OFFSHORE SURVEY IN THE OIL & GAS INDUSTRY...WHAT’S THAT ALL ABOUT?

Ian Douglas
Head, Offshore Surveys,
Shell Projects & Technology Europe
Why Position Matters
The Exploration & Production Lifecycle
Seismic
Rig Moves
Seabed & Geohazard Surveys
Construction Support
Subsidence Monitoring
Emergency Response
Careers in Offshore Survey
Conclusions
WHY POSITION MATTERS

- Around 80% of the data used in the Upstream Oil & Gas industry are spatially referenced.

- Errors in positioning, or a poor understanding of spatial relationships, can be extremely costly and have hugely significant safety and commercial implications.

- With just some of the implications:
  - Major HSSE incidents, legal costs, drilling targets missed, incorrect interpretation and understanding of reservoir characteristics, loss of asset value, loss of revenue, higher lifting costs, delays to schedules, loss of reputation
IS YOUR SURVEY REFERENCED CORRECTLY?

- **Coordinate Systems & Datum**
  - 18 Offshore systems
  - 15 Onshore systems
  - 8 Datums (3 x ED50)

- **Vertical Reference**

  Units (metres/feet)
  - Drill Floor Elevation, Kelly bushing?
  - Datum, Mean Sea Level (MSL), Lowest Astronomic Tide (LAT)?
  - Vertical Offshore Reference Frame (VORF)

- **North References**

  True, Grid or Magnetic North?
## THE UPSTREAM OIL & GAS INDUSTRY LIFECYCLE

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### Coordinate Reference Systems & Geodetic Parameters
- Geo-Info & data management
- GIS & Mapping
- Remote Sensing
- Emergency Response
- Seismic, Well and Asset Coordinates

### Positioning & Navigation
OFFSHORE SURVEY IN THE INDUSTRY LIFECYCLE

**Explore**
- Scouting
- Seismic
- Environmental Baseline
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Stratigraphic Coring
- Geotechnical Borehole

**Appraise**
- Seismic
- Seabed Survey
- Geohazard Assessment
- Rig Positioning

**Develop**
- As Built Survey
- Seismic
- Geohazard Assessment
- Rig Positioning
- Stratigraphic Coring
- Shallow Geotechnical Borehole
- Geotechnical Borehole

**Produce**
- Seismic
- Environmental Monitoring
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Pipeline Inspection
- Shallow Geotechnical Construction Support

**Decommission**
- As Left Survey
- Environmental Monitoring
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Pipeline Inspection
- Shallow Geotechnical Construction Support
- 2D Seismic
- 3D Seismic
- 4D Seismic
- Broadseis
- Wide Azimuth (WAZ)
- Multi Azimuth (MAZ)
- Undershoot
- Transition Zone (TZ)
- On Bottom Cable (OBC)
- Node Surveys
- Electro Magnetic (EM)
• 10+ steerable streamers
• 6 – 8 kms long
• 100 – 150 m lateral separation
• 2400 hydrophones to be positioned every 11.5 seconds
• For a 1000 sq km 3D survey = 135 million coordinated hydrophone positions

• Vessel Navigation
• Gun timing control
• Streamer steering
• Streamer positioning
• Real time navigation data processing
• Post Processing
SEISMIC NAVIGATION & POSITIONING

Vessel Guns & Paravanes  Front End  Acoustic Pod  (Compass & depth)  Active Steering  Tail Buoy

Seismic Airgun  Gun Array  Acoustic Network  Instrument Room
- Seismic array covers an area of 40 sq. km
- >120 kms of 4D seismic cable
- 300m between cables
- Designed around seabed infrastructure
- Available hub connectors allow for adding more cables in the future.
- Cable trenched into seabed
- Umbilical connection to platform based seismic recording system

Cables trenched to an average depth of 1.1 metres
79 locations were rock dumped

Seabed Array Termination Canister
RIG POSITIONING

- Jack Up Rig
- Semi-Submersible Rig
- Dynamically Positioned (DP) Rig
- Drill Ship
- Exploration & Appraisal
- Development
- Workover
- Abandonment
FRONT END FEASIBILITY STUDIES

Using GIS analysis to assess ease of access to Drilling Permits

Underlying Data

- Protected Habitats (Oyster Ground)
- Migratory Birds
- Fish & Mammals

and also

- Shipping Activity
- Explosive Remnants of War
- Military Areas
Seabed surveys – Design, Acquisition and Reporting:

Shallow Geohazards?

