seatools

Carrera E – Precision Flow Excavation Spread

Introduction - December 4, 2018

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Why mass flow excavation?

- Subsea excavation method whereby a large volume flow is applied to the seabed through which seabed is fluidized and the fluidized (non-cohesive) soil is transported
- Used for:
  - Burial, re-burial, or de-burial of assets
  - Seabed levelling
  - Rock dump removal
  - Free-span corrections
- Advantages of mass flow excavation:
  - Non-contact method (reduced risk of asset damage)
  - Initial position and orientation relative to asset (e.g. cable) less critical (in case of de-burial)
  - Allows for creation of tight curvatures (e.g. near monopile)
  - Wider range of seabed conditions (e.g. slopes, sand dunes)
  - Typical spread day rate lower in comparison with trenching spread
- Disadvantages of mass flow excavation (as it is now):
  - Relatively low production rates, especially in cohesive soils
  - Relatively much seabed disturbance
  - Largely uncontrolled (process)
  - Limited workability

Large potential for improvement

- The MFE market exhibits relatively little innovation: it is dominated by the same equipment as 15 years ago
- At Seatools, it is our belief that incorporating state-of-the-art subsea and ROV technology allows for different performance levels
- More specifically, we believe there is potential for strong improvement in:
  - Operational economics
  - Productivity
  - Environmental impact
  - Commercial risk
  - Safety

Potential for improvement – Operational economics

- Direct and indirect cost drivers:
  - Day rate MFE and jetting spread
  - Cost of personnel (direct and indirect)
  - Cost of surveys
  - Vessel day rate
  - Costs related to (de-)mobilization (e.g. transportation)
- Potential for improved economics:
  - Reducing the number of operators
  - Reducing the (direct & indirect) costs related to surveys
  - Increase vessel independence (i.e. spot market opportunities and smaller vessels)
  - Improve productivity
  - Reducing (de-)mobilization time
- Potential for improved overall costs of MFE operations is large, especially for larger jobs

Potential for improvement – Productivity

- Direct and indirect factors that influence productivity:
  - Generated flow rate and velocity
  - Positioning accuracy
  - Ability to locate product
  - Ability to cope with cohesive soils
  - Workability
  - Equipment reliability
  - Survey quality
- Potential for improved productivity:
  - Improve (3D) motion control of excavator
  - Increase installed power
  - Use more efficient work flow through which survey related time is reduced
- Potential for improved productivity is substantial, especially when motion control is improved

Potential for improvement – Environmental impact

- Mass flow excavation creates environmental impact by:
  - Seabed disturbance
  - Hydraulic (oil) emissions to environment
  - Noise
  - Energy consumption
- Potential for reduced impact on environment:
  - Improve (3D) motion control of excavator which results in smaller trenches
  - Efficient all-electric drive to:
    - reduce noise
    - prevent hydraulic emissions
- Potential for reduced environmental impact is substantial, especially with tighter dredging tolerances

Potential for improvement – Commercial risk

- Commercial risk in relation to MFE is induced by:
  - Risk of product damage (e.g. physical contact, overstressing pipeline through over dredging)
  - Mobilization window
  - Equipment downtime
  - Launch and recovery window
  - Lower than anticipated productivity
  - Not able to meet prescribed depth of burial
- Potential for reducing risk:
  - Improve (3D) motion control of excavator
  - Minimization of spread modules and required interfaces
  - Improve on dredge capability, especially in cohesive soil conditions
- Commercial risk for both MFE service provider, installation contractors, as well as the asset owner can be reduced significantly

Potential for improvement – Safety

- Common safety issues in relation to MFE:
  - Launch and recovery operations, especially in case of crane deployment
  - Tugger wires handling
  - Large hydraulic hose bundle handling
- Potential for improving on safety:
  - Dedicated AHC LARS which does not require manual assistance
  - Eliminate need for tugger wires
  - All-electric subsea tool with integrated jetting capabilities to eliminate hose bundling
- Safety can be greatly enhanced while simultaneously improving on operational efficiency

Conclusion from technology and market review

- A subsea flow excavation spread that:
  - features position control in all three dimensions
  - has smaller footprint and requires a minimum of vessel interfaces
  - has a more powerful all-electric drive
  - includes high levels of automation
  - includes survey capabilities

  will generate significant value in relation to all MFE performance criteria.
- Our solution: Carrera E Precision Flow Excavation Spread

Carrera E – Precision Flow Excavation Spread

Non-contact, patent-pending, subsea flow excavation spread showcasing surgical precision under any environmental condition

- 3D motion control: full DP capabilities in combination with dedicated AHC LARS
- Integrated survey capabilities
- All-electric subsea drive with unrivalled 630+ kW power rating
- Deep water capability: excavator 3000 msw rating
- High level of automation
- Highly compact spread: 3 x 20ft container footprint

