

ANNUAL REPORT 2015

TABLE OF CONTENTS

Summary	3
Vision and Objectives	4
Vision	4
Mission Statement	3
Grand Challenges	5
Research Plan / Strategy	6
Recruitment	6
Organization	10
Organizational Structure	12
Partners	12
Cooperation Between the Centre's Partners	13
PhD Recruitment from Industry Partners	13
Scientific Activities and Results	14
Drilling Course	14
Infrastructure Funding: Motion Laboratory	15
Presentation at NFA Subsea	15
International Cooperation	16
International Advisory Board	17
Offshore Data Community Workshop in Houston	17
Presentation at Lund University	17
Drillbotics International Student Competition	18
Recruitment	19
Communication and Dissemination Activities	20
Social Media and Other Activities	20
Dissemination Activities:	22
Other	23
Defined Master Thesis Projects, Spring 2016	23

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Summary

The research centre SFI Offshore Mechatronics was officially started on April 1, 2015. The launch in Kristiansand took place on April 22, 2015. During 2015 the focus in the centre was to ensure real involvement from all partners. This was achieved by establishment of reference groups for each work-package.

The main activities outlined in this report are:

- Establishment of the SFI organization
- Defining the grand research challenges
- Defining the research themes in the work-packages
- Focus on recruitment with relevance for the industry partners
- Establishment of good communication platforms



From the official launch Torunn Lauvdal (Rektor, UiA) Eirik Normann (Director, Research Council of Norway) Anne Grete Ellingsen (CEO, GCENode) and Frank Reichert (Dean, UiA).

Vision and Objectives

Vision

The SFI will become the international knowledge and research hub for the next generation of advanced offshore mechatronic systems for autonomous operation and condition monitoring of topside drilling systems under the control of land-based operation centres, to ensure safe and efficient operation in deeper water and in harsh environments.

The SFI shall contribute significantly to growth and innovation in the industry, creating jobs and business with potential both within the target sector, and beyond, such as maritime industry, with a net positive impact on society.

Mission Statement

By 2023, the SFI Offshore Mechatronics shall have succeeded in becoming an internationally renowned research based innovation centre reaching national, international and longterm targets. National target – develop new concepts for autonomous systems where the construction, engineering and design, invite autonomy to minimize the number of manual processes, as well as to reduce risk and cost related to offshore drilling operations.

Grand Challenges

The grand challenges outlined during the workshops organized in 2015 are illustrated below.



Research Plan / Strategy

During 2015 the focus was placed on detailing the number of research positions in the centre. This activity was made in close collaboration with the SFI Partners, by using the reference groups in each work-package. The research themes of the positions starting in 2016 were outlined in more detail. The partner companies have been part of the process defining these research themes with the result that several of the positions announced in 2016 are filled by qualified engineers from the industry partners.

Recruitment

During 2015 the following 8 year plans were made for the entire SFI period (2015-2023).



Work-Package 1: Drives

Work-Package 2: Motion Compensation



Work-Package 3: Robotics and Autonomy



Work-Package 4: Modelling and Simulation

	20	15		2016				2017			2018				2019			2020			2021				2022				2023						
Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q Q									Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
						WP4.1 (PHD, NTNU)												-					10.004-0												
-						(PhD, NTNU)													New	Post Do				New Ph	O NTN		_	_	_	_					
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Work-Package 5: Monitoring Techniques

	20	15		2016				Ι,	2017				2018			2019				2020				2021					20	22	į	2023			
Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
	WP5.1 Industry (PhD, Ui4/Teknova) + Espen Oland & Eric Bechhoefer (Teknova)																																		
		WP5.2 Rune Schlanbusch - Teknova																																	
	WP5.3 Industry (KhD, UA/Teknova)																																		
WP5.4: Felix Strassburger and Achim IME - Aachen												s Achim sh	Felderr	name)																					
Zbigniew Mikulski Associated KD-Position (PhD, UA)																																			

