National Subsea Research Initiative
Condition Monitoring Workshop - Aberdeen

NSRI – the focal point for Research and Development for the UK subsea industry

Dr. Gordon Drummond

2017
Safety stuff

No fire alarms
AGENDA

10:00 - Introduction & Welcome
10:10 - The size of the prize: our performance in terms of subsea equipment failures
10:30 - How “Smart Data” has become the new “Big Data”
11:00 - Sensory Systems, Existing Subsea Capability, and the Opportunity for development
11:30 - Data analytics and Intelligence, Existing state of the art, what might it bring to subsea Integrity Management
12:00 - NERC Funding opportunities to support monitoring
12:20 - Lunch
13:15 - Table Workshops
14:30 - Coffee & Networking
15:00 - Wash-up & review of ideas from tables
15:45 - Who’s doing what?
16:00 - ENDS
Who we are

A ‘not for profit’, industry led, expertly guided organisation

To enhance the UK’s position as the leading technology provider for the subsea industry

The technology arm of Subsea UK
What we do

Subsea Industry Sectors

- Oil & Gas
- Defence
- Wave and Tidal
- Ocean Science
- Mining
- Offshore Wind

www.nsri.co.uk
Objective of the day

Determine the barriers / challenges / issues preventing widespread usage of condition monitoring and predictive maintenance and therefrom develop a list of the technical issues that need to be overcome and how to overcome them

Form collaborative teams to pursue projects
Deliverable from the day

- Issued to all delegates a “technology roadmap” of issues, their resolution and further work.
The size of the prize: our performance in terms of subsea equipment failures
How “Smart Data” has become the new “Big Data”
Sensory Systems, Existing Subsea Capability, and the Opportunity for development
Data analytics and Intelligence, Existing state of the art, what might it bring to subsea Integrity Management
NERC Funding opportunities to support monitoring
Format of the day

- Lunch
- Workshop
  - Tables chaired and scribed in the following themes:
    
    2 x Integrity Management
    2 x Sensors & devices
    2 x Communications
    2 x Data Analytics

- Swap at half time
Overview

• Economics

• Governing Law

• Failure modes
UKCS numbers

17 million Boe in 2015 deferred production

= 46,500 Boe per day ; £2.8 million per day

Sounds like a prize worth pursuing

But, 1 well ~5000 bbpd
Therefore ~10 wells out of service out of a population of 500 ~ 2%
One new generation Operator

Barriers to achieving full potential;
1. Optimised production possible if all key data was available from all subsea wells every day as per original design.
2. Intervention to changeout/modify/repair subsea hardware continues to have significant economic obstacle with vessel costs.

Estimate 1% lost potential Production”
Worldwide Subsea Performance: Major operator 2010-16

subsea LPO by equipment type

- Wellhead, Manifold: 10%
- Subsea pump: 33%
- SCM: 18%
- Riser: 2%
- PT/TT: 1%
- Instrumentations, Controls: 2%
- Flowlines, Pipelines: 34%
Uptime > 95%

Therefore:

Scheduled and Unscheduled < 5%
Overview

• Economics

• Governing Law

• Failure modes
The Management of Health and Safety at work Regulations 1999

requires every employer to

• Make a suitable and sufficient risk assessment
• Make and give effect to such arrangements as are appropriate...for the effective planning, organisation, control, monitoring and review of preventative and protective measures

*in order to ensure, as far as reasonably practicable, the health safety and welfare of all his employees (and those not in his employ, but affected by his activities)*
The Management of Health and Safety at work Regulations 1999

- Corrosion
- Defective conditions
- Human Error (includes flow assurance)
Failure to Comply

- Threats
  - Time dependent
  - Stable
  - Random
Leakage (DNV RP116)

- Impact = trawling
- Anchors drags (separate)

Corrosion dominated by internal corrosion (twice as many)

- Ref Parloc 1069 steel lines
Incidents – (not necessarily leaks) DNV RP 116

a) The North Sea

- Corrosion: 27%
- Impact: 24%
- Anchor: 18%
- Nat. Hazard: 5%
- Other: 11%
- Structural: 5%
- Material: 10%

b) The Gulf of Mexico

- Corrosion: 40%
- Impact: 7%
- Anchor: 6%
- Nat. Hazard: 17%
- Structural: 8%
- Material: 4%
- Other: 18%
Overview

