DEME

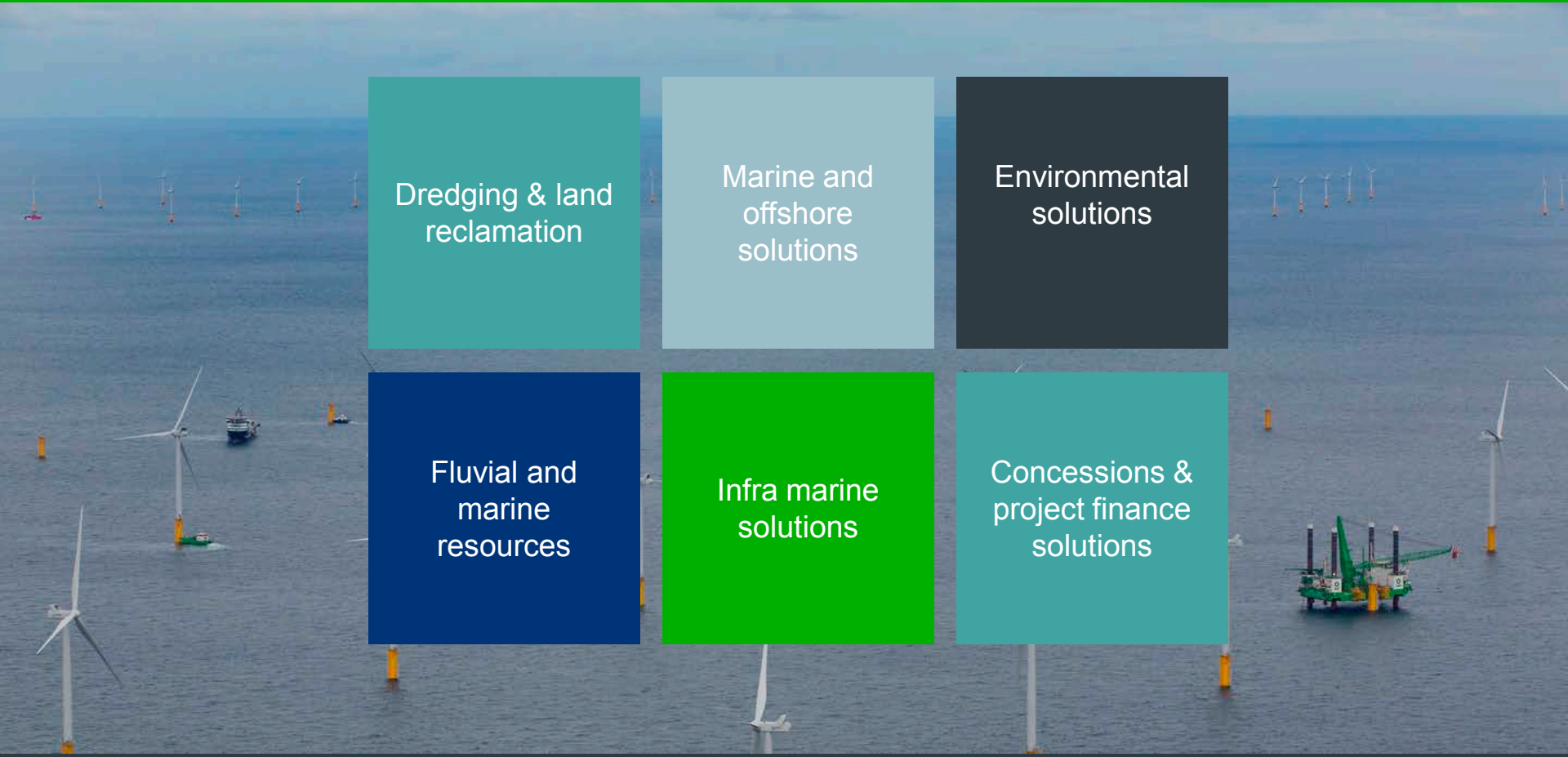
Dredging, Environmental & Marine Engineering

Innovative grab dredging

The rebirth of an old technique

Simon Boel – WODCON XXI – 15/06/2016

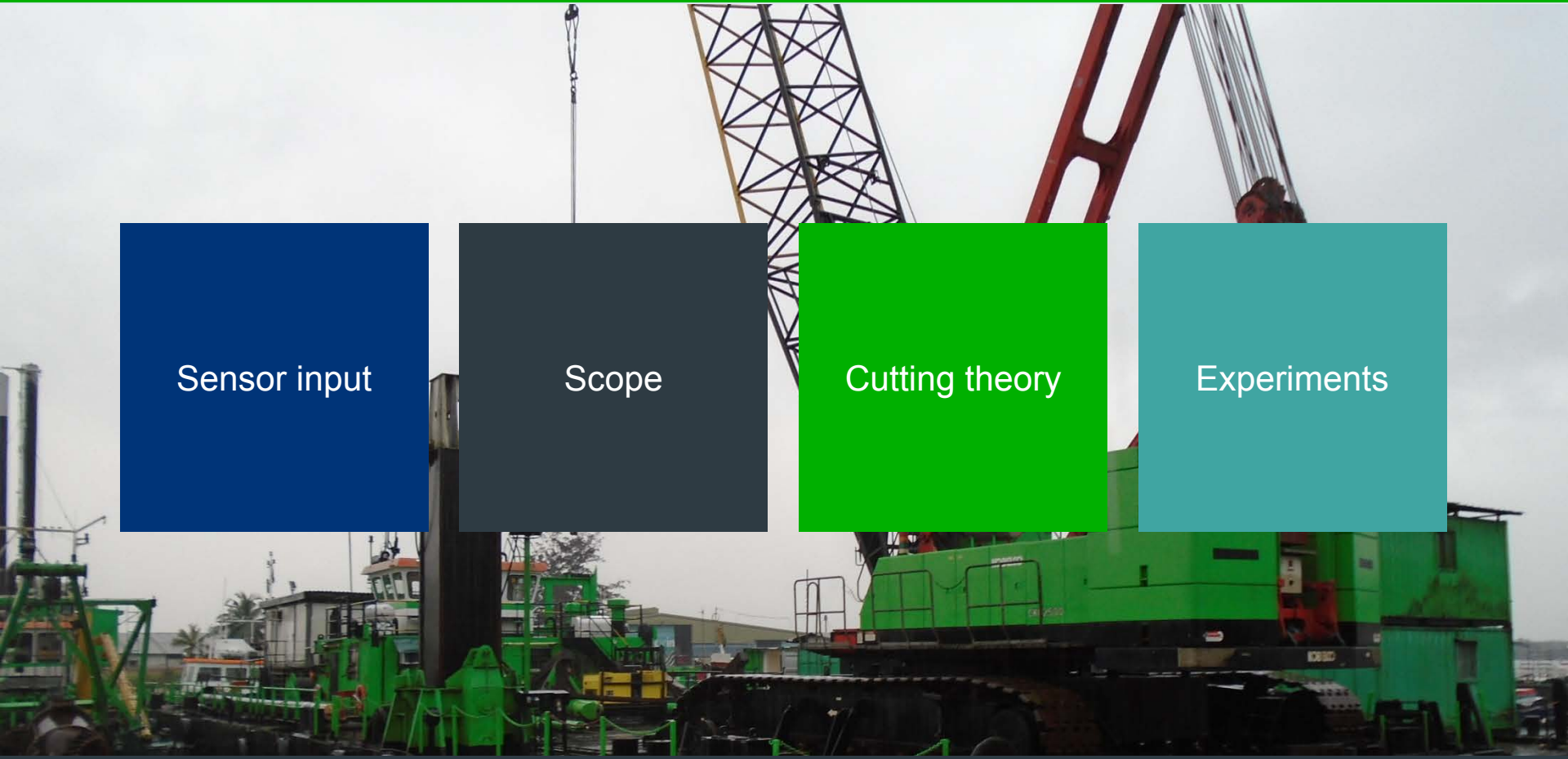
Activities for global solutions



- Dredging & land reclamation
- Marine and offshore solutions
- Environmental solutions
- Fluvial and marine resources
- Infra marine solutions
- Concessions & project finance solutions

