IO Center
Center for Integrated Operations in the petroleum industry
Established by the Research Council of Norway
Integrated Operations is a new way of optimizing the operation of oil and gas fields by making smarter decisions through integration of people with different expertise, integration of work processes, and integration of information and communication systems from different domains.

The traditional oil and gas field operation used to be based on the organization of people, processes and computer systems in functional silos (drilling, sub surface, operation and maintenance, logistics, HSE). The operational processes were confined within the limitations of each silo. Obviously, this strategy did not take full advantage of the synergies and interdependencies between the functions. By putting these together in integrated operations the expected result is smarter decisions leading to optimization of the whole value chain.

In the near future decisions will be made by virtual teams operating across organizational, functional and geographical domains. Experts from anywhere in the global networks of the oil companies and their suppliers will work together to solve local problems throughout assets around the world. The virtual teams will have at their hands real time analyzed information collected from a variety of information systems which previously did not communicate very well.

This future perspective is raising several issues regarding new business processes, human communication and culture, collaboration environment, data communication and advanced mathematical models, just to mention a few. All though the oil companies and service suppliers already have embarked on implementing Integrated Operations, there are still many challenges left, where further research and development is needed. This is the reason for establishing the IO Center.

VISION

- Develop next generation IO solutions for People, Processes and Technology
- Give the partners a competitive edge in IO compliance and operational performance
- Bring new IO technology to the petroleum industry as a whole

Introduction to Integrated Operations

INTEGRATED OPERATIONS is a new way of optimizing the operation of oil and gas fields by making smarter decisions through integration of people with different expertise, integration of work processes, and integration of information and communication systems from different domains.

www.ntnu.no/iocenter

IO Center Annual Report 2008
Major elements of Integrated Operations

**BUSINESS OBJECTIVES**
- **ASSETS**
  - Reservoir
  - Wells
  - Process system

**INFORMATION SYSTEMS**
- Integrated data acquisition and information systems

**ANALYSIS & VISUALIZATION**
- Integrated modelling and analysis tools

**DECISION & PLANNING PROCESS**
- Integrated interpretation and decision process

**SUCCESS CRITERIA AND GOALS FOR THE IO CENTER**

**RESEARCH**
- Long-term industrial research of a high international calibre
  - World class research
  - Generate new ideas/solutions
  - PhD projects
  - Publishing
  - International co-operation
  - Increased R&D among partners

**INNOVATION**
- Value for increased production, enhanced oil recovery, reduced costs and improved HSE,
- Value for supplier industry through new competitive products and services
  - Use of technology
  - Pilot projects
  - Transfer of knowledge
  - Mobility of personnel
  - Support to implementation/innovation
  - New enterprises

**EDUCATION**
- Providing IO-competent people to the industry
  - Master students
  - Continued education

**NETWORKING INDUSTRY – RESEARCH**
- Arenas for co-operation and networking
  - Industry-research network
  - Strategic think tank
  - International Conference
Strategy
The chosen strategy for achieving the goals and success criteria for the IO Center is:

- R&D activities shall, at all levels, address the 3 aspects: People, Process and Technology
- The R&D shall combine long term research with short term deliverables
- Deliverables shall be
  - Methods, tools, concepts and knowledge which can be implemented in the business processes or products/services within the participating companies
  - Support for implementation and innovation
  - Education; master students and continued education courses
- The research shall involve industrial collaboration through pilot projects
- The IO center shall coordinate its activities with other R&D initiatives at a national and international level, and strengthen networks within IO

Human resources

<table>
<thead>
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<th>Actual</th>
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<tbody>
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<td>Research Scientist, manyears</td>
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<td></td>
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<tr>
<td>Guest Research Scientists</td>
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<td></td>
</tr>
<tr>
<td>PhD students</td>
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<td></td>
</tr>
<tr>
<td>Postdoctorate students</td>
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<td></td>
</tr>
<tr>
<td>Master students</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Results

