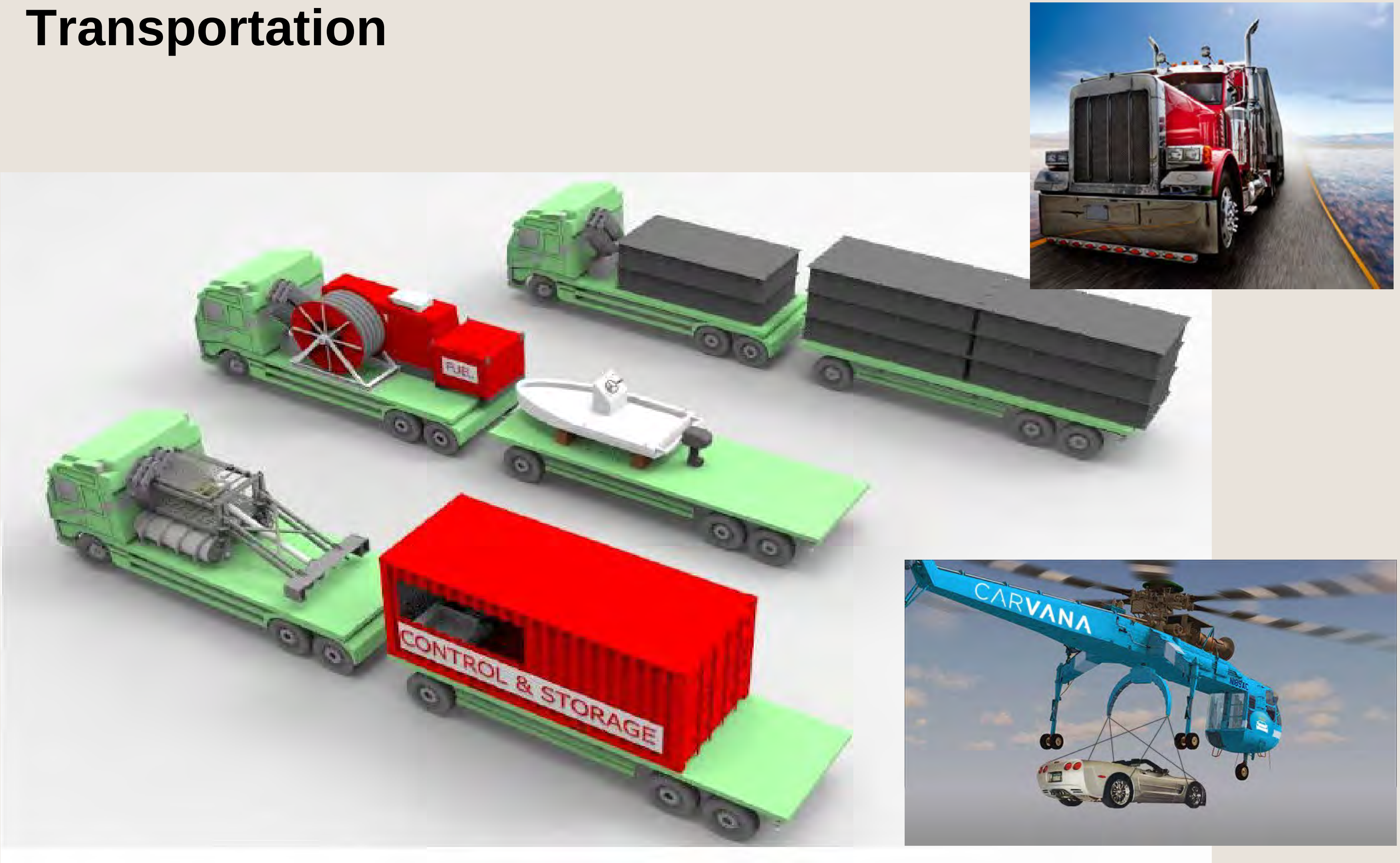
Reservoir dredging



Dredging in locks

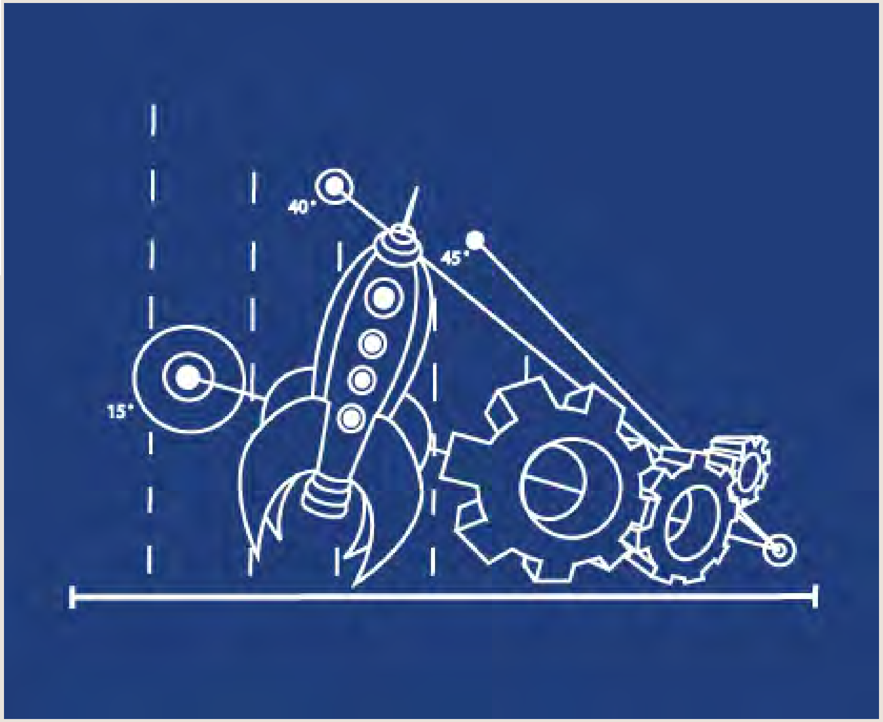


Transportation



Prototyping of DredgeBot

ENGINEERING CONSIDERATIONS



Available excavation crawlers (dredge crawlers)

id	Make/Type
a	Sludge Eater
b	Rangga Mas Gading dredging robots
c	SEABED DREDGER "SBD2
d	EDDY PUMP® SEV4045 Compact Submersible Tracked Dredge
e	SEABED EXCAVATOR
f	Mud Cat™ ROV SRD-6E

Type of Propulsion for Dredge Crawlers

Most common option to drive crawlers over the bottom are tracks.

However when the soil becomes loose or water content is high:

- The carrying capacity is too low for tracks (sinking into the soil or get stuck).
- It is impossible to get enough traction to move forward.
- Reaction forces of the crawler tool (auger) become difficult to transfer back into the bottom.

As a result, in extremely soft bottom conditions tracks may not be best appropriate.