Figure 1 Impression of Carrera E

Dynamic positioning for surgical excavation

- Included DP-functionalities:
  - Station keeping
  - Follow target
  - Auto-speed
  - Auto-track
  - Auto-swing
- The operator can pre-program a specific track (e.g. cable route) where after the Carrera E, and vessel, follow this track
- Through the combination with its integrated survey capabilities, the tool is also able to fully automatically follow a target (e.g. pipeline)
- Seatools ROV DP-technology widely used in FP-ROVs
- Value creation through:
  - Increased productivity
  - Reduced seabed disturbance
  - Faster backfilling through smaller trenches
  - Less operators and relieving operators from exacting labor

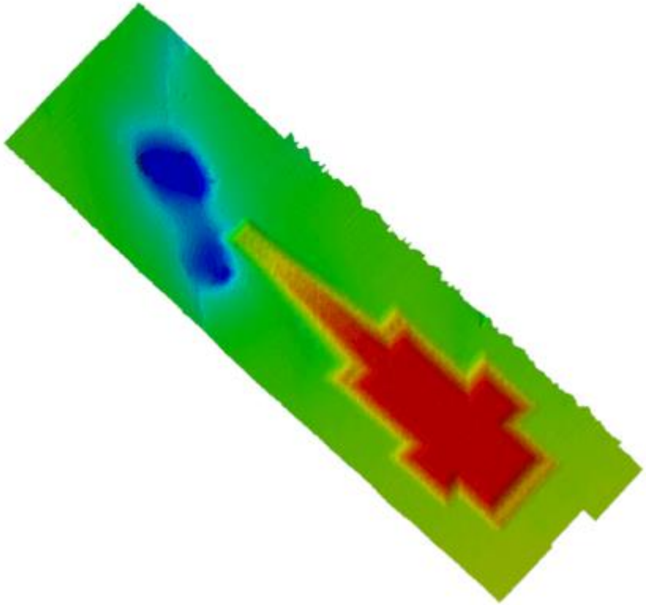

Figure 2 Subsea rock bed created by Seatools' fall pipe ROV executed with highly accurate DP-technology. The same technology is applied to the Carrera E which allows for tight dredging tolerances.

AHC LARS for productivity and safety

- The LARS, executed with Active Heave Compensation (AHC), generates value by:
  - Creating safe working environment (as opposed to a swinging tool in case of crane deployment)
  - Preventing physical contact with asset
  - Allowing for operating closer to the seabed. This results in (strongly) improved jetting performance
- Two AHC modes are included:
  I. Basic mode. Provides moderate AHC accuracy and is to be used when performing MFE operations at significant standoff distances (> 2 meter)
  II. High performance mode. Active in case a minimum of residual heave is allowed, such as when performing jetting operations close to the seabed or during surveying
- By means of up-front simulations, a minimum of required standoff distance plots can be provided. Minimum standoff distance is plotted as a function of actual heave conditions.

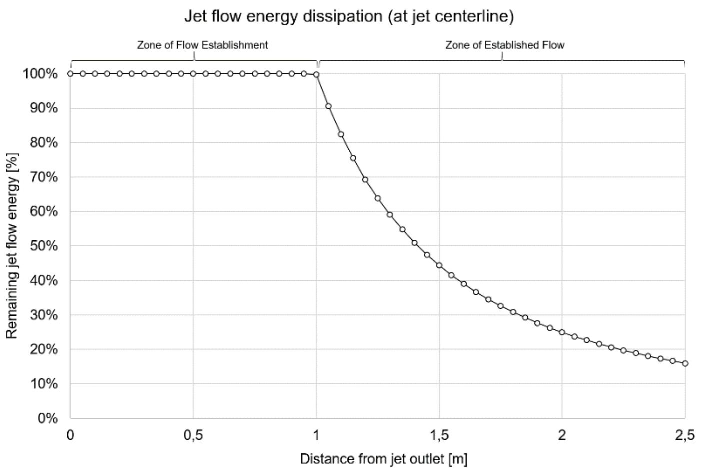

Figure 3 Jet flow energy strongly degrades as a function of standoff distance. As a consequence, we deem active heave compensation essential for achieving adequate jetting performance

Integrated survey capabilities

- 3D motion compensation in combination with the integrated survey frame enable high-quality pre-process, intermediate, and post-process surveys
- The survey frame, able to carry high performance survey equipment such as Innomar SES-2000 quattro, can rotate along the tools' axis through which the vessel can operate in its favorable heading
- Value creation:
  - Far more efficient work flow (i.e. reduction of deployments)
  - Detailed feedback on (actual) excavation performance
  - Automatic asset identification and tracking (e.g. pipeline)
- The combined excavation and survey capabilities also allow for cost-efficient Post Lay Inspection and Burial campaigns: encountered depth of burial deviations can be corrected immediately