A rope, a bucket and a lifting crane. Simple.

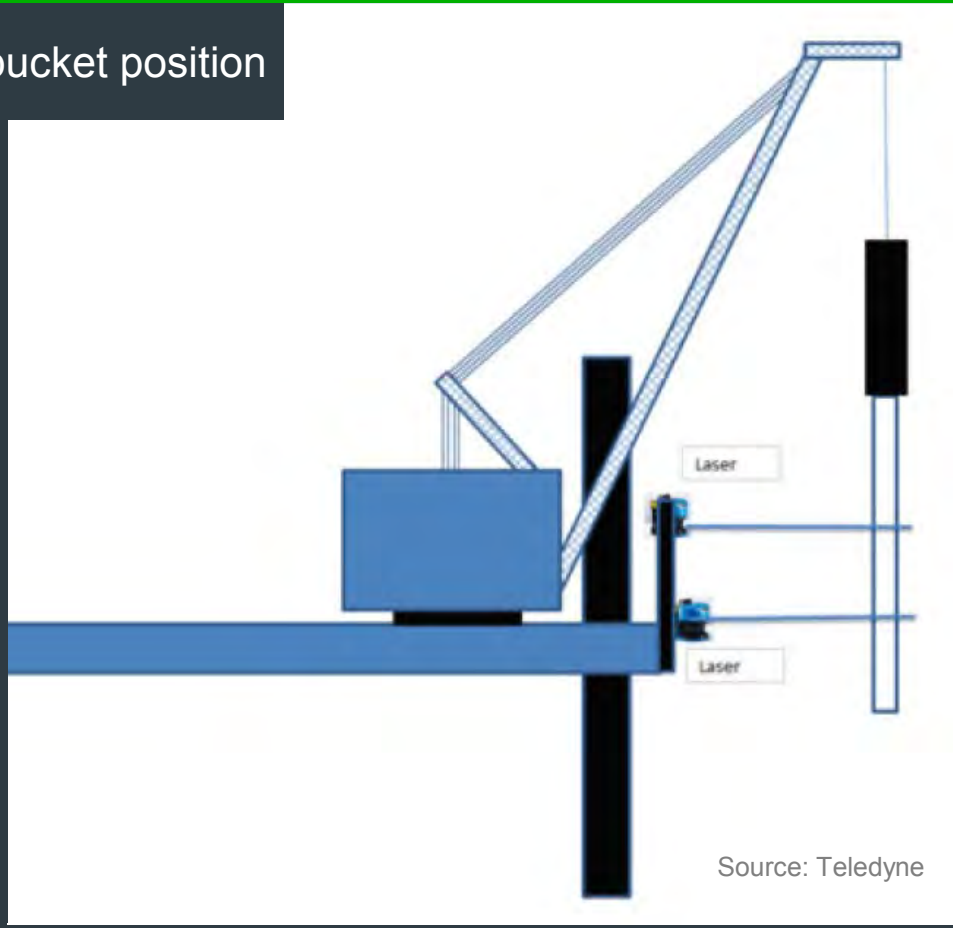
Innovative grab dredging – The rebirth of an old technique



Sensor input

Innovative grab dredging – The rebirth of an old technique

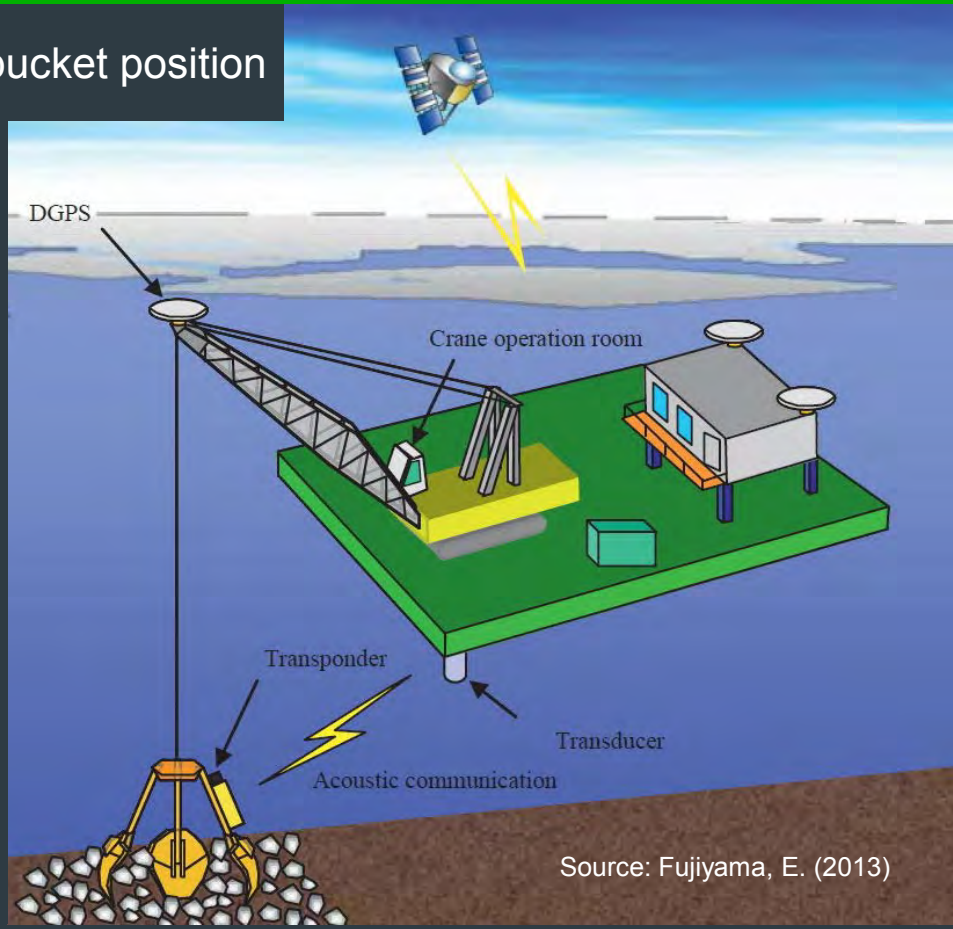
Sensor input: bucket position



Source: Teledyne

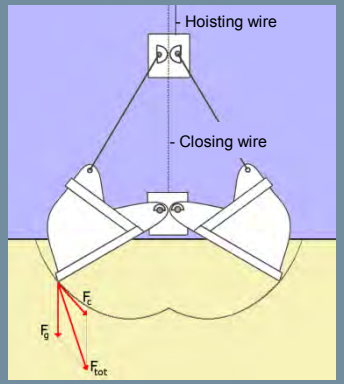
Innovative grab dredging – The rebirth of an old technique