• Economics

• Governing Law

• Failure modes
## Failure modes

<table>
<thead>
<tr>
<th>Human Error</th>
<th>Time Dependent</th>
<th>Stable</th>
<th>Random / Time Independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trawler damage</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Dropped objects</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Anchor damage</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Design errors</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Operator pressure overload</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
## Failure modes

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<th>Human Error</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Wax</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Hydrates</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
## Failure modes

<table>
<thead>
<tr>
<th>Corrosion</th>
<th>Time Dependent</th>
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<th>Random / Time Independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal corrosion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External corrosion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal erosion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microbiological induced corrosion (SRB)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Stress Corrosion Cracking (SCC)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Failure modes

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen Embrittlement</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC corrosion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Failure modes

<table>
<thead>
<tr>
<th>Defective conditions</th>
<th>Time Dependent</th>
<th>Stable</th>
<th>Random / Time Independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free spans - vibration</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free spans – self weight yield</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatigue of material, construction defect</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material, manufacturing, construction defects</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
How smart data has become the new big data

Presented by
Gavin Rogers, Research, Development and Innovation Manager
Mike Reuss-Newland, Lead Controls Engineer
From Industry 1.0 to Industry 4.0

First Industrial Revolution
- Based on the introduction of mechanical production equipment driven by water and steam power
- First mechanical loom, 1764

Second Industrial Revolution
- Based on mass production achieved by division of labor concept and the use of electrical energy
- First conveyor belt, Cincinnati slaughterhouse, 1870

Third Industrial Revolution
- Based on the use of electronics and IT to further automate production
- First programmable logic controller (PLC) Modicon 004, 1969

Fourth Industrial Revolution
- Based on the use of cyber-physical systems

Degree of complexity
Smart Data is the new Big Data

- **Customer Experience**
- **Data-driven intelligence**
- **Business Model**
- **Operational Process**

- **Tesla**: Cellular update of features
- **Uber**: $50B service with no taxis
- **Amazon**: Bookstore without stores
Industry Environment

Contributors to Change

Cost environment
High costs following sustained industry growth

Macro supply environment
Oil/gas oversupply driving low prices

Innovation and technology environment
- Higher bandwidth communications (fibre optics)
- Higher processing power
- Connectivity, offshore and onshore
- Technology gains in monitoring and inspection
- Availability of Data:
  - Much more data available than ever before, only a small amount of which is used

Digital Revolution

Operators keen to explore value
- Value-driven environment
- Efficient technology solutions
- Data-driven environment
- Safety-driven improvements

Efficiency and Cost Reduction
- Key enabler to development and continued production
- Innovation in inspection and condition monitoring is an enabler to efficiency
- So is optimal data use. Big data is not smart data “typical offshore rig has 30,000 sensors capturing millions of data points yet less than 1% of this data is used for decision making.” (McKinsey)
CASE STUDY # 1

Insulation Resistance
Insulation Resistance Example

**Power Distribution**
1. Umbilical
2. UTA to SDU jumper
3. SDU
4. TSCJ to 901
5. TSCJ to 902
Insulation Resistance Example

• Case study 1 – Loss of insulation resistance:
  • EPU insulation resistance
  • MCS communications failure rate
  • SCM house keeping data
Insulation Resistance Example

• Case study 1 – Loss of insulation resistance:
  • EPU insulation resistance
  • MCS communications failure rate
  • SCM house keeping data
Insulation Resistance Example

Limit of LIM device 1 MΩ

LIM alarm 250 kΩ

LIM trip 50 kΩ
Insulation Resistance Example

One month trend, February 2011
Insulation Resistance Example

Three year trend.
Insulation Resistance Example

February 2011.
Insulation Resistance Example

1 MΩ.

400 kΩ.

15 month period.
Insulation Resistance Example

34 day electrical isolation.
Insulation Resistance Example

22nd September 2011.
Insulation Resistance Example

22nd September 2011.

5 kΩ.
Insulation Resistance Example

1st January 2012.
**Insulation Resistance Example**

- **3 day electrical isolation**
- **1st January 2012.**
- **500 Ω**
Insulation Resistance Example

Location of the fault
1. Umbilical
2. UTA to SDU jumper
3. SDU
4. TSCJ to 901
5. TSCJ to 902
10 month falling trend.
Insulation Resistance Example

29th January 2013.
Insulation Resistance Example

Insulation resistance drop
no shutdown
Insulation Resistance Example

Insulation resistance drop
no shutdown

29/01/2013 at 09:30
Insulation Resistance Example

• Case study 1 – Loss of insulation resistance:
  • EPU insulation resistance
  • MCS communications failure rate
  • SCM house keeping data
Insulation Resistance Example

