

FACE

Annual Status Report 2007



Subject	: FACE Status Report
Period	: August 2007 – December 2007
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Compiled by	: Erik J. Holm

Executive Summary

The report covers the period August-December 2007. The FACE centre is a Centre for Research driven Innovation (CRI), a collaboration between the research partners NTNU, SINTEF and IFE.

The funding partners in 2007 have been: ConocoPhillips Skandinavia AS, FMC Technologies, Norwegian Research Council, SPT Group, StatoilHydro ASA (entering the centre as the two companies Statoil and Hydro), and Vetco Gray Scandinavia AS.

The consortium agreement was signed by the partners in the period June – August 2007. The major part of the work in 2007 consisted in developing the plans in a process involving all the FACE partners. Work on some of the scientific topics has started, and this will accelerate through the first half of 2008; thereafter, the FACE centre will have a more stabilized, normal momentum.

In this document, we describe quite briefly the main purpose of the centre, some headlines of the scientific work and an economic overview. For a more detailed progress reports, we refer to proceedings of our FACE workshops, and to the bi-annual progress reports. For more details on the scientific plans, we refer to the current documents on the FACE plans.

Less effort was spent in 2007 than planned. This was due to the fact that the FACE consortium agreement was not signed by any of the partners before late June, and the centre not officially started before August.

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1 Introduction

This is a annual report to the Norwegian Research Council for FACE (Flow Assurance Centre). The report covers the period August-December 2007, i.e. the start up period of the centre. The FACE centre is a Centre for Research driven Innovation (CRI), a collaboration between the research partners NTNU, SINTEF and IFE.

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In this document, we describe quite briefly the main purpose of the centre, some headlines of the scientific work and an economic overview. For a more detailed progress report, we refer to proceedings of our FACE workshops, and to the bi-annual progress reports. For more details on the scientific plans, we refer to the current documents on the FACE plans.

2 FACE: Main Strategy, vision and values

The FACE KPIs (Key performance indicators), vision and values will be developed in parallel with the development of the centre spirit. The current working text for the FACE vision is “to become the preferred Flow Assurance centre”. The headline of the targets is to create a significantly increased understanding of complex fluids on the Macro and on the Micro scale. The overall working method will be to design and characterize synthetic fluids based on real crude oils, to design and perform experiments on these fluids, and to create mathematical

models from these experiments. In addition, FACE will be a forum for Flow Assurance problems, and aim at recruiting and educate researchers for the Flow Assurance community. Important values in the FACE work should be Scientific, Long term, Ambitious, Daring and Industrially relevant.

3 FACE: Strategy and research plan

Plans have been developed for the first three years of the FACE centre. They serve as a starting point and direction pointers for the initial work. The plans will be developed further along with the emerging results of the Centre. These plans are collected in an extensive set of documents including CTRs, distributed to and shared by all the FACE partners. These detailed plans will not be published.

4 FACE: Organization

The FACE organization is described in the document “Governance structure” following the consortium agreement. The FACE organization is depicted in the figure below.