Sensor input: bucket position



Source: Fujiyama, E. (2013)

Sensor input: Active Closing Process Control



Standard method

- Lower open grab until seabed
- Hoist *closing wire* until closure
- Hoist both wires
- Manual / simple autopilot
- Craters

Active Closing Process Control

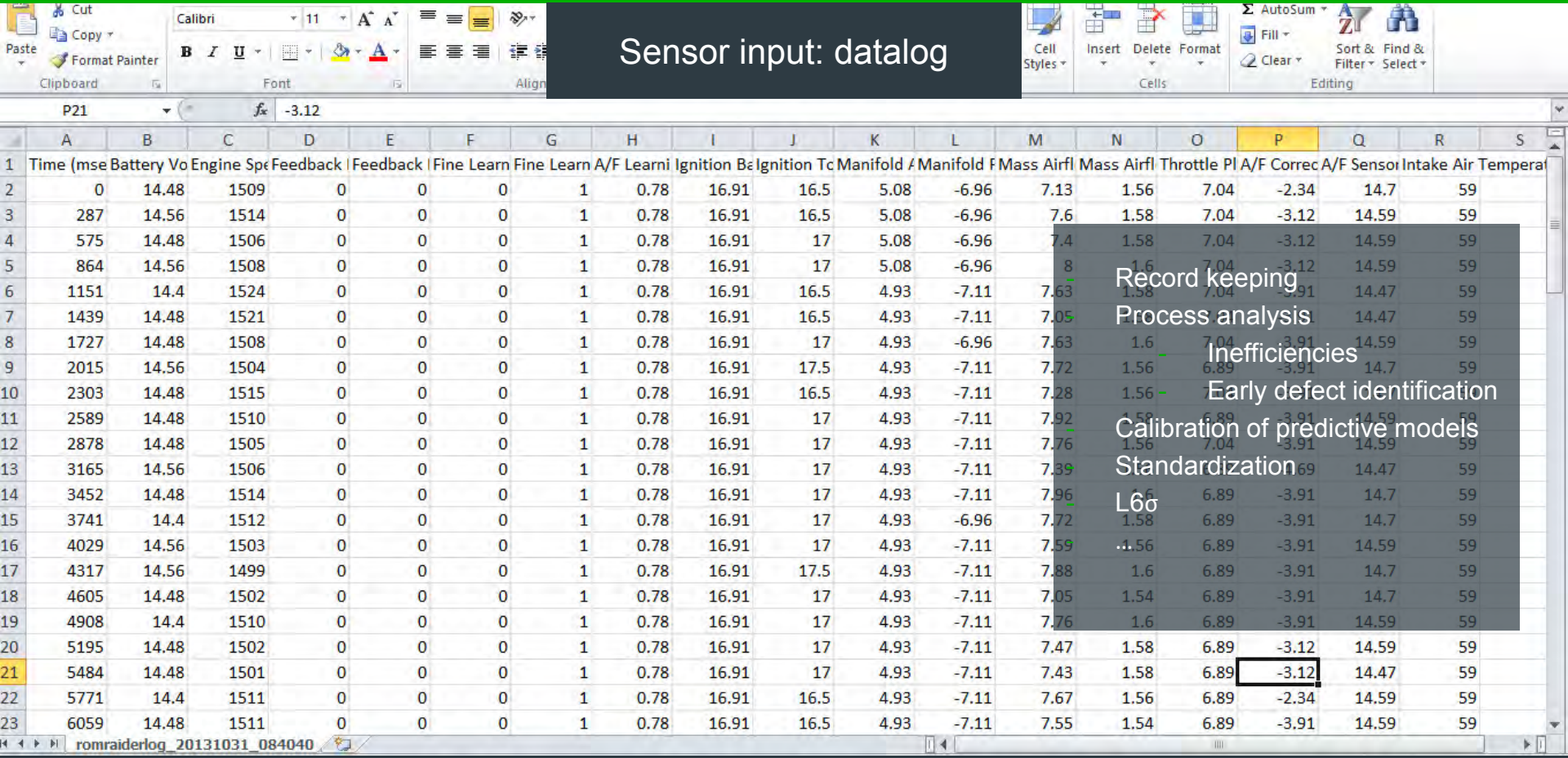
- Lower open grab until seabed
- Combined hoisting *closing wire* & reeving out *hoisting wire*
- Hoist both wires
- Complex control
- Horizontal profile

Sensor input: Active Closing Process Control

Source: Liebherr

Innovative grab dredging – The rebirth of an old technique

Sensor input: datalog



P21 | -3.12

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Time (mse	Battery Vo	Engine Spe	Feedback	Feedback	Fine Learn	Fine Learn	A/F Learni	Ignition Ba	Ignition Tc	Manifold A	Manifold P	Mass Airfl	Mass Airfl	Throttle Pl	A/F Correc	A/F Sensor	Intake Air	Temperat
2	0	14.48	1509	0	0	0	1	0.78	16.91	16.5	5.08	-6.96	7.13	1.56	7.04	-2.34	14.7	59	
3	287	14.56	1514	0	0	0	1	0.78	16.91	16.5	5.08	-6.96	7.6	1.58	7.04	-3.12	14.59	59	
4	575	14.48	1506	0	0	0	1	0.78	16.91	17	5.08	-6.96	7.4	1.58	7.04	-3.12	14.59	59	
5	864	14.56	1508	0	0	0	1	0.78	16.91	17	5.08	-6.96	8	1.6	7.04	-3.12	14.59	59	
6	1151	14.4	1524	0	0	0	1	0.78	16.91	16.5	4.93	-7.11	7.63	1.58	7.04	-3.91	14.47	59	
7	1439	14.48	1521	0	0	0	1	0.78	16.91	16.5	4.93	-7.11	7.05	1.58	7.04	-3.91	14.47	59	
8	1727	14.48	1508	0	0	0	1	0.78	16.91	17	4.93	-6.96	7.63	1.6	7.04	-3.91	14.59	59	
9	2015	14.56	1504	0	0	0	1	0.78	16.91	17.5	4.93	-7.11	7.72	1.56	6.89	-3.91	14.7	59	
10	2303	14.48	1515	0	0	0	1	0.78	16.91	16.5	4.93	-7.11	7.28	1.56	7.04	-3.91	14.59	59	
11	2589	14.48	1510	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.92	1.58	6.89	-3.91	14.59	59	
12	2878	14.48	1505	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.76	1.56	7.04	-3.91	14.59	59	
13	3165	14.56	1506	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.39	1.56	6.89	-3.91	14.47	59	
14	3452	14.48	1514	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.96	1.6	6.89	-3.91	14.7	59	
15	3741	14.4	1512	0	0	0	1	0.78	16.91	17	4.93	-6.96	7.72	1.58	6.89	-3.91	14.7	59	
16	4029	14.56	1503	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.59	1.56	6.89	-3.91	14.59	59	
17	4317	14.56	1499	0	0	0	1	0.78	16.91	17.5	4.93	-7.11	7.88	1.6	6.89	-3.91	14.7	59	
18	4605	14.48	1502	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.05	1.54	6.89	-3.91	14.7	59	
19	4908	14.4	1510	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.76	1.6	6.89	-3.91	14.59	59	
20	5195	14.48	1502	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.47	1.58	6.89	-3.12	14.59	59	
21	5484	14.48	1501	0	0	0	1	0.78	16.91	17	4.93	-7.11	7.43	1.58	6.89	-3.12	14.47	59	
22	5771	14.4	1511	0	0	0	1	0.78	16.91	16.5	4.93	-7.11	7.67	1.56	6.89	-2.34	14.59	59	
23	6059	14.48	1511	0	0	0	1	0.78	16.91	16.5	4.93	-7.11	7.55	1.54	6.89	-3.91	14.59	59	