Separate power and communications distribution systems
Insulation Resistance Example

Only one component in common: Subsea Distribution Unit (SDU).
Communications errors running total
Insulation Resistance Example

Flat line
No new errors recorded
Insulation Resistance Example

29/01/2013 at 09:30

SCM 902
SCM 901
More communications errors on SCM 902
Insulation Resistance Example

• Case study 1 – Loss of insulation resistance:
  • EPU insulation resistance
  • MCS communications failure rate
  • SCM house keeping data
Insulation Resistance Example

29/01/2013 at 09:30
Sudden jump in voltage
Insulation Resistance Example

Sudden increase in interference

SCM 902
Insulation Resistance Example

SCM 902 effected more than SCM 901
Insulation Resistance Example

- Insulation resistance
- Communication failure rate
- SCM house keeping
- All implicate SCM 902 more than SCM 901
- Due to inductive couplers at the SCMMB the SCM can be ruled out
- This identified the SDU or TSCJ for SCM 902 as the most probable source of the fault
Insulation Resistance Example

Probable location of fault
1. Umbilical
2. UTA to SDU jumper
3. SDU
4. TSCJ to 901
5. TSCJ to 902
Insulation Resistance Example

Probable location of fault
1. Umbilical
2. UTA to SDU jumper
3. SDU
4. TSCJ to 901
5. TSCJ to 902
Insulation Resistance Example

Location of the fault
TSCJ connector to SDU
Insulation Resistance Example
Insulation Resistance Example

• No condition monitoring:
  • Long lead items 16 week delivery
  • Manufacturing 2 to 4 weeks
  • Lost production 10,250 bpd
  • Lost production £59,340,000

Note:
• Calculation based on 20 weeks lost production, Brent Crude oil price (19/04/2017) of $53.01 per barrel and an exchange rate of $1 = £0.78 the lost production would have been £59,334,093.
• Based on the Brent Crude oil price at the time of the event, 29/01/2013 of $115.22 per barrel and an exchange rate of $1 = £0.6351 the lost production would have been £105,007,878.
Insulation Resistance Example

• With condition monitoring:
  • Condition monitoring gave 17 months notice of a failure
  • Spares were purchased and dive procedures written;
  • The most probable location of the failure was identified prior to the DSV sailing
Insulation Resistance Example

• With condition monitoring:
  • Production was restored within 8 days of the failure
  • Lost production £3,390,000
  • Saving £55,950,000

Note:
• Based on the Brent Crude oil price on 29/01/2013 of $115.22 per barrel and an exchange rate of $1 = £0.6351 the savings were £99,007,427.
CASE STUDY # 2

Valve Actuators
Predictive Maintenance (Advanced Analytics)

Machine Learning approach to hardware health monitoring

Post-doc data scientists working with Wood Group dedicated to predictive maintenance development
Asset map view dashboard reading latest CBM data / reporting

Degrading, failed or other watch list equipment flagged with clickable links to key sensor data

Summary data for all map components available on hover
CASE STUDY # 3

Acoustic Sand Detectors
ASD pattern detection signal parameter tuning GUI

Automated detection and visualization of concurrent events

Choke valve movement + ASD event

Automated alarm signal extraction and classification
Future Trends

Smart inspection and monitoring

Focus on value and risk management
Driving disruptive change in inspection and monitoring

Opportunity to derive more value from:
- Less focused
- Value-driven, inspection and monitoring

Remote condition monitoring (RCM), with predictive analytics to replace periodic inspection
- Why to inspect and what for?
- Focus on leading / lagging indicators of failure

Game-change may not be in the inspection or monitoring technology itself but on the way it is deployed and its value offering

AUV’s and Inspection systems

Disruptive change in ROV and AUV technology
- Subsea infrastructure
- AUV Pipeline inspections
- Infield ROV for normal infield inspection

Automated Anomaly Detection
Using machine vision to automatically detect anomalies

Remote and elevated infrastructure
- Drone inspection of onshore pipelines/infrastructure
- Safety-driven inspection innovation
Future Trends

Sensor and Communication

**Reliable sensor technology**
Data is only as good as the sensors producing it and their reliability

**Fibre optic systems evolution**
- Communications
- Discrete sensing
- Distributed sensing
- Relatively low cost and reliable
- Potential for all-fibre-optic monitoring systems? (could this be a realistic offering?)