Work-Package 6: Data Analytics, IT Integration and Big Data

2015 2016							ŝ	2017				2018			2019				2020			2021					20	22		2023					
Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4
							WP6	1 – Ma (Post	ria Ange Doc, Ui	les Sem A)	ъ																								
WP6.2 - Thilina Nuwan Weensinghe (Ph0, UW)																																			
New PhD, UA																																			
					-																New PhD, UA														



The working titles of the positions started in 2015 and starting in 2016 are listed below:

- WP1.1 Secondary Control in Hydraulic Systems.
- WP1.2 Using Digital Hydraulic in Secondary Control of Motor Drive.
- WP1.3 Using Digital Hydraulic in Secondary Control of Cylinder Drive.
- WP1.4 Electrical and Electrohydraulic Linear Actuators.
- WP2.1 Computer vision and 3D sensors for topside automation of offshore drilling.
- WP2.2 High-Performance Control for Motion Compensation.
- WP2.3 Nonlinear friction compensation in motion compensation systems with significant elasticity.
- WP2.4 Vision Systems for Offshore Crane Control in Ship-to Ship Operations.
- WP2.5 Real-Time Multiple DOF Motion Compensation using an Industrial Robot, Sensor Fusion and Conformal Geometric Algebra.
- WP2.6 Optimal Control for an Offshore Drilling Rig.
- WP3.1 Development of Offshore 3D Sensor Package.
- WP3.2 Autonomy Systems Foundation Development.
- WP3.3 Handling of Sensor Fusion, Point-Clouds and 3D Maps.



WP3.4 Implementation of Situational Awareness/Human Factors Concepts for Operators Using Virtual Arena.

- WP3.5 Formal Verification of Hybrid Systems (associated PhD position)
- WP4.1 Integrated simulation of multi-physical systems in offshore operations.
- WP4.2 Component-based simulation systems for drilling automation and crane systems.
- WP4.3 Protocols and standard for integration of simulation models and co-simulation.
- WP5.1 Tapered big bearings.
- WP5.2 Large diameter steel ropes.
- WP5.3 Fiber ropes.
- WP5.4 Condition-based lifetime prediction as result of calculated component loads.
- WP5.5 Modelling the fatigue damage mechanism in welded joints (associated PhD position)
- WP6.1 Distributed in-network intelligence across multiple components.

WP6.2 Design of architecture and self-organized cross-layer protocols for a heterogeneous wireless network platform.

Organization

The SFI Offshore Mechatronics is led by the Centre Director, Professor Geir Hovland (from November 2015) at the Host Institution, University of Agder. The centre leader until November 2015 was Professor Frank Reichert who was elected to become the new Rector at UiA. The Administrative Manager is Rachel Funderud Syrtveit, and the Technical Manager Morten Kollerup Bak. In addition UiA provides necessary resources from the Faculty and Central Management.



Geir Hovland



Rachel Funderud Syrtveit



Morten Kollerup Bak

The organizational structure is shown in the figure below:

The WP-Leaders in 2015 are listed below:

WP1: Drives (Prof. Michael Rygaard Hansen / UiA)

WP2: Motion Compensation (Prof. Olav Egeland/NTNU)

WP3: Robotics and Autonomy (Prof. Geir Hovland / UiA)

WP4: Modeling and Simulation: (Prof. Olav Egeland/NTNU)

WP5: Monitoring Techniques (Dr. Thomas Meyer/Teknova)

WP6 Data Analytics, IT Integration and Big Data (Prof. Baltasar Beferull Lozano/UiA)

WP7: Technology Vision (CEO Anne Grete Ellingsen/GCE NODE)



Michael Rygaard Hansen



Olav Egeland



Geir Hovland



Thomas Meyer



Baltasar Beferull Lozano



Anne Grete Ellingsen

The table below summarises the main activities organized in 2015:

Key numbers 2015

Steering Board Meetings	6
WP leader meetings	7
Workshops	3
Conferences	1
General Assembly	2

The SFI Offshore Mechatronics Steering board The Steering board consists of 7 members, and 2 deputy members:



From left to right - Chairman Leif Haukom (GCE NODE), Deputy Chairman Charlotte Skourup (ABB), Member Kari Nielsen (Lundin), Member Bjarne Sandrib (MHWirth), Member Jørn Vatn (NTNU), Member Felix Strassburger (RWTH Aachen) and Member Rein Terje Thorstensen (UiA).