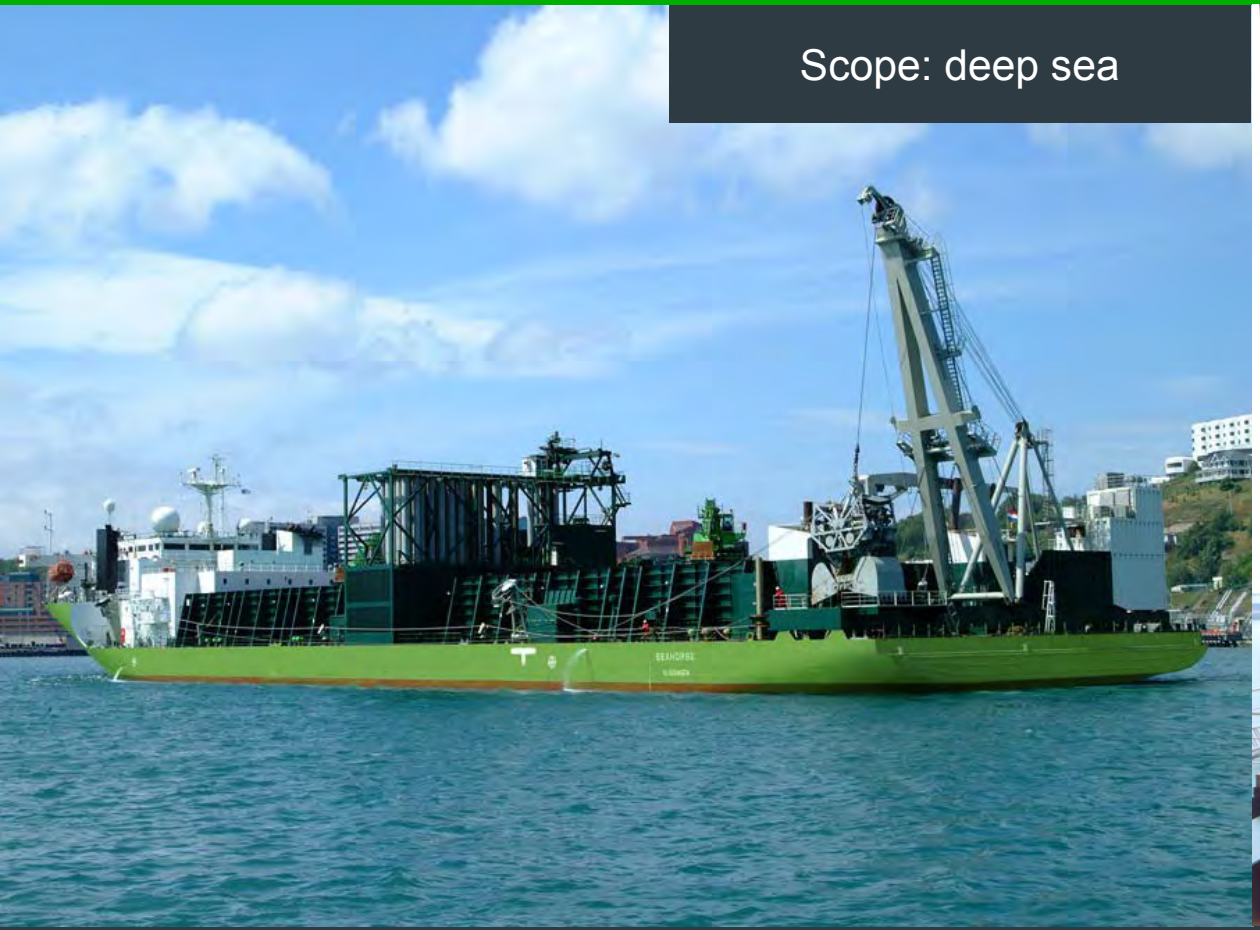
romraiderlog_20131031_084040

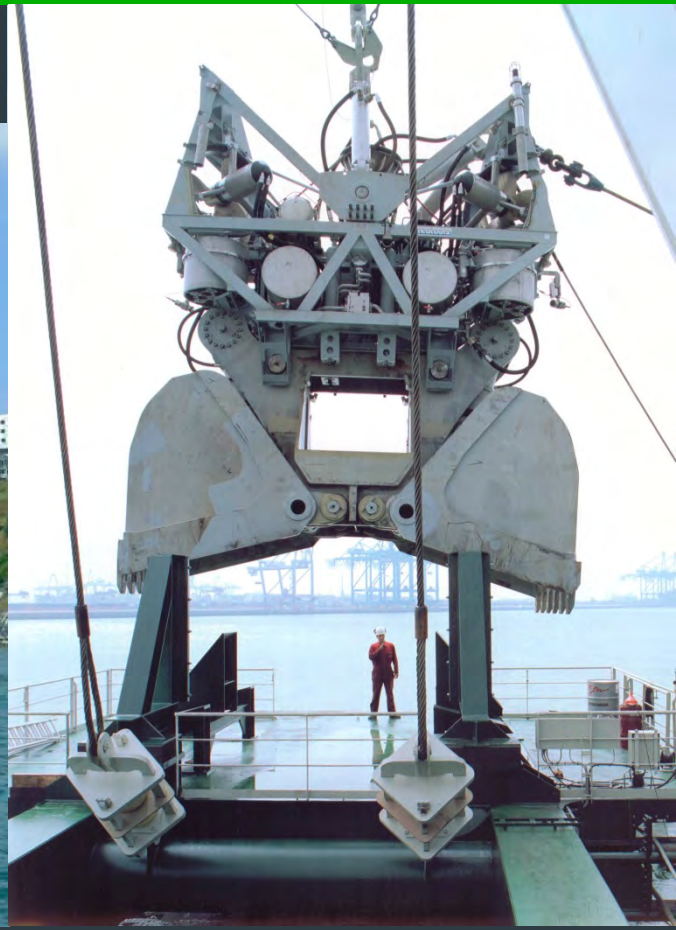
- Record keeping
- Process analysis
  - Inefficiencies
  - Early defect identification
- Calibration of predictive models
- Standardization
- L6σ