- Journal papers: 2
- Conference papers: 18
- Technical reports: 17
- Workshops, internal seminars: 10

Funding (1.000 NOK)

- Research Council of Norway: 12 800
- Industrial partners: 23 950
- Research partners: 4 100

Operating costs (1.000 NOK)

Total budget 2008: 40 850

Gender distribution

<table>
<thead>
<tr>
<th>Category</th>
<th>% Female Target</th>
<th>% Female Actual</th>
</tr>
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<tbody>
<tr>
<td>PhD students</td>
<td>30</td>
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</tr>
<tr>
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<td>Sub project managers</td>
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</tr>
<tr>
<td>Board</td>
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<td>20</td>
</tr>
</tbody>
</table>

In connection with recruitment of PhD students, the announcements have stimulated women to apply for positions. Female participation has also been one of the criteria for hiring sub project managers and program managers. However, in both cases we have experienced problems with finding a sufficient number of female candidates.

ORGANIZATION

Research partners

Collaborating international academic partners

Industrial partners

StatoilHydro, ConocoPhillips, Aker Solutions, FMC Technologies, IBM, Eni Norge, TOTAL, Shell, KONGSBERG, DNV, GDF Suez
National collaboration
The center collaborates with various research institutions in Norway and with the petroleum authorities.

Common PhD projects have been organized with the University of Stavanger and International Research Institute of Stavanger (IRIS). The IO Center supports and is represented in the Steering Committees of the three projects "IO in the High North", "RIIO (IO and Safety)" and "Codio" (Decision support for drilling).

The Norwegian Safety Authority and the IO Center have co-sponsored an industrial seminar on major hazards and IO. A seminar for research and industry was co-arranged with the Research Council of Norway/Petromaks program to discuss strategies for continued R&D within IO.

Organization
The consortium consists of 11 industrial partners, three research partners and associated external research institutions.

The governance model is shown in the figure below.
Research Plan

The activities of the IO Center are structured in four programs with a number of sub projects. The activities are closely integrated wherever synergy effects are present.
Program 1 Drilling and Well Construction

Safer and more efficient drilling operations
Make the invisible visible; Make the impossible possible!
Drilling problems reduced by online simulation while drilling
Integrated Drilling Simulator test with real well log data

An Integrated Drilling Simulator (IDS) with virtual wellbore has been demonstrated on historical data from the Hans well drilled by Total. Also, IDS/eDrilling has been extensively tested on data in real time during drilling on the Ekofisk Field (ConocoPhillips). These demonstrations have given valuable experience and lessons related to data integration, data quality and new work processes. The tests carried out by the IO Center have proven that the Integrated Drilling Simulator can support safe and efficient drilling by giving valuable diagnostic information and early warnings on incidents like kicks, lost circulation, cuttings transport problems, and that the IDS/Flow model can function as a “Virtual Pressure While Drilling” (PWD) when the PWD malfunctions or when data are not transferred to the surface. 2 SPE papers have been published on results from Ekofisk Pilot.

Prevention of hazards and downtime problems through early warning systems
Various Artificial Intelligence (AI) based methods for diagnosis have been evaluated and tested. The following incidents have been evaluated: detection of drillpipe washout, mud pulses in the stand pipe pressure, poor hole cleaning and stuck pipe and prediction of bottomhole pressure and rate of penetration. Very promising results have been achieved. 3 conference papers have been published on the use of AI based methods for diagnosis.

New work processes in drilling - exploiting the potential of real time data
Generic integrated work process development: Workshop on “Work processes and organizational change regarding future implementation and use of IDS” has taken place, and the report “Managing Change with the Integrated Drilling Simulator” has been issued. Also a close follow-up of eDrilling/IDS pilot at Ekofisk (CoPNO) has taken place, and the report “eDrilling - Expectations and factors for successful implementation in ConocoPhillips” has been issued.

Wired Drill Pipe – High speed data communication from the drill bit to the surface
Interviews with industrial participants with experience in wired drill pipe have been performed and the Report “Industry Status and Expectations for Wired Drill Pipe” has been issued.