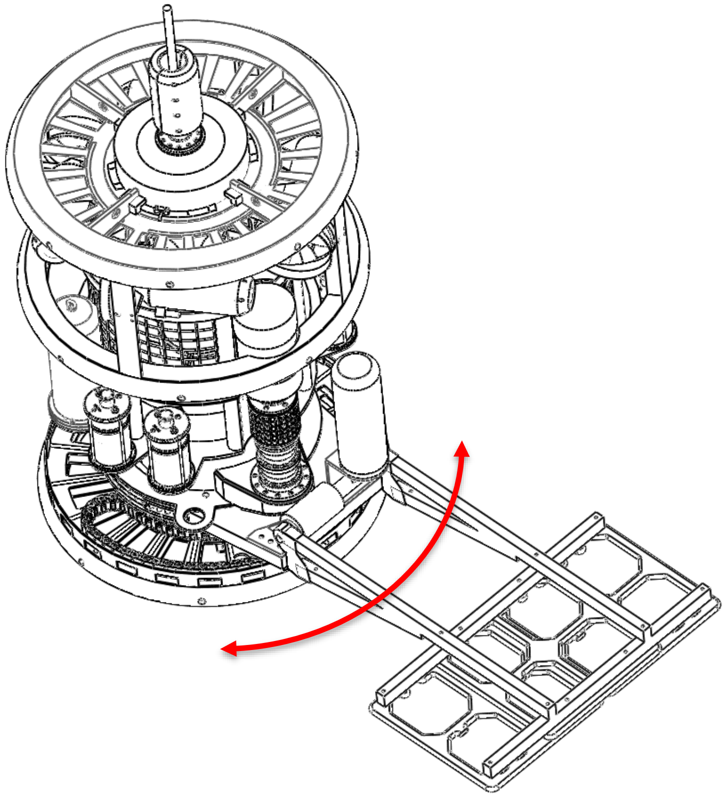

Figure 4 Rotating survey frame supports a wide range of high-performance survey sensors

A high level of automation

- Like all other Seatools ROVs, the Carrera E comes with a high degree of automation. Resulting value creation:
  - Reduction of crew size. The complete spread can be operated by a crew of four in case of 24-hour operations
  - Relieving operators from exacting labor
- Two MFE related functionalities are under development:
  - Backfill mode. Automated motion patterns (e.g. zigzag across the cable route), combined with flow rates that are automatically varied as a function of cross-track distance. Allows for efficient and automated backfilling.
  - Auto-flow mode. This mode is especially beneficial during (for instance) (re-)burial projects whereby buried cables show 3D curvatures and depth of burial varies considerably. This mode automatically adjusts the volume flow rate according to the actual depth of burial along the track. This features enhanced operational efficiency, while minimizing overdredging and seabed disturbance.

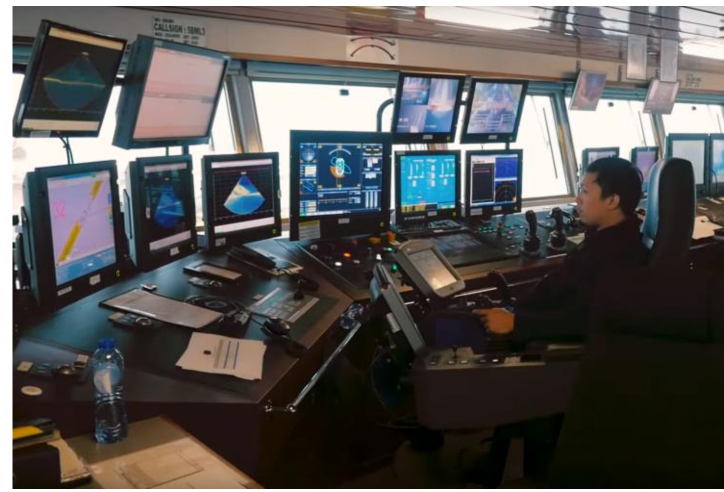

Figure 5 Seatools has an extensive track record in ROV automation. Like our fall pipe ROVs, the Carrera E comes with a large degree of process and navigational automation. Thanks to these ROVs high degree of automation, a complete ROV system, can be operated by a single operator.

Small footprint and all-electric drive

- The all-electric drive configuration has resulted in an extremely compact tool (58 kW/m^3, a 3 times higher power density in comparison with most competitive spread)
- The Carrera E spread further consist of:
  - LARS including umbilical winch (20 ft footprint, incl. tool)
  - Power container (20 ft footprint)
  - Spares container (20 ft footprint)
- Furthermore the spread consists of portable controls which can be placed at the bridge for direct communication with DPO
- The spread requires a minimum number of mechanical (e.g. no tugger wires) and electrical interfaces between the various modules and the host vessel
- Value creation:
  - Can be deployed from a wide range of vessels (incl. small vessels)
  - Short mobilization times

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