Scope

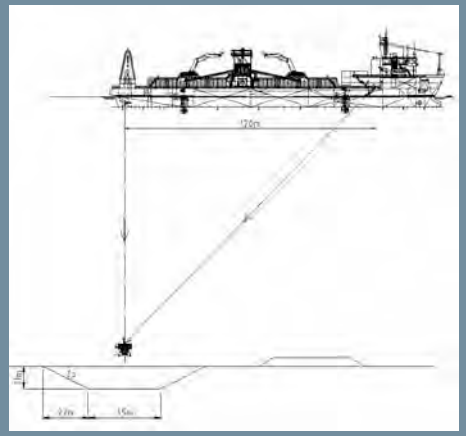
Innovative grab dredging – The rebirth of an old technique

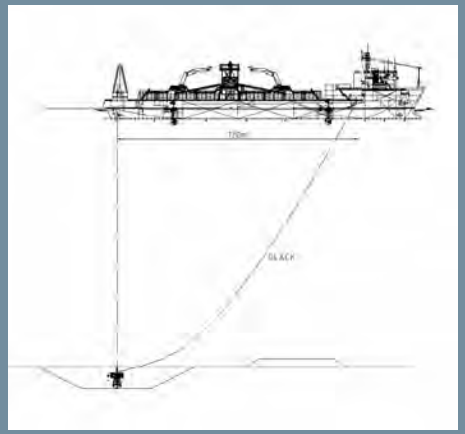
Scope: deep sea

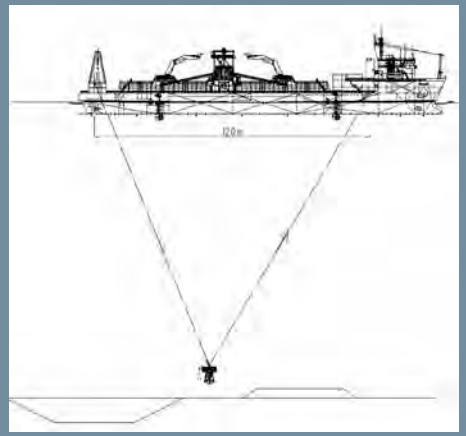


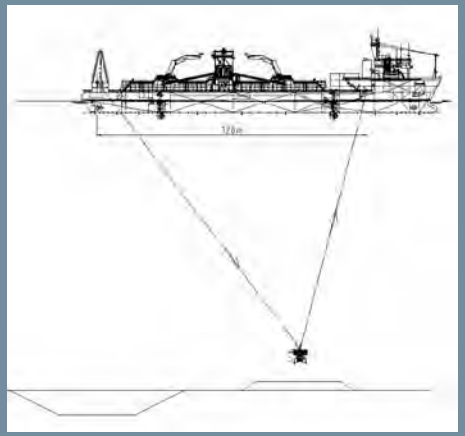


Scope: deep sea



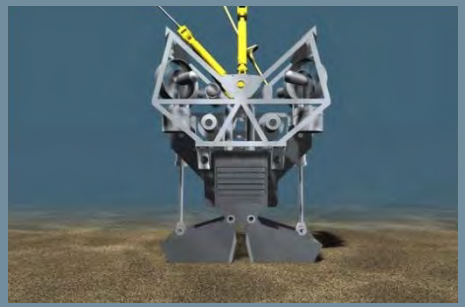


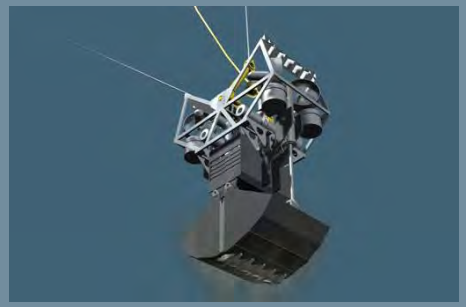


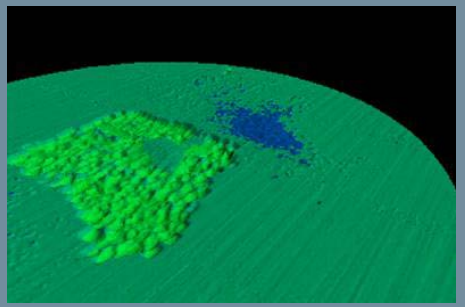


- FPV Seahorse

- 20 m³ / 80 ton