Associated Projects
“eDrilling” Project has been ongoing for 3 years performed by SINTEF and partners, and completed in 2008. This project has developed an integrated system for real time simulation, visualization and decision support in drilling.

“eControl” is continuing with SINTEF and Aker MH, developing a local and remote drilling optimization and control system for drilling conditions with application on “Extreme” rigs and other similar advanced drilling rigs.

New Company established: “eDrilling Solutions”
A new company “eDrilling Solutions” has been established by IO Center Partner SINTEF, partly as a result of IO Program 1 achievements. In IO Program 1 the Integrated Drilling Simulator with its associated Virtual Wellbore has been tested and demonstrated on wells from StatoilHydro, Total and ConocoPhillips, and this has been important demonstrating the great potential for eDrilling.

Rolv Rommetveit (now with eDrilling Solutions) and Knut Bjerkevoll (SINTEF) demonstrating eDrilling during ONS in 2008.

Tests carried out by the IO Center have proven that Integrated Drilling Simulator (IDS) can support safe and efficient drilling by giving valuable diagnostic information and early warnings on incidents like kicks, lost circulation, cuttings transport problems.
Closed-loop reservoir management

A large portion of the IO value potential lies in reservoir management. Our guiding principle is the concept of closed-loop reservoir management. This means work flows for maximizing reservoir performance utilizing assisted history matching and decision support through model-based optimization in a near-continuous process. We emphasize on fast and reliable tools for data assimilation, fast methods for optimization of well configuration/location and future reservoir management work processes.

The closed-loop reservoir management framework is inspired by control theory as used in the process industry, but a direct translation to reservoir management is typically impractical due to reservoir model complexity. Even though computing resources are increasing fast, model detail and complexity tends to increase at the same pace. Thus, making the optimization workflow truly efficient requires speeding up simulation time. This makes model reduction techniques and alternative fast simulation technologies an important area of research. Keeping in mind that the level of detail of a typical reservoir simulation model (in space, time and physics) is extremely high compared to the number of input controls in for instance a well rate optimization loop. As a result, the potential for coarsening and model reduction is large. Early but promising results have been published, using both streamline simulators and recent multiscale methodologies.

A crucial factor in the development of model-based methods is understanding how existing and new tools can be used in future work processes. We emphasize that the goal of the closed-loop paradigm is not to replace humans, but to process and arrange available data to best support the expert decisions. To enhance the understanding of these issues, we have conducted interview series with operational personnel. Findings will be published later this year.

Integrating data from different sources is critical to IO, and in data assimilation we focus on production history and 4D seismic and the interplay between these two diverse types of data. History matching methods have been developed through both field-specific studies and methodological research. This research is performed in close collaboration with the Smart Field Center at Stanford University.

We are very pleased that the Norne-field licensees have agreed to release a huge amount of data to challenge researchers. We are currently preparing a unique benchmark test-case which will be made available Spring 2009. The Norne-benchmark is a unique opportunity for researchers world-wide to test and compare models and algorithms on a common set of real-field data, and has received positive response both in industry and academia. Furthermore, it provides a starting point for a new open approach to field development within the industry.
Local decision support technologies for real-time production optimization

Two concepts for decision support technologies are being developed: local decision making and value chain optimization. The application is operational decisions on a daily/weekly/monthly basis like production allocation between producers and possibly injectors, routing between pipelines, and the choice of operational settings on the facilities and export section.

Our working hypothesis is that IO does not imply that everyone should have access to all information. This is in fact undesirable. On the other hand, mathematical models may need and digest information from large parts of the value chain. We are exploring this duality and have developed a new concept to distribute just enough information between local teams to make them act towards common goals like for instance maximizing oil throughput on a platform or NPV for an asset. The challenge was initiated by StatoilHydro’s Troll Oil organization, since current technology cannot handle the production allocation and routing problem for this complicated production system.