From left to right - Deputy Member Klaus Schöffel (Teknova) and Deputy Member Stian Myhre (NOV).

The majority of the SFI Offshore Mechatronics Steering Board members are from the Industry Partners. The Steering board is appointed for 2 years. It is the General Assembly which appoints the Steering board. For the coming 2 years period, this Steering board will appoint an election committee which will suggest new members for the General Assembly in November 2016.



The first General Assembly was held on April 21, 2015. The SFI Offshore Mechatronics project was officially launched the next day.

There was an additional General Assembly on Nov. 18 2015, where the budget for next three years and the WP annual work plans were presented and approved.

Organizational Structure

Partners

The SFI Offshore Mechatronics consortium consisted of 20 partners at the beginning of the project. One partner left the Consortium in November 2015: GCE Blue maritime. In the SFI Offshore Mechatronics General Assembly November 2015, it was decided that the centre management was allowed to start discussions with Bosch Rexroth as a new project partner. Bosch Rexroth signed on February 29, 2016.

Per 31.12.2015 the following companies and institutions were the partners in the SFI:





Cooperation Between the Centre's Partners

The project started up April 1, 2015. To get a best possible start with the goal of involving industry partners and make the SFI project relevant for all partners, there were 3 workshops in the beginning of the period. The reason was to get the themes and the scientific focus areas as relevant for all partners as possible. In addition it was important to align the research with the industry partners which were faced with a difficult situation caused by low oil prices and a significant reduction in orders. Several of the SFI partners had to reduce the number of employees in 2015.

There are 7 work-packages in SFI Offshore Mechatronics. For each WP there is a reference group. Effort has been put in to engage relevant people from the partners in the reference groups. This is an important action, to get the SFI activities relevant for the industrial partners. In January 2016 as much as 8 PhD positions were announced. These were on themes and problems the industry partners have influenced together with the researchers in workshops and reference groups meetings.

PhD Recruitment from Industry Partners



The WP leaders for WP 1-6 used all Wednesday Nov 4. to visit the four main industry partners in the Agder region: MHWirth, NOV, Cameron Sense and MacGregor.

The purpose of this tour was to inform about the main research tasks in the project, get feedback for adjustment of the 2016 work-plans and to inform about the possibilities for employees in the companies to apply for PhD-positions within the different work-packages. The industry experience will be important to get a relevant research output, and applicants from industry partners are encouraged to apply for the PhD positions in the SFI Offshore Mechatronics centre.

Scientific Activities and Results



The industrial PhD candidate Witold Pawlus received the best presentation award at the IECON 2015 conference in the session "TS-140 Electrical Drive Applications". The paper presented at the conference was: W. Pawlus, D. Frick, M. Morari, G. Hovland and M. Choux, "Drivetrain Design Optimization for Electrically Actuated Systems via Mixed Integer Programing", 41st Annual Conf. of the IEEE Industrial Electronics Society (IE-CON2015), Yokohama, Japan, Nov. 9-12, 2015. The paper was a collaboration between the Automatic Control Laboratory at ETH Zürich, the SFI Partner MHWirth and the University of Agder.



Drilling Course

During October 26-27 over 30 of the SFI people – both from industry partners and from all academic partners – had a two days drilling course held by drilling expert Thore Bergsaker.

Thore Bergsaker lead the participants through geology, well design, drilling technology, production of wells and well intervention. There was also a discussion on effectiveness, safety and risks.



Infrastructure Funding: Motion Laboratory

The Motion Laboratory received funding from the Norwegian Research council in July 2015. The application was written by Senior Advisor Alf Holmelid, Geir Hovland and staff from Christian Michelsen Research in Bergen. The amount awarded was 8 MNOK which will be used to purchase 1) a laser tracker system, 2) a high-speed camera tracking system and 3) a mobile motion platform for outdoor use.