- 20 cm accuracy
- Range: 1000 m
- 2 x 200 kW thrusters







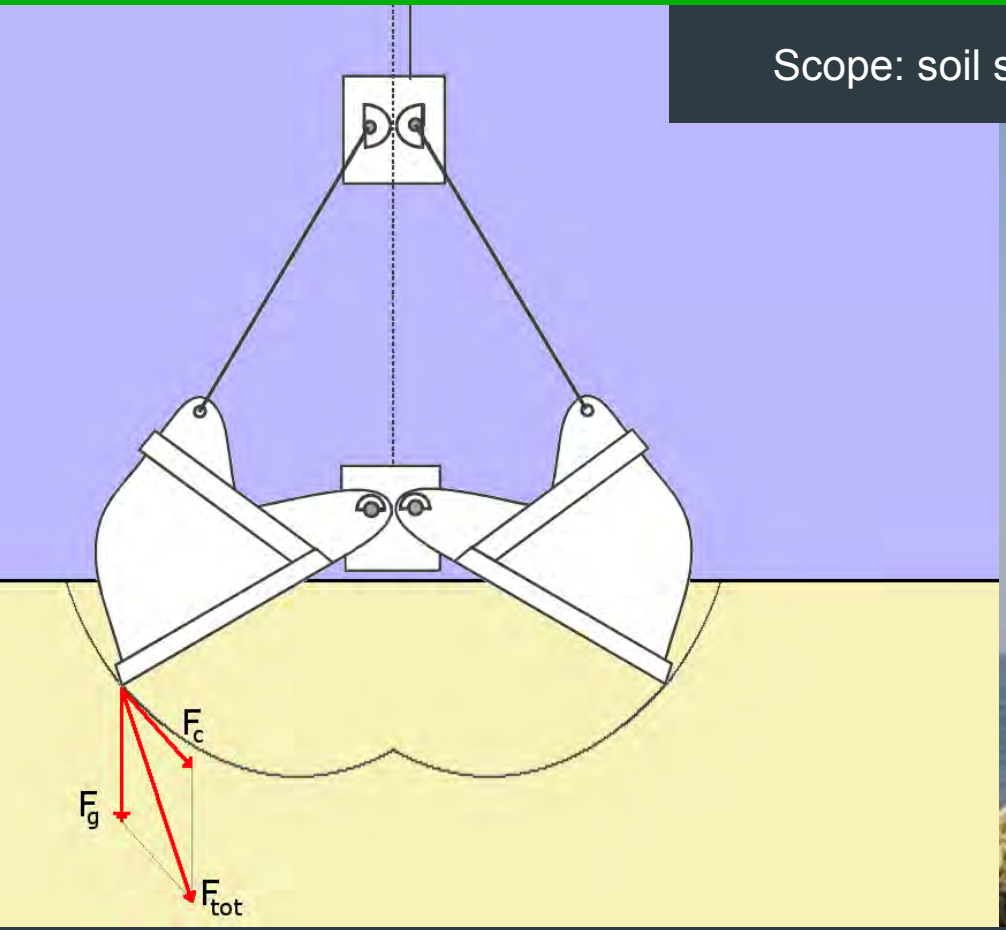
Scope: environmental remediation

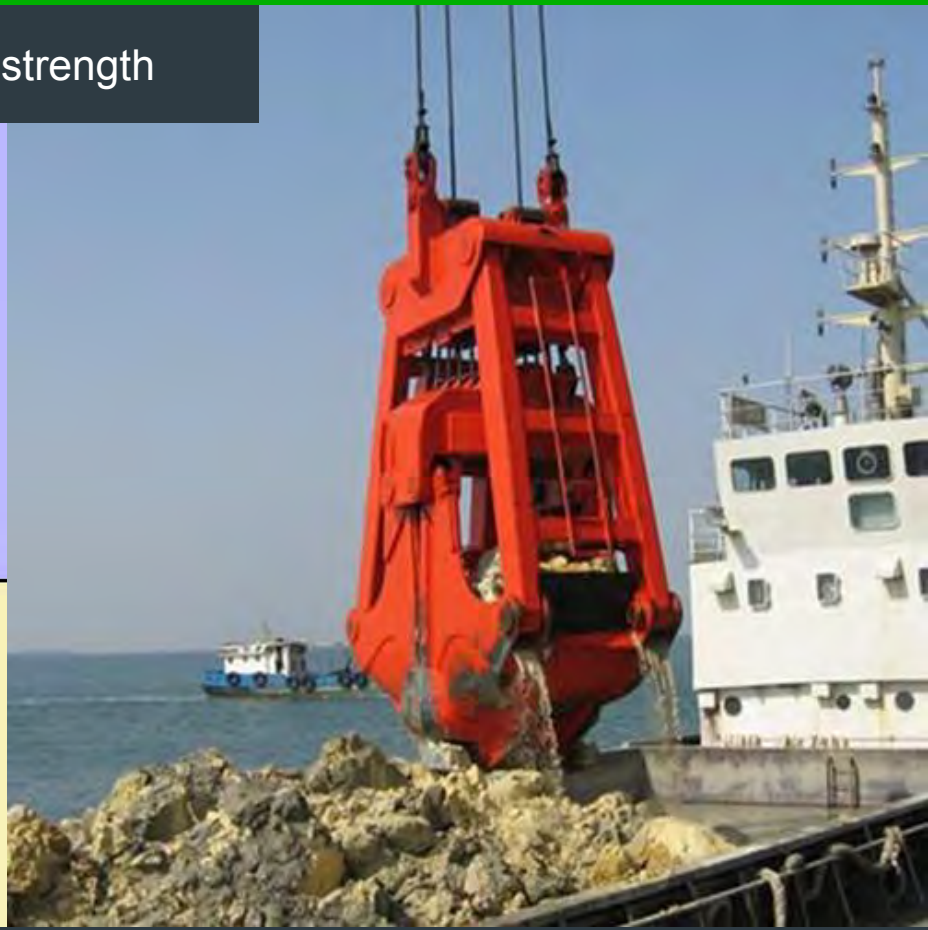
- Accuracy & selectivity
- Horizontal cutting profile
- Minimum spill (shutter plates)
- Minimum upstirring

Scope: increasing project & equipment size

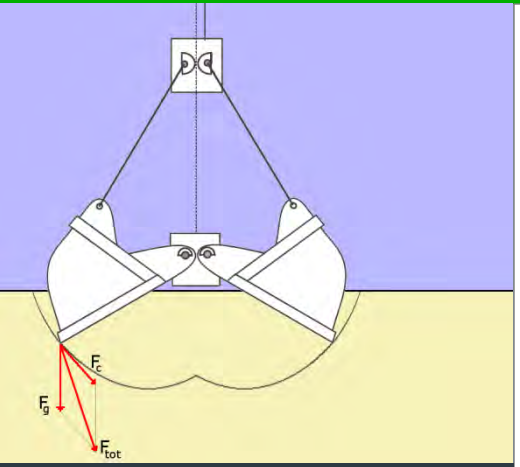
Innovative grab dredging – The rebirth of an old technique