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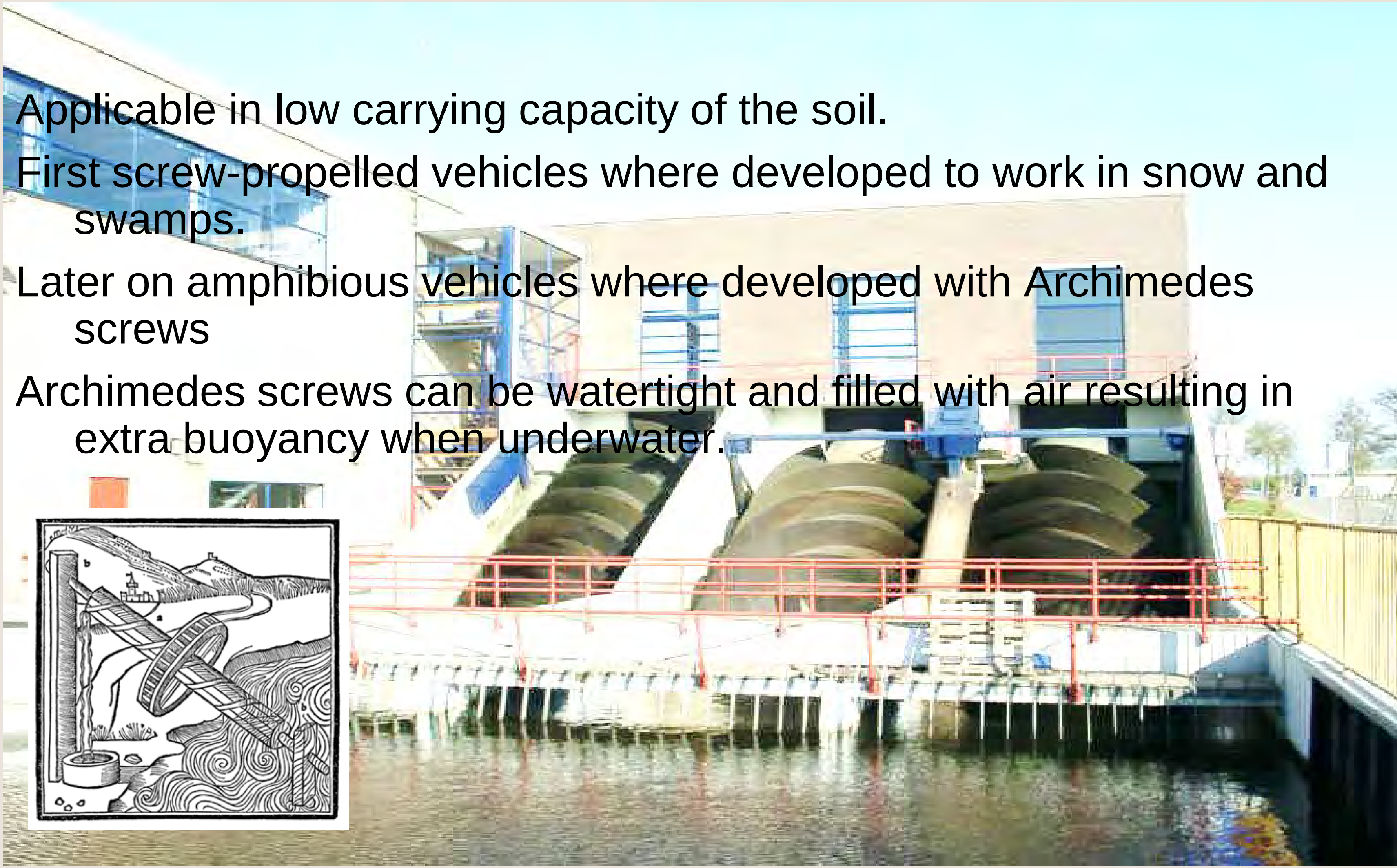
Application of Archimedes Screws



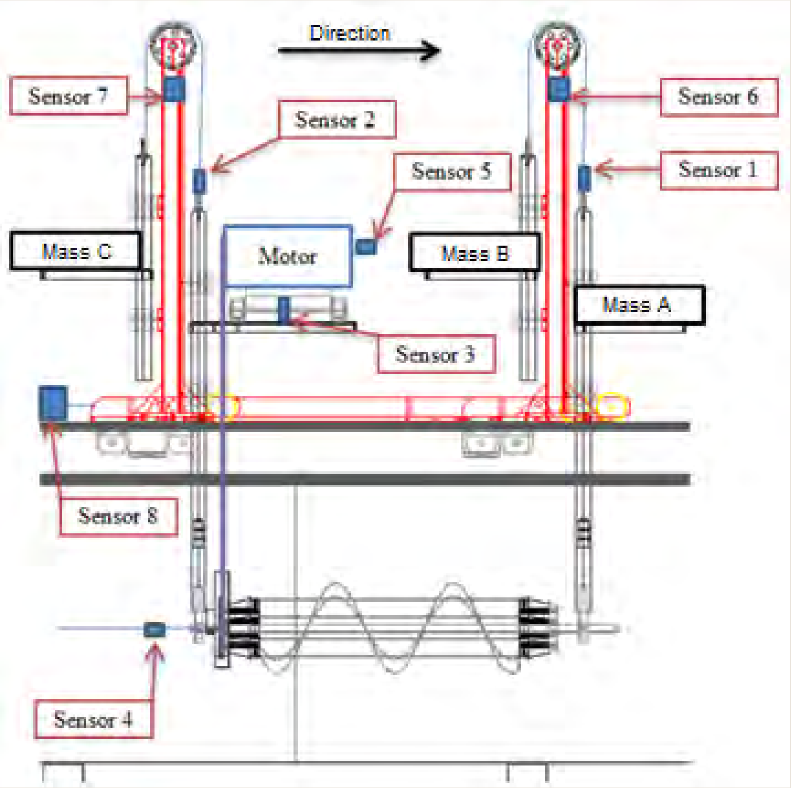
Applicable in low carrying capacity of the soil.