We are developing the concept into workable procedures supported by advanced mathematical optimization techniques. This means developing a sound theoretical foundation, efficient algorithms and testing on production systems like Troll Oil. Results are being accepted in scientific journals and we are enthusiastic on acceptance in the industry. Furthermore, we foresee new applications to many complex operational decision problems like balancing resources and activities between production optimization and maintenance, and value chain optimization. This latter point brings us to the second concept. Optimal operation of large oil & gas systems may require a holistic view of the value chain to exploit a hydrocarbon asset to its maximum. Present industrial practice typically takes a silo approach in the sense that one part of the supply chain is treated quite separately from other parts. This is reasonable provided these two parts do not interact heavily. If, however, the coupling is tight it makes sense to explore the gains by treating the value chain as one large system. This is the case for many gas-condensate value chains where an LNG-plant is part of the value chain as in Snøhvit, and when some of the processed gas is re-injected. We are developing procedures for value chain optimization by combining local decision technologies with mathematical optimization and methods for connecting fluids models along the value chain. We believe that a mathematical representation of the production chain from reservoir and wells to export is necessary to utilize collaboration technologies towards their maximum. A mathematical backbone should always complement advanced collaboration technologies for integrated productions systems.

A unique teaching environment for IO

Remote asset management is becoming an integral part of petroleum operations. The Remote Operations in Oklahoma Intended for Education (ROOKIE) project will give students the opportunity remotely manage gas wells in Oklahoma, USA from a control room at NTNU.

The first well in this project is currently being set up for remote management, and will transmit real time rate, pressure, temperature and liquid level data. Students may control the well by activating a beam pump, or closing/opening a choke. Potentially twelve more wells may be connected to the ROOKIE project in the future.

Program 2 conducts workshops and seminars for dissemination of results to user partners in the IO Center. During 2008, 2 seminars were arranged.

The outlets for results are recognized international journals, conferences, workshops, industry courses and keynote lectures. More information is available on http://www.ntnu.no/iocenter/research/program2

Student project, remote control of gas wells in Oklahoma
Program 3 Integrated Operations through optimized planning of production, maintenance and logistics

For People to get the most out of Technology and natural resources, the responsible Organization must re-structure itself and its work-processes to facilitate collaboration and decision support on a scale not yet seen in the Oil and Gas industry! A holistic vision of the future must be implemented now! When function, discipline and planning staff have shared access to the status and prognoses for critical information, - only then will it become possible to optimize overall recovery, production and HSE.

Optimizing maintenance to maximize production potential
According to the Norwegian Oil Industry Association (OLF), operation and maintenance represents 32% of the potential value in implementing IO. For a facility to be available for production as many days of the year as is safely and sustainably possible, a maintenance philosophy and plan must be in place. The required analysis will result in the optimal blend of predictive-, condition based-, opportunity-, time based- and, - yes – breakdown-maintenance! Non-Intrusive Inspection (NII) methods, condition monitoring, analysis and prediction are the keys which make this possible.

Condition information collection
Much technology is available for detecting the condition of equipment whilst it is running and in operation, but it is not used to the full in the oil and gas industry. Vast funds have already been used on monitoring critical rotating machinery, so we focus on the largely untapped potential related to static process equipment, namely separators, heat exchangers and valves, - all of which can be safety and production critical too.

For separators, a laboratory test rig has been installed at MARINTEK, in cooperation with IFE and SINTEF ICT. The objective is to test NII methods suitable to detect internal conditions, such as damaged/loose internal parts, blockage, presence of sand, scale, emulsions and foreign objects. The first test runs using acoustic and gamma monitoring are currently being analyzed, and test on other problem conditions will follow.

Testing is underway on another laboratory rig for Safety Critical Valves, with focus on frequency analysis of acoustic emission signals for leakage detection of valves in the closed position.

Condition information analysis, predicting the future
Condition monitoring and predictive maintenance: - the challenge of reducing thousands of data points to meaningful information about equipment condition to maintain it in the most efficient and effective way.