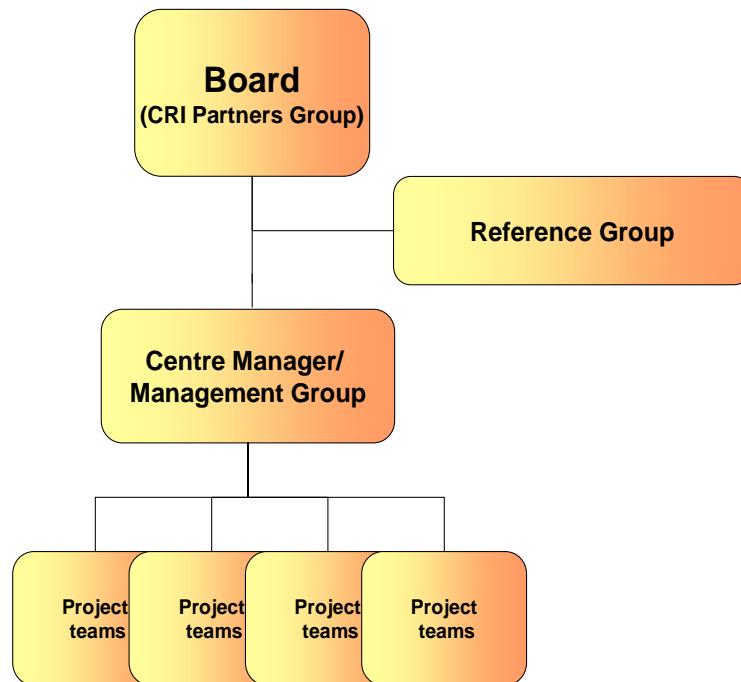


Figure 1: FACE governance structure

To overcome some of the leadership challenges in this virtual centre with three independent organizations, FACE has defined a leader group consisting of personnel that hold executive line management positions in the three research institutions. This CRI Partners Group forms a subgroup of the Board with special responsibility for the supervisory control of leadership and operational management of the Centre. Effectively, this group shall support the centre manager when operation of the centre require decisions in the CRI partner line organizations. At present, this group consists of Dag Thomassen from IFE (Host institution), Torstein Haarberg from SINTEF and Bjørn Hafskjold from NTNU.

The following individuals have been filling the roles of the FACE centre:

FACE Board

Company	Representative	Period
Conoco Phillips	Ole Lindefjell	
FMC	Kjartan Berg	For the period August - October 2007
FMC	Rune Fantoft	From November 2007
IFE	Dag Thomassen	
NRC, observer	Tor-Petter Johnsen	
NTNU	Bjørn Hafskjold	
SINTEF	Torstein Haarberg	
SPT Group	Håvard Eidsmoen	
StatoilHydro 1, Chair of the Board	Eli Aamodt	For the period August-September 2007
StatoilHydro 1, Chair of the Board	Per Gerhard Grini	From October 2007 -
StatoilHydro 2	Ruben Schulkes	
Vetco Gray	John Friedemann	

FACE Reference Group

Company	Representative
Conoco Phillips, chair of the Reference Group	Kris Bansal
FMC	Randi Moe
IFE	Jan Nossen
NTNU	Sigurd Skogestad
SINTEF	Jon Harald Kaspersen
SPT Group	Norbert Hoyer
StatoilHydro 1	Per Gramme
StatoilHydro 2	Per Fuchs
Vetco Gray	John Friedemann

FACE Project leaders

P1: Flow Assurance Modelling	Roar Skartlien	IFE
P2: Fluids and characterization	Johan Sjøblom	NTNU
P3: Separation	Paal Skjetne	SINTEF
P4: Flow Assurance Experiments	Tor Erling Unander	SINTEF
P5: Make FACE a centre	Erik J. Holm	IFE

FACE Centre manager	Erik J. Holm	IFE
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The scientific work is described in the next chapters.

5 Project 1 – Flow Assurance Modelling

A workshop with all the FACE partners was organized in November 2007, focusing on presenting and further developing the first three year plan in the modelling project. The result was that most of the plans will be carried out as outlined, but with some extra effort on fluid/fluid modelling coordinated with the modelling work in the Separation project. The coupling to the Experiments project was also addressed at the workshop.

A central part of the current modelling plans is modelling of suspensions. Currently under development are suitable Reynolds stress equations for the fluid, with particle effects included. Afterwards, these will be implemented in a Reynolds stress solver. The next step is then to couple these equations to the continuum equations for particles derived from kinetic theory.

The fluid-fluid modelling project is starting up with the implementation of VOF simulations in cooperation with Cd-Adapco (as part of their in-kind contribution). The diffusion of surfactant on the interface will be accounted for. An amphiphilic Lattice Boltzmann code has been tested. The plan is to study the effects of surfactants with this code.

A close cooperation with the Experiments project has led to initial tank experiments where we can study the instability of rising oil/water fluid columns with or without surfactant. Tor Erling Unander and Ivar Eskerud Smith have done an excellent job in this respect. Mr. Eskerud Smith is also cooperating in developing the LBM code.

A temporary employee at IFE, Espen Sollum, is implementing MPI in the LBM code for adaptation to parallel 3D simulations.

Professor Paul Meakin (Idaho National Laboratory, also Prof. II at UIO) will work on modelling in FACE through a 20% position at IFE.

A meeting with the University of Newcastle at IFE was held February 28 and 29, where we planned upcoming work in the suspension project. A PhD student was recruited in 2007 and started his work on modelling suspensions. He is residing at the University of Newcastle, and is supervised by David Swailes and Peter van Dijk. They are working with modern models including kinetic theory for particles in turbulence.

6 Project 2 – Fluids and Characterization

A crude oil sample from one of the industrial partners is currently being characterized at the Ugelstad Laboratory at NTNU. A different oil sample will soon be delivered in a much larger quantity. In addition to serving as the basis for reference fluids, this oil will be used for various FACE experiments, e.g. in wax and hydrate studies.