First screw-propelled vehicles where developed to work in snow and swamps.

Later on amphibious vehicles where developed with Archimedes screws

Archimedes screws can be watertight and filled with air resulting in extra buoyancy when underwater.

Testing of the Archimedes Screws in the IHC Innovation lab.



Test parameters

In these tests the following parameters were tested:

- Ground pressure front and aft.
- Torque of the electromotor.
- Traction of the vehicle.
- Speed of the electromotor.
- Sinkage of the screw in the soil.
- Distance driven by the vehicle from which the speed is derived.

Learned:

- Optimization of traction can be made on the pitch angle and height of the vanes.
- Diameter and length of the screws influences friction and slip velocity.

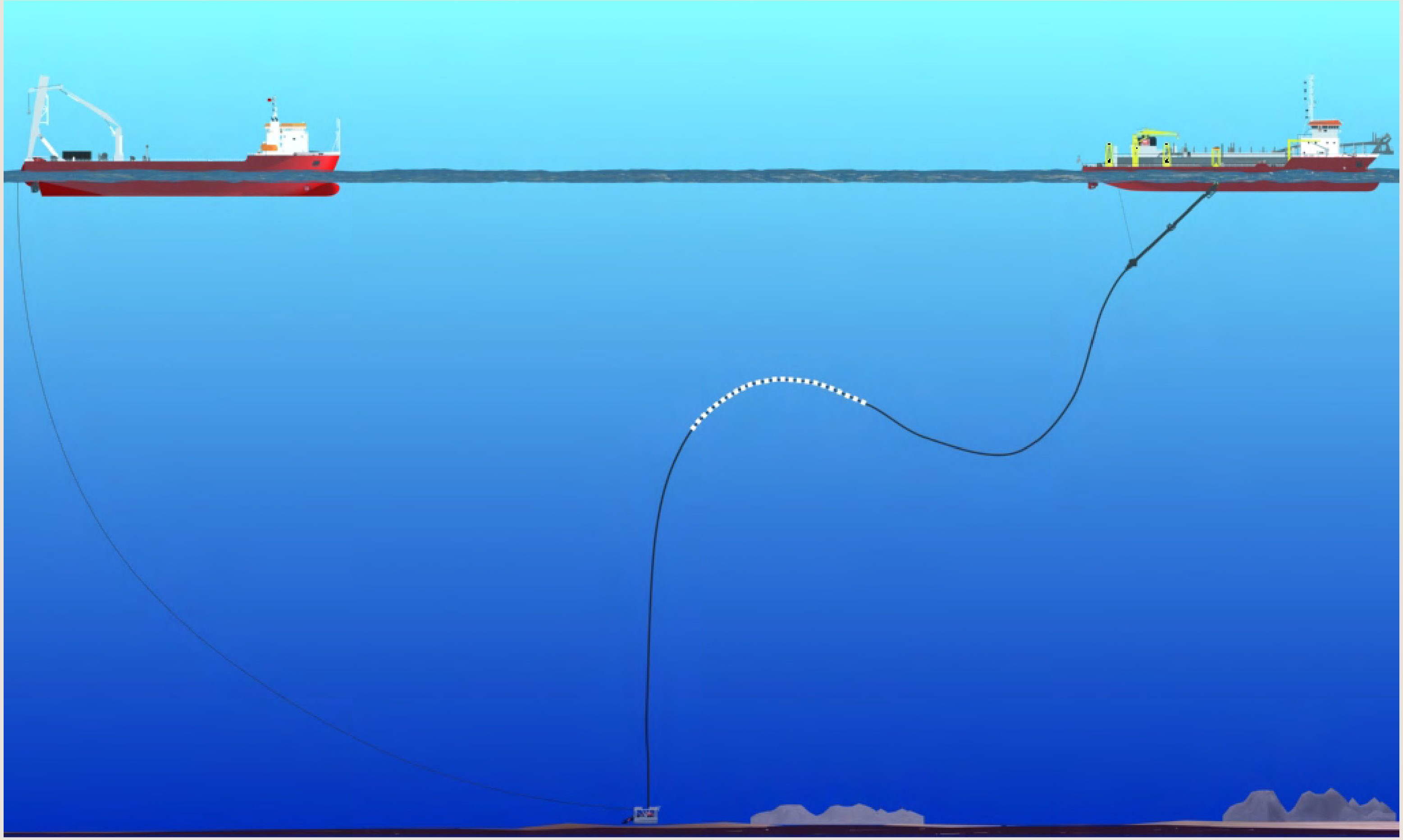
Conclusion: On soft bottoms Archimedes Screws are more beneficial than tracks.