Separator test rig
© MARINTEK
New tools for assessment and prediction of equipment condition need to be developed. This requires a common platform (currently not available in the industry) onto which customized applications for data reduction and processing can be built, tested, and integrated with centralized data repositories. The Mímir platform developed by IFE within the IO Centre is designed to fill this gap. It is based on standards such as the ISO 13374 and the Mimosa OSA-CBM specification, and provides a functional integration layer designed to sit on top of existing data integration layers (e.g. IBM’s Integrated Information Platform (IIF) or StatoilHydro - Global Operation Data Integration (GODI)). Development is on schedule, and the first release of the Mímir platform is planned for the end of 2009. It provides a standardized and expandable set of tools to deploy advanced decision support functions for predictive maintenance management.

We also research novel Remaining Useful Life (RUL) models which are central to the prognostics and condition-based maintenance technologies that are being developed.

**Integrated Planning to optimize the potential and value of resources**

Integrated Planning (IPL) is the cross disciplinary planning activity required to establish the overall operational plan. The basic elements in IPL is a formal planning process and an Operations Support Centre (OSCC) managing the plan execution and deviations. The main challenge in offshore operations is the uncertainty associated with a plan.

A successful agile organization must be able to benefit from unforeseen deviations from plans, and dynamically reallocate resources across functions, to optimize total HSE, production and cost savings.

Integrated Planning concept theory originates from several domains, Network Centric Warfare, Agile Manufacturing and Agile Project Management.

Research activities centre on case studies with partners. We focus on three topics:

i) measuring performance within planning,

ii) creating shared situational awareness using information displays in collaboration arenas,

iii) decision making processes in cross disciplinary teams looking particularly at communication.

The effect of implementing IPL will be an organization with a better holistic view of the operation more capable of understanding the constraints under which the operation is working thus better realizing the assets plans in terms of productions and recovery.

The result from the IPL project if implemented in operation will enable true optimization of resources to increase facility uptime and pave the way for agile operations.
Program 4 New work processes and enabling technologies

New and innovative technologies can either promote or impede IO teamwork.

Team Brage’s (StatoilHydro) definition of the outcome of successful collaboration is: “...high production and strong focus on HSE”. From studying how Brage uses their simple, but extremely well adapted work surfaces, several issues were identified that new technologies need to support in order to achieve this outcome. Together with IO Center partners a series of laboratory studies are planned to investigate the hypothesis: “Application of new and innovative technologies will provide a better basis for decision-making by clarifying risk factors”.

What is a successful IO collaboration environment?

Focus on HSE. Even SAP can be an excellent collaboration surface. Avoid “read-only” situations. Status report is both the agenda and meeting minutes. “Play each other better”.

NEXT STEP:
What are the effects on risk identification in team decision processes when applying risk visualisation technologies in maintenance planning?
Work and decision processes in virtual teams: The important thing is not where you belong, but how you can contribute

Team training
Training is of critical importance for ensuring high performance and high safety levels in virtual teams within IO. Extensive literature study, as well as extensive field study in Shell Norway, [Draugen & Ormen Lange] has built a solid knowledge basis for design and delivery of virtual team training. Such training should focus on skill-building in two main areas: 1) the hands-on use of collaboration technology; 2) the challenges related to communication and trust. This knowledge will be used to test training systems for virtual teams, starting with operations and production optimization teams in Shell Norway.

Key factors for virtual collaboration
Research and field studies in Shell Norway [Draugen & Ormen Lange] indicate that there are three critical success factors that will help overcome the challenges of virtual teams:
- Communication
- Shared understanding
- Trust
Details of the project results are published in the IO Center report "Keys to High-Performance Virtual Teams in Integrated Operations", October 2008. The research in this area has focused on operations and production optimization. This topic will be further explored through studying effects of virtual team training, and study of people’s “IO mindset.”