How hard is the seabed?

Seabed Flat?

Obstacles & Debris
ANCHOR PLANNING & MOORING ANALYSIS

All executed in GIS ......
POSITIONING RIG & ANCHORS IN THE CORRECT PLACE

- Ensure rig & anchors are positioned within tolerance
- Design Anchor Plan or jack up location
- Compile Well Set Procedures
- Manage positioning Contractor
- Confirm location
- Antenna Offsets & Winch Offsets
- Gyro Checks & Known Errors
- Subsea Structures
Seabed Survey & Geohazards

- Seabed Survey
- Bathy Survey
- Geohazard Survey
- High Resolution 2D (HR2D) Seismic Survey
- Shallow and Deep Geotechnical
- Environmental
A SURVEY SPREAD
UNDERWATER VEHICLES FOR SEABED SURVEYS

Autonomous Underwater Vehicle (AUV)

- Designed to run multiple survey sensors simultaneously
- Sharp clean data possible
- More coverage in less time
- Accurate positioning is a challenge over extreme topography

Remotely Operated Vehicle (ROV)

- Not designed to run full survey sensor spread simultaneously
- Very high resolution data possible
- More time for less coverage: expensive for large areas
- Greater control on subsea positioning
- Greater flexibility for close inspection or changing survey

Image source: www.mbari.org
EXAMPLE OF SEABED SURVEY

30 to 60 metre peaks
Drilling Hazards
- Shallow gas
- Faults
- Boulders
- Loose sands
- Reactive clays

Other Geohazards and Hazards
- Buried channels
- Geotechnical/shallow soils
- Seabed topography
- Obstructions
- Habitats
- Archaeological
- Explosive Remnants of War
OFFSHORE CONSTRUCTION

Explore  Appraise  Develop  Produce  Decommission

- Pipelay
- Pipeline Bundle Tow & Installation
- J-Lay, S-Lay
- Manifold / Template Installation
- Heavy Lift Barge
- Ploughing, Trenching & Jetting
- Out Of Straightness Survey
- Seabed Intervention
- Metrology
- Spool Piece, Jumper, Riser
- As-Built Survey
- Decommissioning
“The process of capturing waste CO₂ from large point sources, such as fossil fuel power stations...”
“... and **transporting** to, and **storing** in, an underground geological formation.”
What is decommissioning?

Decommissioning is the process by which options for the physical removal and disposal of structures at the end of their working life are assessed; a plan of action is formulated by the operator, approved by government and then implemented.

The overall timescale for this is several years, as it needs to take into account many diverse factors and involves many organisations.

Brent Spar:
- a) towed to shore,
- b) part of a new dock construction

The decommissioning of Southern North Sea fixed platforms
SUBSIDENCE & RESERVOIR MONITORING

- Tilt & Settlement Surveys
- Continuous GPS Monitoring
- Air Gap Survey
- Scour monitoring
- Seabed Geodesy
- Time lapse (4D) Gravity
SEABED GEODESY

- Method to ascertain reservoir compaction
- 175 AMTs on seabed to measure subsidence and deflection
- Pilot project of 10 stations deployed in 2007
- Full network in operation since 2010
- Sample every 2 hours
- 22.5 million measured ranges observed and analysed since start of the full network
- 2 x Data download operations per year
SEABED GEODESY
EMERGENCY RESPONSE

- Explore
- Appraise
- Develop
- Produce
- Decommission

Emergency Response

- Incident Preparedness
- Oil Spill Response
- Search and Rescue
- Incident Investigation
DATA INTEGRATION TO PROVIDE SITUATIONAL AWARENESS

Available anywhere in the world where Shell operates (upstream, downstream, shipping)