Scope: soil strength



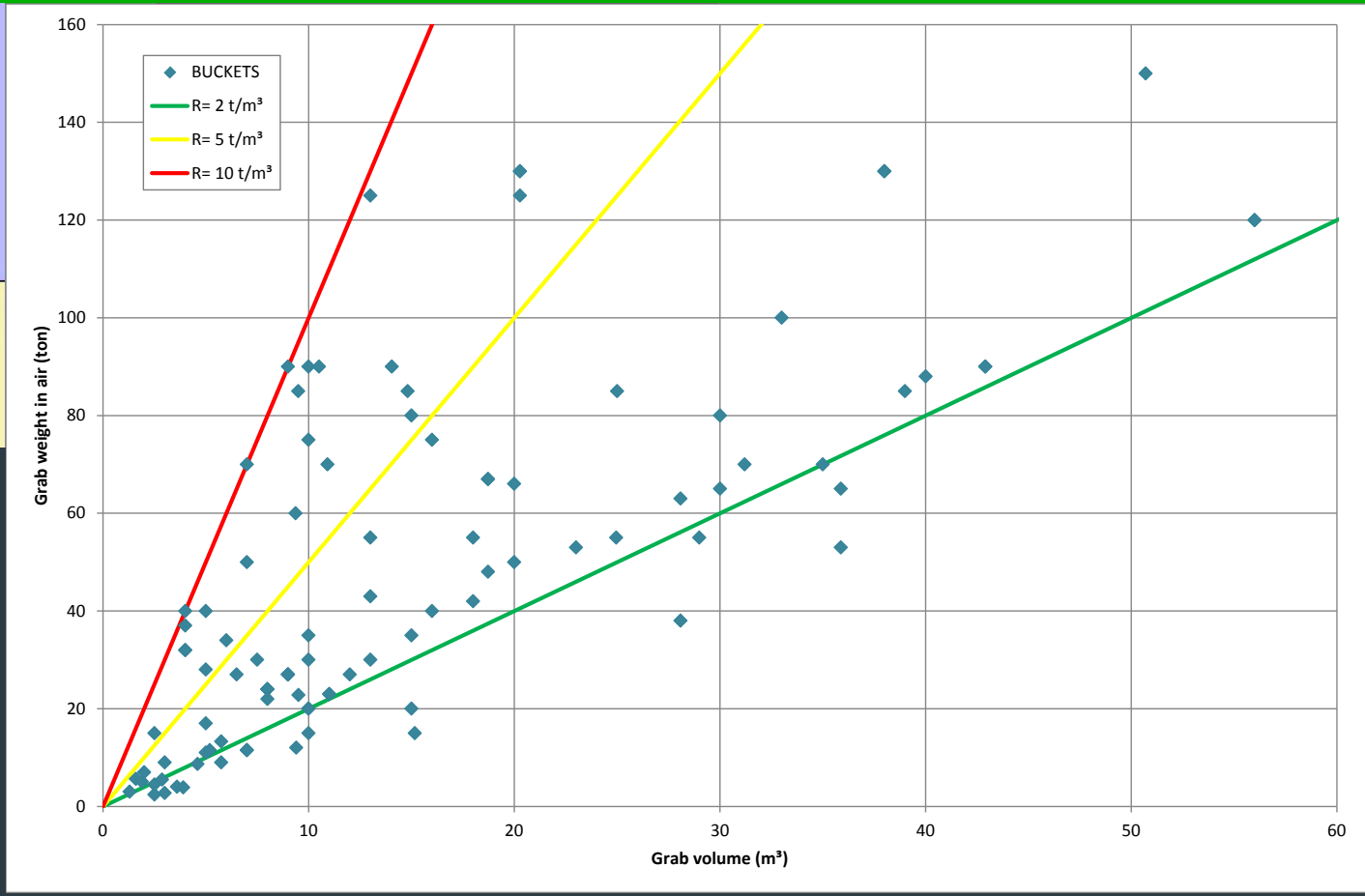


Innovative grab dredging – The rebirth of an old technique



- Driving force: Grab Weight (W)
- Bucket volume (V)
- Ratio $R = \frac{W}{V}$

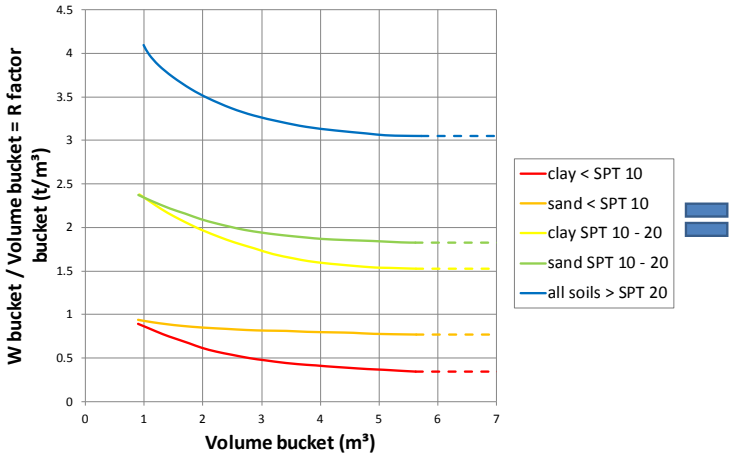
- R: 0 – 10
- Soft soil ~ low R
- Hard soil ~ high R

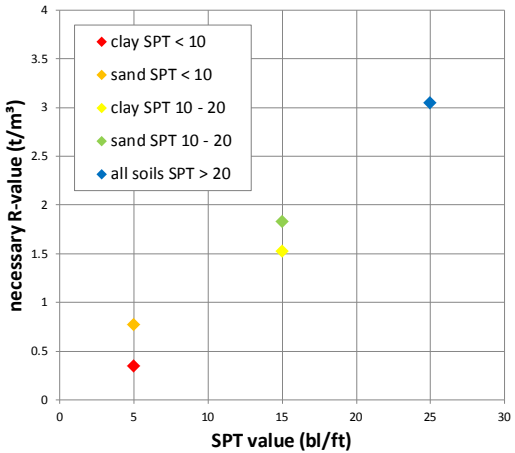


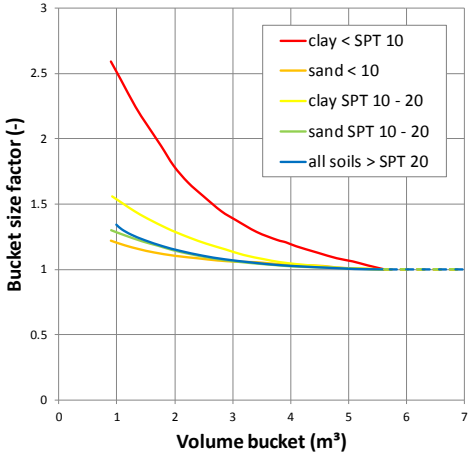
Cutting theory

R-ratio in literature

- Aim: easy correlation soil strength (SPT) – R ratio
  - Optimal bucket for given soil
  - Bucket filling for a certain bucket (in given soil)
- Harder soils???

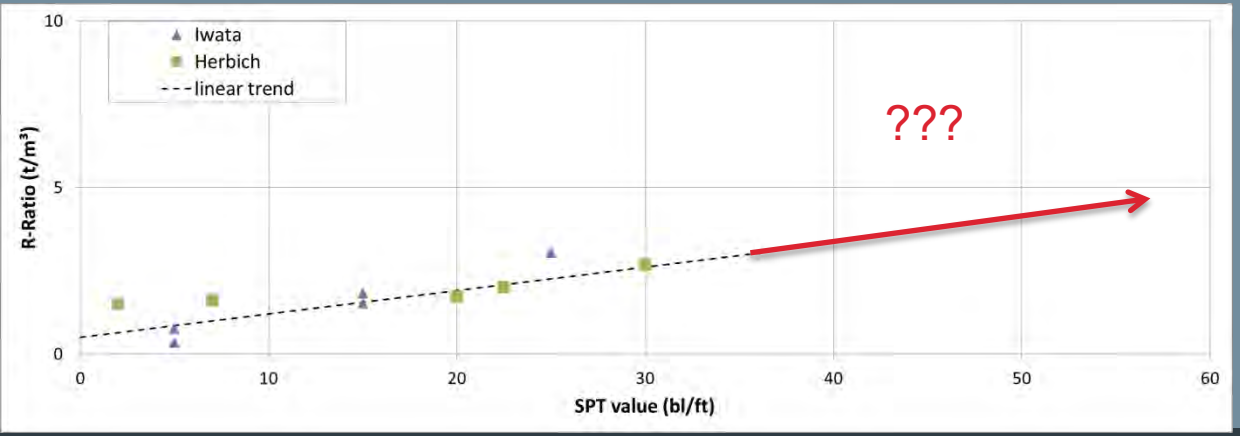






R-ratio in literature

- Aim: easy correlation soil strength (SPT) – R ratio
  - Optimal bucket design for given soil
  - Bucket filling for a certain bucket (in given soil)
- Harder soils???