Data Analytics/Edge Analytics

Evolution from diagnostics towards advanced analytics

Predictive systems

Cognitive systems (machine learning)

Edge analytics systems:
Evolution from all data flowing back to value data flows enabled by analytics in the field (requiring less bandwidth)

(*Human + machine*) better than (*human or machine*)
Summary

• Industry and economic forces driving disruptive change

• Search for efficient, lower cost, risk-based, innovative and reliable solutions

• Key developments
  – value-driven (smart) inspection and monitoring
  – autonomous and robotic vehicles and inspection systems
  – data analytics and edge analytics
  – Fibre-optics monitoring/sensing and comms.
  – Innovative technologies that deliver value

• Need to adapt to survive….
“The best time to plant a tree was 20 years ago, the second best time is now.”

Chinese proverb
Subsea Condition Monitoring and Predictive analysis

Subsea UK, NSRI, The DataLab and CENSIS workshop 25 April 2017
Introduction & what we do
Case studies
Trends in SIS
Subsea, trends and sensing
The Innovation Centres

Supported by The Scottish Funding Council, Highlands and Islands Enterprise and Scottish Enterprise.
Direct Support: Glasgow and Aberdeen

Supply Chain & Research Staff
- Full Scottish supply chain
- Researchers across all HEIs

Space, Skills and Software
- IoT Centre
  - Industry-experienced engineers
  - Hardware, software and tools
  - Hot desk space

Stakeholders and Support
- Integration - SE/HIE/SDI and Govt packages
- Engagement & referral - inc Catapults, other ICs and industry bodies
Progressing new products and markets
An Identified need for end to end mentoring
Enabled delivery of IoT Boost
SME challenges fast tracked into IoT products and services

- Demo space, drop-in centre, seminars, mentoring
- Engineering support

Developed with support that includes:

- Microsoft
- SEMTECH
- NXP
- Libelium
- IBM
- Aruba
- Silicon Labs
- Stream
- Abercorn

Av. 1 per month since launch mid 2015
Using best in class /disruptive IoT device enablement tools and kits

**Radio**
- Xbee Zigbee
- Wifi
- BLE
- Wifi, BLE, 6lowpan, Zigbee
- 6lowpan

**Micro**
- Red Pitaya
- Intel Galileo
- Arduino
- Freescale Freedom
- Beaglebone
- Libellium Wasp mote
- Raspberry Pi

**Sensor**
- 9 DOF IMU
- Barometric Pressure
- IR camera
- Temperature Humidity
- PIR (motion)
- Gas
- GPS
- Ultrasonic range finder
- Camera
Engagement models

Vision
Feasibility
Review & Positioning
Planning & Scoping
IoT Centre
Demonstrators and test beds
Funding and Partnering

Supporting projects
Case studies
### Challenge

- Low-pixel automatic target and recognition
- Recognition of objects based on data from sensors

### Project

- UWS expertise in image processing and object detection algorithms
- Develop algorithms using low-resolution thermal image data

### Impact

- Auto detect people and vehicles
- Identify vehicle type
- Operate in real time with limited processing hardware

**Partners:** Thales UK Glasgow, CENSIS and the University of the West of Scotland
Environmental sensing measures CO2, wind speed, precipitation, humidity, sulphates, particulates etc.

‘Data noise’ creates challenges: how do we filter innocuous readings from those requiring action?

Sensors age and degrade over time: how do we ensure data reflects conditions on the ground?

Sensing Environmental Risk

Statistical models from St Andrews Uni incorporated to Topolytics SW platform for real-time, accurate gas emissions

In collaboration with:

• Increase confidence in data.
• Better understanding of environmental impact
• More effectively monitor waste
• Potential new commercial offerings in a market valued at $20Bn by 2020
<table>
<thead>
<tr>
<th><strong>Challenge</strong></th>
<th><strong>Project</strong></th>
<th><strong>Impact</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Data gathered by Scottish Water in operational environments is not being used to extract maximum value</td>
<td>• Decision support for management of water and wastewater assets</td>
<td>• Transforming asset management</td>
</tr>
<tr>
<td>• SW assets often situated in remote/demanding environments</td>
<td>• The establishment of a high-quality decision support environment to optimise equipment in the field</td>
<td>• Timely and planned intervention for repairs and maintenance</td>
</tr>
<tr>
<td>• Signal processing advances can bring new value to existing data</td>
<td></td>
<td>• Significant cost savings</td>
</tr>
<tr>
<td>• New techniques will identify key signatures in data</td>
<td></td>
<td>• Potential worldwide interest</td>
</tr>
</tbody>
</table>