At the Ugelstad Laboratory the following persons have been employed to work in FACE:

Johan Sjöblom (Project manager, 20%)

Sebastien Simone (Post Doc, part time)

Serkan Kelesoglu (PhD student, 100 %)

Asal Amiri (PhD student, 100%)

Yanru Fan (Post Doc, 100%)

Brian Grimes (Post Doc part time)

Geir Sørland (Anvendt Teknisk, NMR, droplet sizes)

Serkan Kelesoglu is occupied with reference fluids for emulsion systems. As starting fluid system he works on a crude oil sample from the North Sea. Mr. Kelesoglu is characterizing this crude oil and its water-oil emulsions.

Asal Amiri works with particulate solid suspensions based on silica particles. She is characterizing the rheological properties in a Physica 301 apparatus. In addition to these properties she has mapped flocculation and sedimentation rates together with gelation properties of the suspensions.

Sebastien Simon is in charge of the separation subproject and works at the time being together with Serkan Kelesoglu on dynamic interfacial properties of the crude oil sample and comparable synthetic systems.

The work of Yanru Fan mainly consists of two parts. The first currently involves undertaking destabilization studies of crude oil-water emulsions with different non-ionic surfactants with different HLB (Hydrophilic Lipophilic balance) values. The second part will be to probe the in-depth mechanism of de-emulsification by using both chemical de-emulsifier and electrostatic devices.

Brian Grimes is employing the technique of Stokesian dynamics to simulate the bulk physical properties of colloidal suspensions. Stokesian dynamics is a micro simulation technique (similar to molecular dynamics, but on a slightly larger scale) that employs the solution to the Langevin equation to track the dynamic evolution of a suspension microstructure based on the characteristic physical parameters of the system (i.e., particle diameter, viscosity of the continuous phase) such that bulk physical properties of the suspension can be determined from an appropriate statistical relationship.

Geir Sørland is developing the NMR technique for emulsion systems to determine droplet sizes.

7 Project 3 – Separation

A thorough review of the field of separation is under way to create a common knowledge base for developing our current understanding of separation. The field of separation is multi disciplinary encompassing: fluid chemistry, interfacial science, colloidal science and fluid mechanics. The overall aim is to provide a starting point for experts from both academia and industry to develop a broad understanding of separation which can ultimately lead to deep insight and innovation.

So far the review has focused on surface and colloid chemistry of crude oil systems, and will soon commence its work on modelling of interfacial phenomena and fluid dynamics. The review document will be made available on the FACE wiki server (see project 5) as a shared resource for all FACE members. Progress on the various contributions is monitored through telephone conferences and local meetings.

StatoilHydro has kindly offered two datasets on separation of crude oils as part of their in-kind contribution to FACE. One set originates from a separation rig at StatoilHydro's research centre in Trondheim, the other from their separation loop at the research centre in Porsgrunn. The analysis of the former data set is well under way, while the second dataset is currently being formally released to FACE.

The former data set consists of a matrix of five live crude oils with respect to emulsion stability and processing conditions. Multivariate data-analysis will be employed to see if more information can be extracted from the data set than has already been obtained by StatoilHydro. This work is performed by Dr. Martin Fossen and Dr. David Arla.

A FACE workshop on Separation was organized in Trondheim in November. In addition a number of FACE members participated/lectured at the TEKNA Separation Workshop in Stavanger in September.

New members of the separation project team in 2008: Dr. Per-Erik Larsson, one of our experts in molecular dynamics and quantum chemistry, has joined our team to contribute to our knowledge of molecular simulations of surfactants at interfaces. Initially, he will be looking at published literature to see if this methodology could be adopted by FACE. Dr. Alireza Ashrafian, Dr. Sjur Mo and MSc. Ivar Eskerud Smith have joined the separation team and will work with modelling of large scale interfaces and meso/micro-scale simulation.

A collaborative meeting on multi-scale modelling was held with Dr. Paul Meakin (INL/UiO/-IFE), and on the modelling of large scale interfaces between the Modelling project and the Separation project in February 2008.

8 Project 4 – Flow assurance Experiments

The start of the Experiments project has consisted of concretizing and developing the plans in cooperation with the other projects. Fruitful discussions between experimentalist groups at Tiller and Kjeller have initiated the important, broad collaboration between the experiment experts at different sites in the FACE community. It is also emphasized the importance of incorporating the industrial experimental experts in this work.

At Kjeller, most of the planning for the modification (mechanical design) of the Low Pressure Loop, which is going to be used for the FACE suspension work, has been completed. This involves a new rectangular cross-sectional test section, particle handling system and changes in the piping layout. Also the instrumentation of the test facility is presently being evaluated. Gustavo Zarruk has been recruited as a new researcher at IFE, and he will be involved in the FACE suspension work. He has background from PIV-work and will begin at IFE in May.

