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Freedom – Realising the Potential

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Freedom – Autonomy in Action

We believe that the award-winning **Freedom™** Autonomous Underwater Vehicle (AUV) is the most advanced, autonomous resident-capable underwater robotic solution available today.

Oceaneering are completely in control of our own development, we research, develop, build and own the technology and we can modify it to meet the requirements. – Today I will describe and show evidence on how we do this.

Underwater robotics capability is advancing at pace.

Freedom started with pipeline inspection…..

Potted History

- Project Start dating back to 2017
- In-house design, build and operation.
- Not just Rules based Autonomy – Machine Learning
- Close customer collaboration to recognize and overcome challenges to introducing **revolutionary** technology. (TotalEnergies, Chevron and Equinor).
- Prototype construction in 2019-20
- DevOps 2020-2024
- Industrial Pilot – 2023 Commercial Project – TotalEnergies
- 2024 - Lessons Learned – Software v1.6
- 2024 - US Navy Award
- 2025 - Ready for service.

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What is Freedom's Differentiator?

- AUV with ability to stop, hover, orbit and reverse.
- Long range, advanced autonomy
- Payload informed feature-based navigation
- Sensor fusion allowing the triggering of autonomous behaviors
- Hybrid – Autonomous, supervised or piloted
- Digital Inspection Solution

Freedom Value Proposition

Improved Inspection Effectiveness

- Maximised coverage through single pass Survey Capability
- Detailed survey through autonomous behaviours
- Data Resolution through proximity
- Minimize Subjectivity though Data quality
- Single reporting output

Lower Cost

- Reduction in campaign timing compared to AUV or ROV
- 3 x Speed of WROV
- No need for ROV infill.

Reduced HSE Risk

- Improved obstacle avoidance
- Lower Crew than both AUV and ROV.
- Launch and Recovery method.
- Ability to situate Operator in OROC.

Reduced CO2 Emmisions

- Wider Vessel selection
- Single acquisition campaign reducing emmiting days

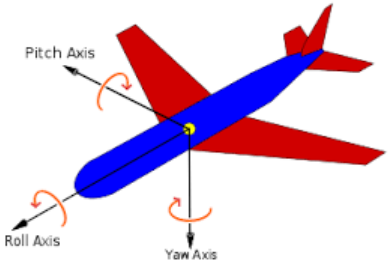
Existing Metrics to be addressed

- Average WROV Pipeline GVI Speed 1km/hr.
- AUVs require to do up to 3 runs over length of pipeline to get required coverage.

FREEDOM: The foundation

FREEDOM offers Maneuverability that Conventional AUVs cannot

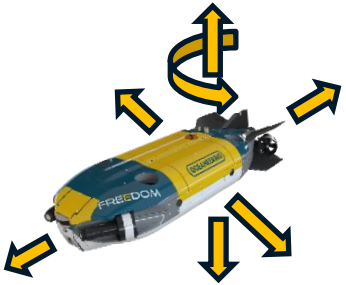
Conventional AUVs (think airplanes)

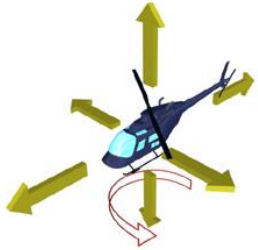


- Can only “fly” forward
- Relies upon vehicle velocity and linear flight control
  - Control surfaces generate force to steer vehicle
  - Control surface forces reduce when vehicle slows

SSW Result: Has difficulty approaching seabed and creating reliable seabed effects. Collision risk increases in busy environments due to limited manoeuvrability

FREEDOM AUV (think helicopters)





- Can “fly” backwards, vertically, and laterally
- Can yaw 360 degrees
- Can station keep (hover) for extended periods

SSW Result: Allows FREEDOM to approach the seabed easily accomplishing seabed effects, even in busy environments, that conventional AUVs cannot

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Deploying Freedom Vehicle = Deploying Digitalisation

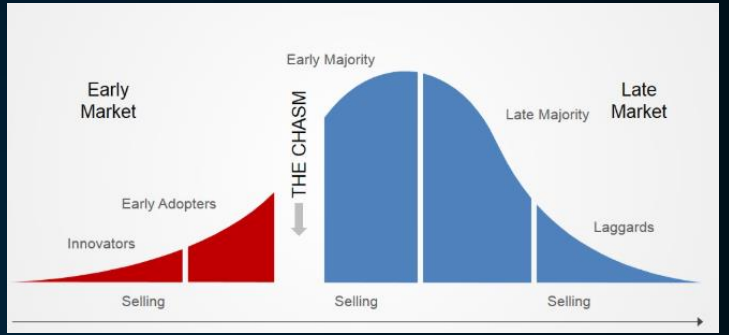
Key Barriers:

•**Customer Resistance** – Preference for familiar manned systems; cultural and workforce concerns.
- *•Process of evaluating disruptive technology?*
- •Is an ROV the gold standard?
- *•How do we convince other stakeholders?*

•**Reliability Perception** – Doubts about performance in harsh or variable environments.
- •What does good enough look like to allow launch?

•**Cost Uncertainty** – Doubts about quality of service in harsh or variable environments.
- •Oceaneering Return on investment pressure
- •Whats the comparative being made between completely different methods and deliverables?
- •What quality of deliverable is considered good enough?

•**Regulatory Compliance** – Meeting safety and improving upon industry standards.
- •Realising the promise of autonomous robotics potential?