**Partners:** Scottish Water, CENSIS and University of Strathclyde
Trends in SIS
Trends and drivers

**Trends**
- Power efficiency
- Fusion & Miniaturisation
- Intelligent edge devices
- Cost reduction
- Diverse communications

**Challenges**
- Battery life, deep sleep, energy harvesting
- Packaging, accuracy and sensitivity
- Local processing, bandwidth considerations
- Ubiquity, ‘lick and stick’
- Spectrum space, bandwidth, range, quality of signal, real time & more

**Drivers**
- IoT, wireless sensing
- Smart devices, wearables
- LPWAN, distributed networks
- Sense everything
- Remote monitoring
Industrial companies are moving towards greater digital value creation, from augmented products to serving digital ecosystems.

- **Augmented Digital Product Player**: Focus on products with digital features like sensors or communication devices.
- **Complete Solution/Service Provider**: Focus on digital products and data-based services, which provide a complete solution for the customer.
- **Data Analytics, Content & Platform Integrator**: Focus on data analytics and data-based services; access to customers via a dedicated (online) platform.
- **Integrated Digital Ecosystem Provider**: Integration of third-party partner or competitor products and control systems in a complete customer ecosystem.

Source: PWC Industry 4.0 Building The Digital Enterprise
Mass Production
Product with Parts
Connectivity and Service Optimisation
Data Monetisation
Information Ecosystem
Subsea trends and sensors
Unprecedented level of cost-focus is changing the dynamics of the market.

There is an increasing interest in sensor data to enable reduction in total cost of ownership (CAPEX and OPEX) of subsea assets.

Data transformed to useful information is now seen as higher value and is changing how partnerships are formed in the subsea ecosystem.

Move towards standardisation and modularity to reduce costs.
LPWAN position in Topside Wireless?

- Licensed exempt ISM bands globally
  - 868MHz EU, 915MHz USA, ASIA 470MHz
- Sub 1GHz has exceptional RF characteristics
  - Ideal for connecting sensors in:
    - Remote locations, long range >10Km
    - Deep inside buildings or underground
- Designed for small IoT data packets
  - Less than 1000 bytes a day (typical)
  - Long Battery life – up to 10 years
- Simple network infrastructure
  - >10K end devices per base station/gateway
- Low cost Capex and Opex
- Essential for a heterogeneous IoT network
  - Up to 75% of IoT connections are predicted to be viable for LPWAN in 2022
Wireless in the subsea world

Source: D. Moodie (TechnipFMC), CENSIS Tech Summit 2016
Wireless in the subsea world

But there are a lot of other factors – not just BW and loss.

Size, weight and power are always a trade off.

Source: D. Moodie (TechnipFMC), CENSIS Tech Summit 2016
Challenging but has some advantages

**Advantages**
- Connector and Cabling costs
- Retrofit (lick-and-stick)
- Retrievable (no shut down)
- Configurable networking

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**Disadvantages**
- Battery Life (energy harvesting options)
- Non-critical use only
- Environment (Immunity to interference)
- Security

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**Generic Industrial Fibre-Optic Connector**
- 5 USD

**Subsea wet-mateable Fibre-Optic Connector**
- 25,000 USD
CPM: No Sensors = No Data

- **Standard**
  - Pressure, Temperature, Single Phase Flow

- **Additional**
  - Leakage
  - Erosion/Corrosion
  - Fatigue
  - Actuator Position (valve, choke)
  - Multi-phase flow
  - Sand Detection
  - Pig detection
  - Process (oil-in-water, level monitoring)
  - Downhole fibre-optic
  - Video inspection
Parameters
Technologies
Accuracy
Power and cost
Deploying
Getting the data
Future proofing?
The Data Lab
Understanding the Business Case for Data Analytics
@DataLabScotland
Duncan Hart
Cumulative value of big data + IoT to the UK economy from 2015-2020

- 2015-2020: £322bn
- Per Year: £54bn
- GDP: 2.7%
17 – 49% Increase in Productivity

11 – 42% ROA

5 – 6% Performance improvement

241% Increase in ROI

1000% Increase in ROI

Booze Allan Hamilton (Field Guide to Data Science 2nd Edition 2015)
It is not about the size of the data, it’s about the value within the data.
• What is the burning question
  Generate greater revenue?
  Retain or acquire customers?
  Increase production?
  Reduce costs?
  Reduce administration?
  Deploy assets more efficiently?