The work group on "Droplets and surfaces" includes four people from SINTEF Petroleum Research, one from SINTEF Materials and Chemistry and two from IFE. This group has had several work meetings. The work is currently closely coupled to the DNS-modelling of the

Modelling project. Currently, we have a double focus: First, we will increase the knowledge of the effect of interface rheology on multiphase flow through simple experiments, DNS-modelling and literature studies. The initial results are now available on the FACE eRoom. Second, we plan an experimental campaign on a flowing liquid-liquid system. A starting point for this planning is the analysis of existing flow data delivered from one of the industrial partners.

The process of building a traversing three-phase gamma densitometer has started. This instrument will mainly be connected to Professor Nydal's laboratory at NTNU. This instrument should be operating by the start of May 2008.

9 Project 5 – Make FACE a centre

Industrial partners' involvement

The partners of the FACE have up to this date all been active participants of the centre, being constructive in their in-kind contributions. CTRs for the In-kind for 2007 and 2008 has been defined, and the In-kind for 2007 was delivered mostly according to the plans. We are emphasizing the importance of involving scientific personnel within our industry partners, having them share their experience and knowledge of industrial challenges through e.g. presentations at the workshops, literature reviews and contribution to state-of-the-art.

Communication: The communication within the centre between IFE, NTNU and SINTEF is a main focus for the entire FACE centre. Four internal workshops have been arranged in 2007; see a list below. At most of these FACE workshops, all FACE partners were represented. The number of attendees has varied around 30-40 people. In addition, the researchers in Trondheim and at Kjeller have met in >20 meetings/Telcons/video conferences in order to coordinate and discuss plans and exchange results. A coordination of modelling between IFE and SINTEF has been initiated by Roar Skartlien and Stein Tore Johansen. This will involve among other topics, Lattice Boltzmann simulations of droplet dynamics and coalescence.

A FACE leader group, consisting of the Centre Manager, the Project Leaders and four central researchers assembles occasionally in order to coordinate plans and workshops. The Centre Manager meets frequently with the members of the Leader Group in order to assert coordination and information flow.

Internal FACE workshops

- 1st workshop, September 24-25, 2007, Stavanger: The main objective of this first workshop was to consolidate, and to present work plans for the first three-year period, 2007-2009, for each of the six FACE projects.
- 2nd workshop, November 8-9, 2007, Trondheim: The main objective of this workshop was the scientific challenges and research tasks within the Separation project.
- 3rd workshop, November 12-13, 2007, Trondheim: The main objective of this workshop was the scientific challenges and research tasks within the Modelling project.
- 4th workshop, November 14, 2007, Trondheim: The main objective of this workshop was to pursue the discussions from the 2nd and 3rd workshop in light of experimental activities.

Literature review work: In the beginning of December, all FACE partners were asked for material for the FACE literature review. Most of the material up till now has come from the research partners, but some has also come from the industry. Martin Fossen and David Arla have been the main contributors to the document so far. Based on the received material, the

review document is currently under construction. Included in the studies so far are results showing that solids/particles are the most important factor contributing to crude oil emulsion stability.

The review work is continued, and updated versions are posted to the eRoom, on a separate folder open to the review activity group. Relevant literature is also uploaded to the folder, and there is a plan for setting up a searchable literature data base that comprises the collected literature (note that copyright restrictions probably must be considered in relation to some of the downloaded papers if they are not free online).

The review document (and the literature data base) is intended to be uploaded to a searchable wiki-server (the "FACEbook") with access for all FACE partners. The FACEbook has been set up (Mac OSX box (UNIX box)), and is currently being tested by the project group. Jon Harald Kaspersen has worked out technical solutions together with ErgoRunit, who will hold the maintenance responsibilities, in order for it to be accessible from outside of SINTEF.

Several work meetings have been arranged on literature review. The meetings serve as an arena for information and status exchange between the participants, as well as for communicating across disciplines. In-kind contribution from the industrial partners will contribute to the review work.

Partner status: The intended partners Total and Aker Kværner did not join the FACE centre. Statoil and Hydro operate in the centre as two partners in 2007 and 2008, but merge to one partner from 2009. ENI and CD-Adapco have signed the FACE consortium agreement (early 2008), and we welcome them warmly to the FACE centre. Shell has stated that they will join and are currently reviewing the contract. With these partners, the FACE centre has approximately the funding needed to follow the original budget for the three year plan, submitted in May 2007. The FACE management will continue to work for including new partners.