- INFRASTRUCTURE
- ADMIN. BOUNDARIES
- NAUTICAL CHARTS
- ENVIRONMENTAL
- INCIDENT FEATURES
- VESSELS
- BATHYMETRY
- INFRASTRUCTURE
- TOPOGRAPHY
- METOCEAN
- WEATHER RADAR
- IMAGERY

- Unified Command
- Situational Status
- Public Information
- Operations
- Planning
- Safety
- Logistics
- Finance

- Static info
- Dynamic info
- Observed data
- Predicted data
**ENTERING THE INDUSTRY**

**Major employers in the Offshore Survey Industry:**
- DeepOcean
- DOF
- Fugro
- Gardline
- Harkand Andrews
- Integrated Subsea Services (ISS)
- iSurvey
- Marine Offshore Designers
- MMT
- NCS
- Osiris Projects
- Sonsub Saipem
- Specialist Subsea Services
- Subsea 7
- UTEC
An indicative career path for in Offshore Survey…

- Trainee Surveyor
- Surveyor
- Senior Surveyor
- Party Chief (in charge of survey work)
- Project Manager
- Senior Management
Tropical, mid latitude and arctic conditions
Water depth 0 m to 3000 metres and increasing
Government and Regulatory authorities, complex & variable
Little standardisation Clients always want something slightly different, improving
Non Governmental Organisations (NGO)
Dynamic industry, project timing constantly changing
CONCLUSIONS

- Offshore Survey is a global and dynamic industry driven by technological innovation
- Offshore Survey plays a critical role in all stages of oil and gas life cycle
- There are significant sub-discipline skills within the sector – geodesy, seismic navigation, site survey, construction, remote sensing, GIS, data management, AUV, acoustics, operations & project management.
- Offshore Survey / Geomatics skills are scarce and not always well understood by non-survey colleagues or management.
- Oil & Gas Industry salaries are very competitive
- There are highly interesting, rewarding, and varied career opportunities with excellent job prospects and security
Q & A
ENTERING THE INDUSTRY

Mature Entry:
• via related discipline

Offshore Surveying

- Land Survey
- GIS
- Marine Industry
- Dimensional Control
- Cartography
- Armed Forces
- CAD Drafting
TIGHT TOLERANCE MOVES – HI SPEC. SURVEYS

PRE move

Laserscan model of K15 FK1

3D model of Hans Deul

POST move

Digital photograph
What are we installing?

Height & Orienting the guide base

Challenges:
- Tolerances +/- 5° & +/- 30 cm.
- Tidal Change up to 2 metres
- Cement Curing
- Impatient Drillers
- ROV intensive

Check & Publish the As-Built Positions
- Position entered into Open Works & GIS (associated error uncertainty)
Pipeline Inspection
SCOPE OF SITE INVESTIGATION - TOOLS

- 2D High Resolution Multichannel Seismic (2DHR)
  - Mapping of sub-seabed structure and stratigraphy (to approx. 1000m sub-seabed)
  - Variations in amplitude allow anomalies (possible shallow gas) to be identified
- Coring / CPTs / Boreholes (Geotechnical)
  - Investigates soil properties
  - Integration with geophysical data
- Environmental Surveys
  - Assesses habitats
  - Categorises flora and fauna using physicochemical analysis
  - Used in conjunction with bathymetry and side scan sonar data
A Geohazard is any geological or hydrological process that poses a threat to people and/or their property.

A ‘shallow’ geohazard is by definition encountered within the top-hole section of the well (prior to installation of the surface casing). This is typically the first 1000m below the seabed.
SAFETY CRITICAL ACTIVITY
DO WE KNOW WHAT ELSE IS ON THE SEABED?

• Drilling Location Requests (DLR)
• Hazard Searches
• Anchoring conditions Surveys
DOES THE CRS MATTER?

Difference in Grid Heading is 2.5° = care required for well planning & operations
UNDERSTAND COORDINATES

LAT & LONG ARE NOT UNIQUE!

The Hub
Meston Building

126 metres

ED 50
WGS 84