Presentation at NFA Subsea

Technical manager Morten Kollerup Bak presented SFI Offshore Mechatronics at the Norwegian Association of Automatic Control (NFA), Subsea Conference in Kristiansand on Sept. 9-10, 2015.

International Cooperation

International Advisory Board

The SFI International Advisory Board (IAB) will be established in the beginning of 2016. Currently 3 members have confirmed, and they are all from international institutions. The confirmed members are:

- Professor Rolf Johannsson, Lund University, Sweden
- Professor Ian Jennions, Cranfield University, UK
- Professor Iraj Ershagi, University of Southern California, USA

It is a goal to have a gender balance in the IAB. Four female professors have been contacted. Three have unfortunately declined the offer, while one answer is pending.

The Research Council of Norway has announced that the "NorTex Data Science Cluster" project is granted funding from INTPART. Out of 47 applications, 19 were granted funding, and the "NorTex Data Science Cluster" project from IRIS Energy was one of them. This is a collaboration project initiated by IRIS, University of Agder (UiA), GCE NODE, Rice University and UT Austin. IRIS and UiA have applied as host institutions for the SFIs DrillWell and Offshore Mechatronics. IRIS has led the work with the proposal and will be the project leader. The project will finance several activities to stimulate and promote research collaboration between Norwegian and US partners, not limited to the mentioned partners, but will include other academic institutions or industrial companies relevant for the proposed Data Science Cluster.

To ensure the activity and integration of the Center's international partners, two visits were planned in 2016 to Germany. The trips were made in Jan. 2016. The goal was to meet both RWTH Aachen and Klüber Lubrication to both discuss how to include these partners in a good way, and to look at the research infrastructure these two partners can provide in the project.

Offshore Data Community Workshop in Houston

Professor Baltasar Beferull Lozano (Leader of WP6) presented SFI Offshore Mechatronics at the Offshore Data Community Workshop in Houston, May 7 2015. The program for the event is available at: https://sfi.mechatronics.no/wp-content/uploads/2015/10/20150507-Offshore-Data-Community.pdf The event took place at Rice University to try to enforce collaboration. Professors from Rice University were present from the Department of Electrical Engineering and Computer Engineering.

Presentation at Lund University

Plans and initial results for sensor-based control of an industrial robot on a 6-DOF moving base. By Geir Hovland and Sondre Sanden Tørdal, SFI Offshore Mechatronics, WP2 at Department of Automatic Control, Lund University, Sweden, Thursday 24 September.

Drillbotics International Student Competition



The University of Agder joined with a team in the Drillbotics International Student Competition (part 1). The UiA team consists of 4 students in the final year of the Mechatronics Bachelor degree. One of the students has experience as a service engineer in one of the SFI Partner companies. Part 2 takes place during spring 2016 where the students are building a scaled-down rig and performing drilling operations and measurements in a foundation consisting of marble, sandstone, limestone and shale. The UiA team competes against another team at UiS and IRIS.



Drillbotics International Student Competition. From left to right: Yvonne Kjellevand, Maxime Marien, Emil Mühlbradt Sveen and Terje Molnes.

Recruitment

The following researchers and technicians were hired in SFI Offshore Mechatronics in 2015.

- Geir Ole Tysse, PhD candidate WP2.1, NTNU. Started Q3-2015.
- Torstein A. Myhre, Post.Doc WP2.2, NTNU. Started Q3-2015.
- Sondre Sanden Tørdal, PhD candidate WP2.5, UiA. Started Q3-2015.
- Knut Berg Kaldestad, Technician, WP3, UiA. Started Q3-2015.
- Jesper Kirk Sørensen, Technician, WP1, UiA. Started Q4-2015.
- Achim Feldermann, PhD candidate, WP5, RWTH Aachen. Started Q4-2015.