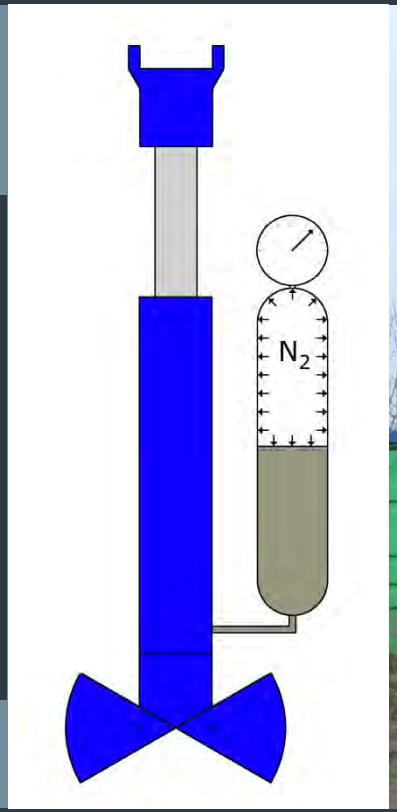


Experiments

Variable weight

Pressure:
- Allows variable bucket “weights”
- Variation: range of R-values
- Pressure reading ~ cutting force

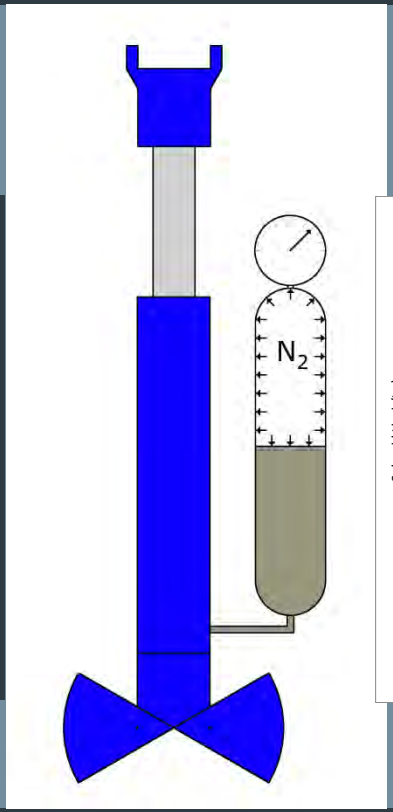
Tested in different soils:
- R-ratio in function of (known) SPT
- Also in harder soils

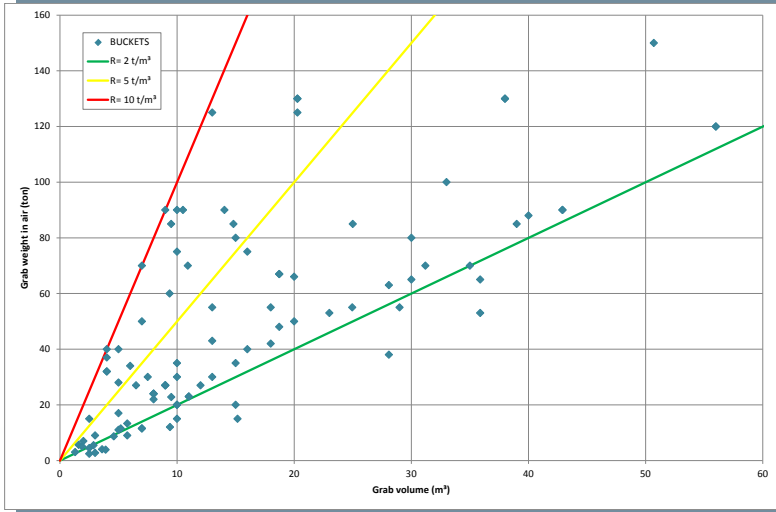


Variable weight

Pressure:
- Allows variable bucket “weights”
- Variation: range of R-values
- Pressure reading ~ cutting force

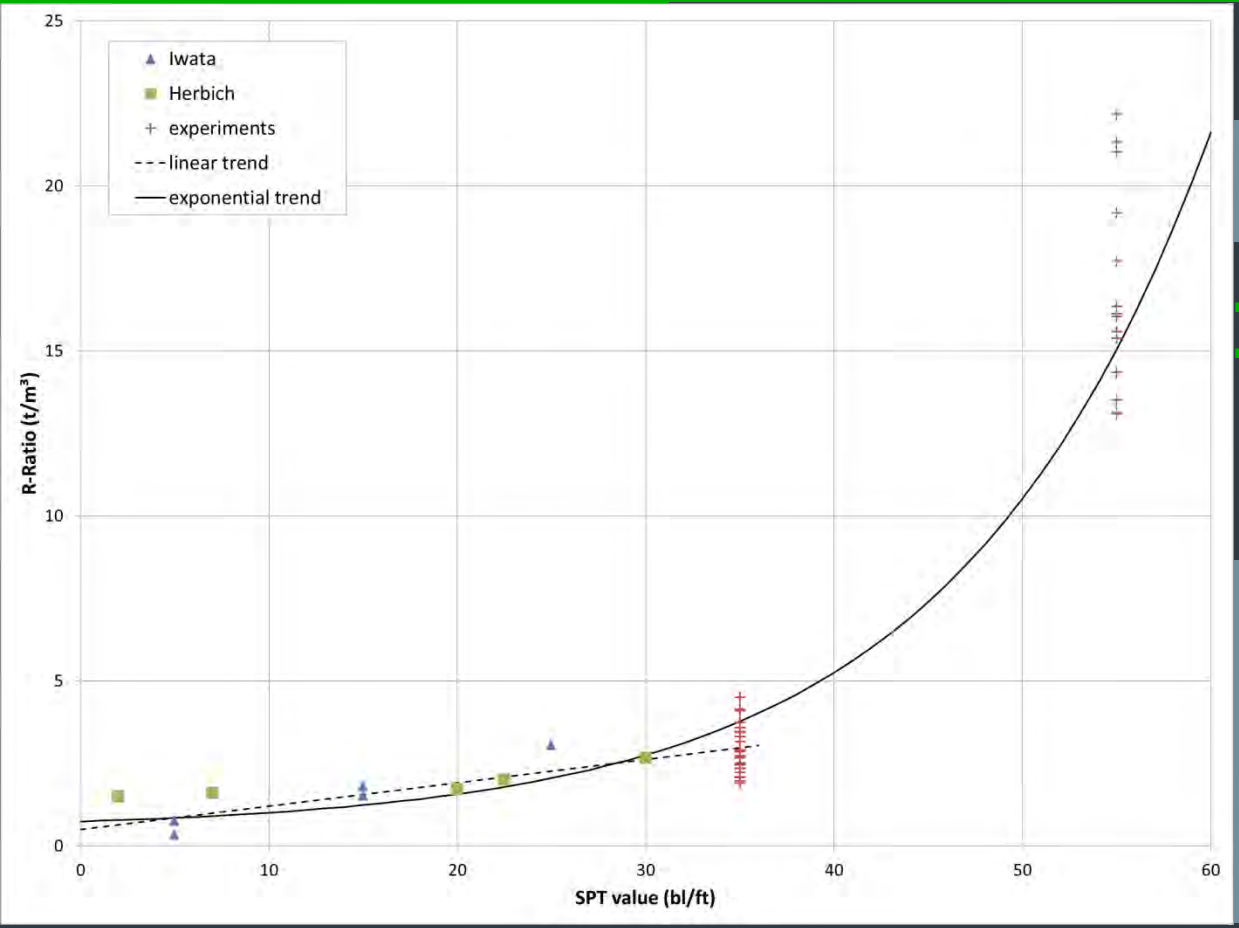
Tested in different soils:
- R-ratio in function of (known) SPT
- Also in harder soils





Results

Innovative grab dredging – The rebirth of an old technique



- Linear → exponential
- Deviations:
  - Soil
  - Force of excavator