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Freedom the Development Project

SOLUTION

Collaboration / Governance / Oversight

Key –

3 Operators agreeing on

- Principle of testing
- Directionality
- Method of interacting / oversight
- Contribution to demonstration and validation events

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- Openness to data sharing from testing with customers
  - Inc. results, setbacks and successes.
- Commitment to relationship

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Technical Challenges – Addressed and Verified early stage

Constraint management

- **Loss of Comms (e.g.)**
  - 5-minute stop and hover on location
  - 15-minute drop weights and surface
- **Minimum altitude**
- **Geofencing**
  - Area avoidance
  - Route verification
- **Collision avoidance**
  - More advanced than a Torpedo AUV.
  - Map the object by path planning

Core Features

Pipeline Inspection
Route following
Docking
Undocking
CP and Leak detection
Data Collection and Management
Etc.

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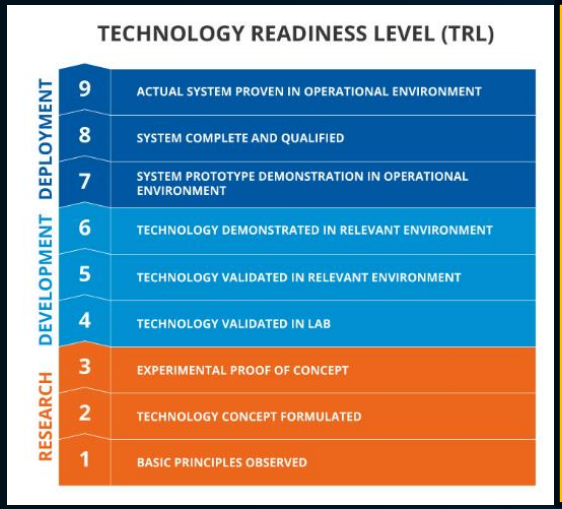
FREEDOM-H Development Timeline

Only Commercially Proven Solution In a Relevant Environment



Stage Gates - Targets for TRL levels

Design Of Experiment
- Factors (Pipe diameter, Speed, altitude etc.)
- Repeats
- Failures
- Reliability (Fail, MVP, Gold Standard)

Guiding
- Coding error fixes
- Edge Case Identification
- Conflicting activities

ProQual
- Sets Targets / Expectations
- Measures progress to meet
- Evaluates readiness for Pilot Projects

equinor

Chevron

TotalEnergies

Oceaneering and energy industry partners
Participating in 40 Days of Technical Maturity Demonstration

- TotalEnergies (Development Partner)
- Chevron (Development Partner)
- Equinor (Testing Partner)

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Capability: Testing, Demonstration and Commercial Projects

Proven System Maturity and recent commercial work

Operational Readiness Demos:

Testing on active pipelines in varying environments resulted in failures and learning opportunities for development e.g. :-

- Docking/Undocking
- Initiation communications
- Obstacle avoidance failure
- Pipeline detects insufficient
- Stability / Endurance and
- Reporting

Lessons learned from industrial pilot projects is vital.

2021 –2025 Development Period

Proven Performance

Commercial Mission Profile:-

- **Over 1100 days testing**
  - >3000km Navigation mode
  - >1700km Pipeline tracking

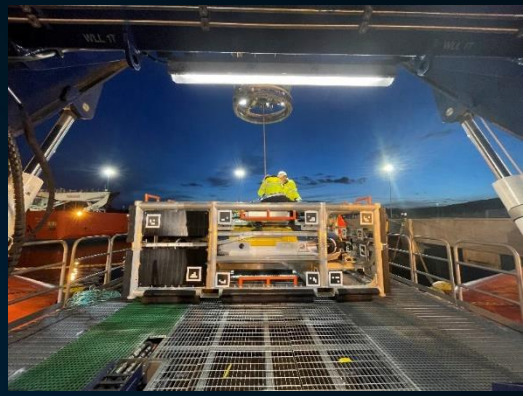
Altitudes:
3m, 5m and 8m

Improving Speed:
2023 – 0.5-0.8 m/s
2024 - 1.0 m/s (1.94 Knots) - 1.5 m/s (2.91 Knots)
2025 – 1.5-1.75m/s (2.0m/s)

Navigational Error:
<0.07% of distance travelled using DVL aiding

Input Factors (Challenges):

- Current: 0-2 m/s (0-4 knots)
- Low visibility
- Soft Seafloor
- Hard Seafloor
- Water Depth – 10m to 600m
- Harsh Weather
- Different vessels of operation



FREEDOM installed onboard vessel PACIFIC DISPATCH

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Pursuing Reliability / Repeatability – 2023 > 2025

Traversing the Challenges:

- **Learning** phases
- Challenges were **bigger** than imagined
- **Good and bad** results were scrutinized
- Evaluation tools **created and refined**
- **Fail fast** lessons were valuable and acted upon
- Building an **effective** team

Making features work once is relatively easy, making features work reliability and repeatedly = trust

Realising the Potential

2025 onwards

Status Report

Oceaneering

- ✅ Successfully addressed the requirements of the initial work scope (Pipeline Inspection).
- Foundational technology is enabler to extend capability – Risers, mooring lines and structures (Roadmap)

TotalEnergies

- ❓ How do we measure success holistically?
  - We have traditional success criteria – contractual and technical
  - Two distinct areas of interest – **vehicle** and **data**
    - ROV SME's review the **vehicle performance**
    - Survey SME's review the **deliverables**

Shared

- It is new, and more **expensive** in certain aspects today than existing solutions as of **today**
  - It is not comparing like-for-like, it is a **different business model**
- Key technical challenges **solved**
- *Let's **go…***

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Connecting What's Needed with What's Next™