Other: All partners in FACE have access to, and are active in contributing to the FACE eRoom. This is a web-based project tool with high security level, well suited for projects in which the participants are geographically separated. The eRoom enables participants to discuss ideas and share information and documents. In this way, all participants have access to all information at all times, regardless of their whereabouts. In addition we also soon share the FACEbook wiki server for collecting review material from the partners. Finally, web pages for external use have been initiated, and a FACE logo is under development.

FACE was represented by a stand presented at the Technoport Festival 2007 in Trondheim.

10 National and international cooperation

PIV measurements at the University of Oslo will be an important resource for the FACE centre, and collaboration has been initiated.

The FACE work has attracted Professor Paul Meakin (Idaho National Laboratory, also Prof. II at UIO) who will work on modelling in FACE through a 20% position at IFE.

Through the PhD student on suspension modelling, the FACE centre is collaborating with the University of Newcastle on turbulence modelling, suspensions and numerical methods.

FACE already has a strong international aspect through the partners ConocoPhillips, Vetco Gray (included in GE), CD-Adapco, ENI and soon also Shell.

11 Recruiting

Three PhD students and one Post Doc have so far been recruited to the FACE centre:

Serkan Kelesoglu: PhD student in the Fluids project.

Asal Amiri: PhD student in the Fluids project.

Yanru Fan: Post Doc in the Fluids project.
The Newcastle PhD student in the Modelling project.

12 Publications

No publications at conferences or international journal have yet been submitted from the FACE centre. A Leader Group seminar in March 2008 will focus on a publication strategy for the FACE centre.

13 Deviations

Less effort was spent in 2007 than planned. This was due to the fact that the FACE consortium agreement was not signed by any of the partners before late June, and the centre not officially started before August. Starting a CRI is a complicated process, and the research groups involved had many other running activities. The FACE centre activities could not be manned before the signatures of a sufficient number of partners were effectuated and the detailed plans were laid.

14 Costs

The accumulated costs for FACE in 2007 are summarized in the table below.

CRI Annual costs 2007- (All figures in 1000 NOK)																			
Item	Type of Research*	Incentive effect****	Bonus Category***	RCN Grant	Host*****	Other Public	Other Private	Skate-FUNN	StatOilHydro	Conoco Phillips	FMC	Vetco Gray	SPT Group	SINTEF	NTNU	Total state aid	Total funding	State aid/total funding	
Type of partner**																			
Project 1: Flow assurance Modelling	I	1101 65		647					676	89	59	70	30				647	1570	0.41
Project 2: Fluids	F	1111 100		1164					221	111	57	65	37				1164	1655	0.70
Project 3: Separation	I	1101 65		385					914	58	52	64	19		190		575	1683	0.34
Project 4: Flow assurance experiments	F	1111 100		140					35	18	33	43	6				140	275	0.51
Project 5: Literature reviews, Work shops, gap analysis	F	1111 100		835					223	508	66	77	157				835	1864	0.45
Centre Management	-			552	132				276	138	46	46	99	244			928	1533	
Total budget				3722	132	0	0	0	2345	921	312	366	347	244	190		4288	8579	0.50
* Type of Research: *F= Fundamental research **I=Industrial Research																			
** Type of partner: R=Non-for-profit research organisation, P=Other public, L=Large Enterprise, SME=Small and medium sized enterprise																			
*** Bonus Category: Large Enterprises in cooperation with non-for-profit research org. 65, SMEs in cooperation with non-for-profit research org 75,																			
**** Incentive effect, 1=OK, 0=Not present, First digit: Increase in Project size, Second digit: Scope, Third digit: Speed, Fourth digit: Total amount R&D																			
*****IPR - Funding from "Non for profit research organisations" should not be included as state aid if they receive ownership to IPR according to their contribution																			
CRI Annual Work Plan 2007- Cost (All figures in 1000 NOK)																			
Item	Host*****	SINTEF	NTNU	Management	In-kind costs	Total funding													
Project 1: Flow assurance Modelling	958	0	0		612	1570													
Project 2: Fluids	0	73	1582			1655													
Project 3: Separation	0	236	559		888	1683													
Project 4: Flow assurance experiments	88	186	0			275													
Project 5: Literature reviews, Work shops, gap analysis	599	559	54		652	1864													
Centre Management				1480	53	1533													
Total budget	1645	1053	2195	1480	2205	8579													

Table 1: Accumulated costs pr. 31 December 2007.