Integrated Operations and Safety
An interview study among four oil companies and representatives from PSAN claims there is no need to develop new DSHAs due to the introduction of IO - the exception may be ICT-related DSHAs.

This statement will be further studied in a crisis management field study looking into the use of DSHA in training and the use of ICT tools in crisis situations. Resilience Engineering supplement more traditional strategies by addressing the ability to handle unwanted incidents with a proactive focus on safety - establishing joint situation awareness and identify key coordination effort. The concept is explored for IO environments in cooperation with Eric Hollnagel.

“There is no need for generating specific IO-related “Defined Situations for Hazards and Accidents (DSHA)”

NEXT STEP:
Development of Proactive Indicators for Resilient Organisations, focusing on their impact on safety management approaches and contributing success factors for recovery and prevention of incidents e.g. attention, risk understanding, anticipation, robustness & redundancy.
General Projects

Crystal Ball
The goal of the Crystal ball project is to generate radical ideas for future IO by looking into the future, and learning from other industries. The results are shared with the industrial partners in their thinking processes for next step IO and are used for proposing new research tasks in the IO Center.

Several student projects have been launched on tomorrow’s collaboration environments for IO, leading to innovations in visualization technology.

One example is a group that has developed a new interaction system between human and computer. The concept is based on tracking of infrared light by use of a high definition video camera. This is cheap and innovative technology with easy calibration and installation procedures. It is excellent for use on large back-projected screens, and the number of input sources is practically unlimited.

Experience has been collected from concurrent design in the building and construction industry and from network centric operations in defense organizations.

Results have been presented through conference papers.

Valuation of effects of implementing IO
The Norwegian Oil Industry Association has estimated that the total Net Present Value of the Norwegian Continental Shelf will increase with 45 billion USD by full implementation of IO during the coming 25 years ("Updated value Potential for IO on the NCS", OLF report October 2007).

In order to assess such benefits at the company level, and being able to defend investments in IO projects, management need methods for assessment of these benefits. To day there is no common practice in this area, and most reports are based on subjective estimates.

The objective of this project is therefore to develop a standardized method for assessment of the value of implementation of IO.

The challenge in IO valuation is to assess the monetary value of changes within of people, processes, technology, and organisations (PPT0) and cost/benefits related to those changes. Moreover the effect of cooperation between companies is often not measured. It is important that IO-valuation methods are transparent on how the value is calculated and also account for potentially improved HSE. Another problem is to establish baseline criteria for “expected performance without IO implementation”.

Requirements to the prospective valuation method are the following:

- Explicit and practical valuation method providing strategic and operational values of Integrated Operations
- Establishment of KPI’s for increased oil recovery, accelerated production, reduced costs and improved health, safety and environment and baseline values before IO implementation
- Valuation of integration of people, processes, technology and organisation across multi-disciplinary value-chain
- Including qualitative analysis of capabilities and value drivers
- Illustrate and describe how decision and information processes are changed
- Illustrating how technological determinants, human factors and other potential value drivers influence value
- Accounting for uncertainty and flexibility
Innovation

The goal for innovation in the IO Center is that our industry partners are picking up results from the center and are using them to improve their business processes, their products and services. We have already seen examples of this during 2008.

Integrated Drilling Simulator/eDrilling

The field testing of the Integrated Drilling Simulator on real well log data in the IO Center has verified the potential of this tool, and the practical obstacles that have to be dealt with regarding data quality. Three of the oil companies in the IO Center consortium are now ready to proceed to trying out the tool in their drilling projects. This will hopefully give added value through enhanced drilling efficiency and safety handling. The establishment of eDrilling Solutions as a new company is another consequence of the IDS/eDrilling project where the IO Center has contributed.

Production optimization

Results from the pilot project on production optimization on Troll [StatoilHydro] in collaboration with FMC Kongsberg will contribute to the development of a new generation of the “Flow Manager” system provided by FMC.