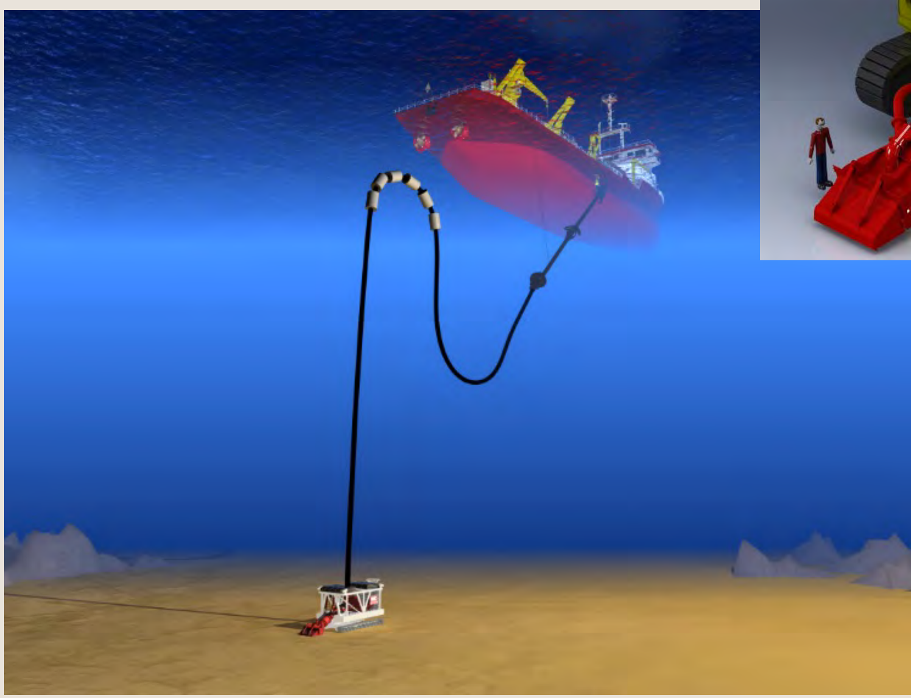
Other engineering aspects, Seabed Terrain

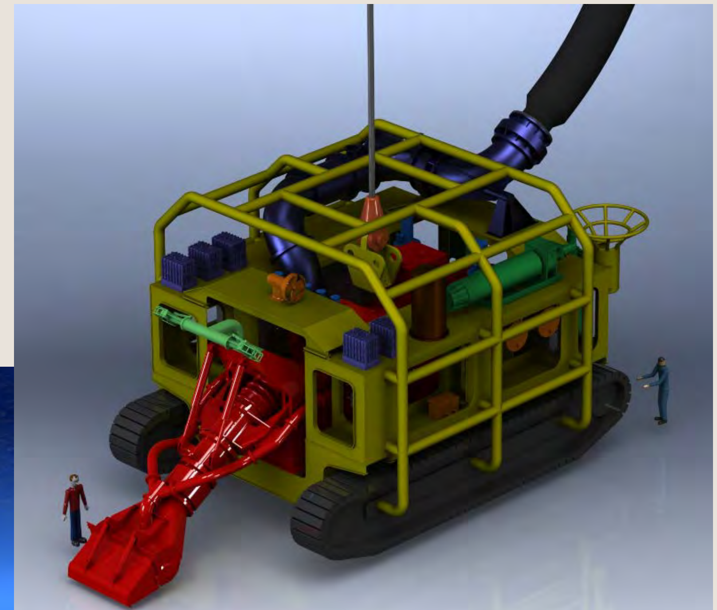
- Often unstable seabed conditions occur
- Crawler stability and maneuverability are key performance characteristics.
- Safe operations require a level operational platform and constant ground contact.
- Equipment must be able to operate on very soft seabed conditions without imposing the risk of sinking.

This has culminated in the design of a unique four-track vehicle.

Concepts under development







Questions?