BRU21: Research and Innovation Program in Digital and Automation Solutions for Oil and Gas Industry

Prof. Alexey Pavlov – BRU21 program manager
BRU21 origin

Fact finding meetings with the industry & authorities: 2016-2017

- What are the major challenges for the O&G industry?
- What are “break-through technologies” for oil prices at 30 $?
- How can NTNU contribute to deliver future technologies & education in O&G?

BRU21 Report – NTNU Strategy for Oil & Gas www.ntnu.edu/bru21

NTNU Strategy for Oil and Gas
What are the major challenges for the O&G industry on the Norwegian Continental Shelf in the future and the contribution from academia for solutions

NTNU Norwegian University of Science and Technology
BRU21 vision
Enable higher efficiency, safety and reduced environmental footprint of oil and gas production through digital and automation technologies

+ support the industry transition to sustainable energy future

BRU21 mission
Mobilize multidisciplinary expertise across NTNU and, in cooperation with industrial partners, produce research results for novel technological and organizational solutions

BRU21 goal
Deliver new knowledge, technologies, innovations and multidisciplinary specialists for the digital transformation of the Oil and Gas industry and for the Norwegian society
BRU21: Industry – NTNU collaboration: 39 (+2) projects

Industrial partners

- Lundin Norway 4
- AkerBP 4
- GASSCO 1
- TechnipFMC 2
- BR 1
- NEPTUNE ENERGY 2
- OILJEDIREKTORATET 2

NTNU 14

Collaboration
Education
Innovation

Industry use cases

- Field development and economics
- Drilling and well
- Exploration efficiency
- Reservoir management, Production optimization
- New business and operational models
- Operations, maintenance, safety & security

Operations, maintenance, safety & security

Innovation

Education

Collaboration

Industry use cases

Exploration efficiency

New business and operational models

Reservoir management, Production optimization

Operations, maintenance, safety & security

Industry partners

- OLJEDIREKTORATET 2
- wintershall dea 2
- equinor 5

Knowledge for a better world
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Detection and localization of subsea leakages
Detection and localization of subsea leakages

Digital operations and future operating models
Remote operations and future operating models
Remote operations and future operating models

Collaboration and digital tools in early stage design of offshore facilities
From idea to discovery: information sharing and cooperation in the exploration value chain
From idea to discovery: information sharing and cooperation in the exploration value chain

Risk-based maintenance
Risk-based maintenance
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Maintenance in remote operations
Predictive maintenance
Predictive Maintenance and Remaining Useful Lifetime

A hybrid data-driven and mechanistic model for production optimization in the oil and gas industry
Predictive technology for production optimization, with focus on gas lift allocation
Predictive Maintenance and Remaining Useful Lifetime

Optimization of production, reservoir and field development
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Data-driven reservoir modelling
Integrated Reservoir Tool/FieldOpt
Machine learning-based production optimization

Avoiding the operation and maintenance of offshore energy hubs
AI for safety-critical remote operations
AI for safety-critical remote operations

Optimization across time-scales in oil and gas production
Risk-based maintenance
Risk-based maintenance

Assisted history matching, reservoir model update and optimization
Assisted history matching, reservoir model update and optimization
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Improved technology for production optimization, with focus on gas lift allocation
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Contribution to reduced environmental footprint
BRU21 model:

Collaboration  Research  Education  Innovation
8 departments / 4 faculties at NTNU

- Engineering
- Geoscience & Petroleum
- Mechanical
- Cybernetics & Robotics
- Data Science & Cyber Security
- People Organization Economics
- NTNU Ocean
- NTNU Digital
- NTNU Energy
Research dissemination

**Video Newsletters**

- **BRU21**: In-House Research and Innovation Program in Digital and Automation Solutions for the Oil and Gas Industry. The initiative brings together experts from NTNU and the oil and gas and technology companies. [Read more]

**Video newsletters**: In this series of newsletters, we present BRU21 projects and selected results in the form of short videos covering both of the following areas:

- **BRU21 program area: Exploration Efficiency**
  - BRU21 aims at developing novel automation tools to improve data analysis efficiency in the exploration workflow and training and artificial intelligence in the exploration field.