• What value would it generate for the business if you could solve the problem *Financially*

• Think laterally and don’t be afraid to think big

• Quick wins can help generate internal buy in
Some Examples
Aims

“Deliver an app that uses the accelerometer in mobiles to automatically monitor road quality”

- Take 2.5s (100Hz) accelerometer data segments (x, y, z, time) and distinguish between ‘potholes’ and ‘other’.
xDesign
xDesign

![Graphs showing data analysis with various axes and values.](image)
xDesign
Success!

Simple amplitude filter  
~ 80% accuracy

with machine learning filter  
~ 95% accuracy

Outcomes
- New product
- New company
Innovative Monitoring Approaches

Subsea Condition monitoring for Predictive Failure and Maintenance Workshop

25 April 2017, Aberdeen

Sarah Keynes
Senior Programme Manager (Energy Innovation)
Tel: 07748 704321  |  Email: saryne@nerc.ac.uk
Our vision

To place environmental science at the heart of responsible management of our planet
Meeting society’s needs

- Benefiting from natural resources
- Resilience to environmental hazards
- Managing environmental change
- Discovery science
We support

- 3000 scientists & 1000 PhD students
- 1000 research projects and 60 UK or international programmes
- 55 universities, 20 research institutes
- UK national capability: 4 ships, 7 aircraft, 6 polar bases, 6 data centres, 32 community facilities
Our centres

- British Antarctic Survey
- British Geological Survey
- Centre for Ecology & Hydrology
- National Centre for Atmospheric Science
- National Centre for Earth Observation
- National Oceanography Centre
Strategic Research

Translation and Innovation
“Enhancing the impact of NERC’s investments by transforming the knowledge, data, capabilities and skills of our community into new value-adding approaches, tools and solutions.”
NERC Innovation

Partner with business to help them find and use environmental science they need

**Understand needs**
How can science, knowledge and evidence help?

**Co-design research**
Where new knowledge is needed

**Broker access**
To data, expertise and skills

**Translate existing research**
Develop innovative tools, approaches and solutions

http://www.nerc.ac.uk/business/
Innovative monitoring approaches for infrastructure, oil and gas and renewable energy

- Application of existing environmental science monitoring capabilities and expertise
  - technologies,
  - techniques and tools for measuring and modelling,
  - deployment and interpretation.

- 3 sectors:
  - infrastructure,
  - oil & gas and
  - offshore renewable energy

http://www.nerc.ac.uk/innovation/activities/naturalresources/oilandgasprog/roundtwo/
Innovative Monitoring Approaches Call

Proposals must meet the needs of an end-user project partner

Assessment criteria:
• Impact and Innovation Potential
• Mechanisms for delivery
Predictive jellyfish bloom dispersal maps for UK coastal electricity generating facilities

- 2011 – EDF Energy’s Torness nuclear power plant closed for 1 week = £1m per day

- NERC investment £160k

- 18 month project to develop early warning tool

“Jellyfish swarms are an occasional but challenging issue for our power stations. They can have an impact on the amount of electricity we are able to supply to consumers. . [we] are pleased to be working with the University of Bristol to develop a tool that will allow us to continue delivering, safe, secure and responsible nuclear electricity.”  

Pietro Bernadara, EDF Energy
Multiple Vehicle Coordination, Command and Control, and Data Systems

**Problem**
- How to integrate these systems together and how to manage the large amounts of data generated?

**Solution**
- Development of improved command and control, associated back-end infrastructure to support scalable fleets of heterogeneous vehicles for persistent monitoring of the oceans and improved data management
- **Demonstration Missions: 2018-2019**
- **Ready for Missions: 2020-2022**

**New Systems/Sensors**
- Improve the deployment pattern to optimise the data collection (improve the quality of data)
- Improvement in range of sensor systems (improve range of data)
- Reduce the cost and administration to process the data

**Potential Energy Sector Applications**
- Increased command, control, and data processing will allow multiple vehicle missions for the energy sector with enhanced data management
Innovative Monitoring Approaches Call

NERC Investment: £3.5M

Max £350k per project

6-18 month duration

Outline Bids deadline: 15 June 2017

Further information:
http://www.nerc.ac.uk/innovation/activities/naturalresources/oilandgasprog/roundtwo/
Any questions?

Sarah Keynes
Senior Programme Manager (Energy Innovation)
Tel: 07748 704321  |  Email: saryne@nerc.ac.uk

Lizzie Hinchcliffe
Programme Manager – Innovative Monitoring Approaches Funding Call
Tel: 01793 411940  |  Email: elihin@nerc.ac.uk
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