From left to right: Torstein A. Myhre, Geir Ole Tysse, Sondre Sanden Tørdal, Jesper Kirk Sørensen, Knut Berg Kaldestad and Achim Feldermann.

The centre management and the WP-leaders are actively working on recruitment of female PhD candidates from the master programs at UiA, NTNU and RWTH Aachen. In general, there are few female master students in the relevant disciplines. The few potential candidates have been actively contacted and motivated to apply for the upcoming positions. The centre management is also constantly looking for female supervisors to join the individual work-packages.

Communication and Dissemination Activities

The SFI Offshore Mechatronics Steering board has decided on a communication plan that is broad and directed to the regional, national and international public. This will be operative in 2016.

Social Media and Other Activities

The Web-site went online in September 2015: https://sfi.mechatronics.no/ The web site is for both partners and general public. All information about the organization, activities and results that are not sensitive is published here. From the web site there is generated a monthly newsletter, with almost 300 subscribers.

The project is also on Twitter (@sfimechatronics), on Facebook (https://www.facebook. com/SFIOffshoreMechatronics) and LinkedIn, SFI Mekatronikk (https://www.linkedin.com/ groups/2556388) with 455 followers.



SFI Offshore Mechatronics has done activities directed to young pupils at highschools in the Kristiansand area. With the 8 years perspective, the recruitment will be important, both to the connected bachelor and master studies. The picture shows a visit to Kristiansand Ka-tedralskole Gimle in Kristiansand where a robot made waffles and the Center Management was present to talk about mechatronics and the possibilities for future carreers. Several hundred pupils were reached in this stunt.

UiA has as a consequence had several visits from KKG and Vågsbygd videregående skole for tutorial sessions and demonstrations in the Mechatronics lab.



A class of 20 students and the teacher from Kristiansand Katedralskole Gimle (KKG) visited the Motion-Lab and SFI Offshore Mechatronics on December 1, 2015.

Dissemination Activities:

Publications

Some publications were submitted by researchers in SFI Offshore Mechatronics in 2015, and these will appear in 2016.

Annual SFI Offshore Mechatronics Conference, November 19, 2015

Place: Campus Grimstad, Norway. Auditorium A2 135. Date: November 19, 2015 Time: 09:00 – 11:30 (Part 1, Open) and 12:30-16:00 (Part 2, Closed)

45 participants attended the first annual SFI Offshore Mechatronics conference on Campus Grimstad. The first part consisted of 4 open presentations while the second part (for SFI partners only) presented the current status of the 7 work-packages. The program for the conference was as follows:

Part 1:

Violet Leavers (CEO), V4L Group, UK: New Trends in Condition Based Monitoring.

Torben Andersen (Professor, AAU): Results from the Fluid Power and Mechatronics Systems Lab at Aalborg University.

Anne Grete Ellingsen (CEO GCENode): Integrated operations next phase – The service providers and equipment suppliers integrated in the drilling and operations in real-time.

Jan-Einar Gravdal (Senior Research Scientist) and Kristin Flornes (Senior Vice President), IRIS: A) Presentation of the NORTEX Data Science Cluster, B) Lessons learnt from the mid-term evaluation of SFI DrillWell.

Part 2 (for SFI partners only):

Presentation of initial results and the 2016 plans for the individual work-packages WP1-WP7.

CM & CBM Specialist Workshop, 8-9 June 2015

Teknova and GCENode organised a 2-day Condition Monitoring (CM) & Condition Based Maintenance (CBM) specialist workshop in Grimstad, June 8-9, 2015. The program for the event is available at: https://sfi.mechatronics. no/wp-content/uploads/2015/11/CBM-Workshop.pdf



Other

Defined Master Thesis Projects, Spring 2016

- 1. Development and Implementation of a Real-Time 6 DOF Pose Estimation Algorithm for a MS Kinect 2" by Alexander Sjøberg/UiA is linked to WP2.5.
- 2. 3D sensor data acquisition and fusion for automatic gas sample taking, by Svein Gjermund Tveide/UiA is linked to WP3.1.

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