- **Project result**: Workflow to classify lithology using 3D and 3D CT images
  - Convolutional Neural Networks-based workflows for high-resolution analysis of lithology.

**BRU21 project**: Automated lithology classification employing whole core CT scans
- Lithology classification enabled by whole core Computational Rock Physics and advanced analytics algorithms

**BRU21 Project**:
- The impact of well data quality on machine learning performance
  - Structuring and preprocessing of imbalanced data for efficient use with machine learning algorithms

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**LinkedIn**

- **Department of Geoscience and Petroleum**
  - 5,594 followers

- **Egil Tjelta Kenney**
  - Norway Research and Innovation Program in Digital and Automation Solutions for the Oil and Gas Industry
  - NTNU

Efficient cross-boundary collaboration and information sharing are still among the greatest challenges for many organizations. In this project, BRU21 PhD Candidate Natalia Korotkova at Norwegian University of Science and Technology (NTNU) is working on digitalization of knowledge collaboration in the Front-End stage of the oil and gas value chain. The research focus is on preconditions, implementation, and exploitation of digital technologies for knowledge collaboration in different parts of complex organizations. Natalia specializes in social systems by analyzing knowledge networking, trust-building, knowledge reuse, and adoption of emerging technological concepts such as digital twins. Ternipetpac sponsors this project.

**LinkedIn Video Newsletters**

**LinkedIn Video Reports**

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**Innovative dissemination strategy**

- 55+ videos on projects and project results
- In total 2+ hours of videos
- Training in business communication
BRU21 Innovation

Innovation projects towards implementation/licensing

**ComputerWell – NTNU spin-off 2020**
Computational surveillance of drilling operations

- Real-time computational drilling dynamics
- Massively tested pattern recognition
- High frequency GUI
- Along string inspection

Visit: www.computerwell.com

**ProDecs – Investment valuation under uncertainty**
Better informed investment decisions

**Well log depth matching**
Well log depth matching using analytical and deep learning

**MAC: Look-ahead method for predicting formation changes and karsts**
MAC Enables detection of small geological features undetectable with existing technologies

**ADF: Drilling data processing**
ADF enables detection of small events in logged drilling data

**PERMEAN: Rapid downhole testing of permeability anisotropy**
PERMEAN provides rapid and accurate downhole measurement of permeability anisotropy within minutes
NTNU Drillbotics Team 2021
Winners of International SPE Drillbotics Competition

Preparing future industry specialists with both digital and petroleum expertise is one of the BRU21 goals.

NTNU team of drilling engineering and cybernetics students – Benedicte Oijendal, Gaute Hänsön, Mikal Viga Skretting and Magnus Steinse – developed a miniature robotic drilling rig for autonomous directional drilling and won the 2021 SPE Drillbotics competition in drilling automation. Coached and sponsored by BRU21, NTNU teams won the competition also in 2018 and took 2nd place in 2017.

1. NTNU
2. OU
3. A&M

1. Texas A&M
2. NTNU
3. UIS
BRU21 Academy: courses for the industry

Petroleum Cybernetics for Engineers and Managers
(A. Pavlov, M. Stanko)

Digital Twins for Managing Safety and Reliability of Systems
(J. Vatn)

Digital solutions for planning and optimization of maintenance
(J. Vatn)

Remote operations
(V. Hepsø)
BRU21 success factors

Success factors:
- Industrial use-cases
- Engaged industrial contacts
- Access to data
- Access to industrial expertise
- Capable & experienced PhDs/PostDocs
- NTNU expertise + supervision
- Focus on Innovation

7 published/accepted
7 submitted
5 in progress

Across 5 BRU21 projects
BRU21

NTNU Research and Innovation Program in Digital and Automation Solutions for the Oil and Gas Industry