SME Innovation program

Another innovation goal is to stimulate SME’s in the IO field (instrumentation, signal analysis, optimization tools, consultancy) to develop new products and services related to IO, and to find customer relations among companies inside and outside the IO Center. The IO Center is in a unique position to transfer needs and technological ideas that have been identified by the industrial and research partners in the consortium, and which may be more efficiently developed by niche companies than by the Center itself.

The IO Center has initiated an innovation program for SME’s. An SME Innovation Forum was arranged in connection with the IO 08 conference, where SME clusters, Centres of Excellence and innovation programs met with researchers from the IO Center to discuss innovation within IO. This arrangement was very well received by the SME’s.

Education

Master students

Recruitment of master students with background in IO-related subjects is a very important “result” for our industrial partners. These candidates will enter important positions in the industry and contribute to implementation of IO from the very first working day.

22 master students who have been affiliated with activities in the IO Center will deliver master thesis related to IO during 2008/2009. Many of them have already received job offers from the industry.

Continued education

The following activities took place during 2008:

- 2 seminars in reservoir management and production optimization, gathering 30 participants
- A continued education course on Human Factors and IO at NTNU, with 30 participants. The course was well received and will be repeated in 2009
- A seminar on Resilient Engineering and Safety, with about 30 participants from industry and research

Communication and dissemination

The 4th international conference on integrated operations, IO 08, was arranged by the IO Center in November 2008 with 300 participants. Keynote speakers from Saudi Aramco, Petrobras, British Gas and Stanford University provided a high international level. Several presentations based on results from the IO Center were given.

The IO Center presented about 20 conference papers and 2 journal level 2 papers during 2008. 8 internal seminars and workshops for industrial partners were arranged by the IO Center. Results have been disseminated to the partners at 2 technical committee meetings. During 2008, 4 articles were published about the IO Center in Norwegian newspapers and magazines.
People in the IO Center

Center Management

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NTNU

Jon Lippe
Operational manager
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Selveig Johnsen
Project Coordinator
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Andrew Gibson
Program 3: Operation and maintenance
MARINTEK

Jon Kvalem
Program 4: New Work Processes and Enabling Technologies
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Program Managers

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MARINTEK

Torgeir Brurok
3.2 Conditioning Monitoring
MARINTEK

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3.1 Generic Framework
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George Halsey
1.4 Utilization of increased bandwidth from borehole
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Torbjørn Korsvold
1.3 Work Process, Experience Transfer and Training
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Thor Ole Gulsrud
1.2 Diagnostic Tool
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Eirik Albrechsen
4.3 Safety, Security and Resilience in IO
SINTEF

Aud Marit Wahl
4.3 Safety, Security and Resilience in IO
MARINTEK

Asgeir Tomasgard
Valuation of Implementation of IO
NTNU

Harald Sleire
3.3 Integrated Planning
MARINTEK

Eric Hollnagel
Program 1: Drilling and Well Construction Solutions
SINTEF

Erik Albrechsen
4.3 Safety, Security and Resilience in IO
SINTEF

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Bernt Aadney
Ove Sandve

Postdoctoral researchers

Bjørnar Aas
NTNU

David Echeverria Ciaurri
Stanford University

Darijus Strasunskas
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Prof. Erik Ydstie

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Jarle Matland
Dag Bakkjord
Kristin K. Braaen
Research Scientists

Sven Inge Ødegård
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Knut Bjerkevoll
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Svein Nilsen
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Ann Britt Skjerve
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Odd Falmyr
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Hans Olav Randem
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Bjørn Emil Madsen
SINTEF

Margit Hermundsgard
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Lisbeth Hansson
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Bjørn Letnes
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Tor Arne Reinen
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Sizarta Sarshar
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Curtis Whitson
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Per Morten Schiefoe
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Jørn Vatn
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Harald P. J. Thunem
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Center for Integrated Operations in the petroleum industry
The IO Center was established in 2006, by leading international oil companies, system suppliers, academic institutions and the Research Council of Norway, with the objective to undertake research, innovation and education on integrated operations.

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