

Report NTNU Ocean Week 2016

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WHAT IS THE OCEAN WEEK

Every year, the *Norwegian University of Technology* in Trondheim hosts the Ocean Week. It is organized by *NTNU Oceans*, one of the four strategic research areas declared by the university in 2014. The conference aims to offer insight into anything related to the ocean: research, technology, politics and economy. Professors, representatives of the industry, researchers of well-known institutes and students participate in the conference by talking about current innovations, ideas and future challenges. The goal is to gather and connect interested parties to work on a sustainable future of the oceans.

WHY I WANTED TO ATTEND THE OCEAN WEEK

As a mechanical engineering student it is not the most obvious decision to go attend a conference in a very small city in upper Norway where it is cold while Berlin is reigned by all the serotonin dancing around in the beautiful month of May. But as a mechanical engineering student it is also known that we do not get much practical insight and are restrained to our theories unless we step out of our square construction box and reach for opportunities.

After having read *The Swarm* by Frank Schätzing years ago—a very recommendable book for anyone who is into the absurd and scary but actually kind of logical future of our planet—I was not able to stop thinking about how we can shape the future of our oceans. One thing that was mentioned at the conference later is the 70-80-90 principle:

70% of our planet is covered by ocean, 80% of it is deeper than a few hundred meters, 90% of it is completely undiscovered.

Mechanical engineering with its multiple specializations, for example ocean engineering or robotics, allows to prepare for this daunting confrontation with a complete unknown universe that we live with right below us. I came to know about the Ocean Week while hunting for possible Master programs in Marine Technology. When I read about it, I immediately knew I had to go and use this opportunity to see whether this field which I think is my passion is indeed what I imagine it to be.

When confronting Professor Thamsen, who I knew had close ties to the *NTNU*, he offered me to undertake this trip and participate in the conference through the *Nordic Water Network*. So off I went to Trondheim!

WHAT WAS TALKED ABOUT

The conference was organized into five main areas on four days: Eco-intensive Aquaculture, Marine Minerals, Maritime Transport, Ocean Innovation and Ocean Opportunities. Due to parallel sessions I was not able to attend all single presentations but thanks to general plenary sessions in the mornings a general overview and impression of all topics could well be obtained.

Generally, the conference's scope ranged from biological and geological to technical all the way to economical and political aspects while aspiring to answer these pressing questions:

How can we feed a rapidly growing world?

How can we provide clean energy?

How can we develop environmentally friendly and sustainable transportation?

eco-intensive aquaculture

For Norway the aquaculture industry is a very important sector in its road to a sustainable future. But what does «eco-intensive aquaculture» even mean?

The world faces the challenge of having to feed two billion more people in 2050. Because humans are prone to take the cheapest, easiest and socially most accepted way, we run the risk of establishing, or rather expanding the food industry of today. That means encouraging an atrocious business that many activists and the media tell us about daily. It counts for meat production as well as fish farming.

Fish farming, then, is actually a very auspicious industry thanks to several reasons. In order for it to be a world-wide player that can compete economically, it needs to expand and increase enormously. If it is done correctly, fish farming has a much lower carbon footprint than the conventional—or innovative for that matter—meat production will ever have. It could be a way of contributing to our planet but is also, like all of the topics concerning oceans, a problem of social acceptance. How can we explain to the billions of people that they should not eat meat anymore but fish instead? And, of course, who is paying?

An eco-intensive aquaculture should therefore be an efficient way to produce enough fish for a decent amount of our population (approximately five millions tons per year) all the while staying sustainable and espousing to the ocean and

the planet. Beside the environmental impact, many Hows and Whats have to be answered while working towards that goal:

How can we manage diseases?

How do we feed the fish?

How to develop the market?

What is a sound animal welfare criteria?

What is a suitable area?

What is a regulatory framework?

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There are several ideas on how to achieve that. First of all, it needs to be established *what* and *where* should be farmed. In order to fulfill all the environmental criteria, it will be necessary to reduce fish farming to fewer species so that production can be more efficient for one of them. Critical volumes need to be considered so that breeding, vaccines and feed can function decently. Yet there still needs to be a flexibility in the product range in order to satisfy the population's demand: we are used to having the choice between fresh fish, fillets, frozen fish, consumer sized packages and since no one (let's be honest) is really willing to give up all of our standards, this flexibility needs to be realized. Eco-intensive aquaculture will not only decrease the variety of fish in our supermarket shelves, but it will increase their price. Unfortunately, making our world more sustainable is expensive: mostly because of the new technology needed and risks taken, leading to a fragile social acceptance.

At the conference, opinions were split: should we rely on the technology we already have established in the oil business and «simply» make some changes to it? Or should we stop clinging to it, use the knowledge which we have gained but adapt it to something completely new? Realistically, it will be a mix of both: taking the best of what we know from offshore oil industry and making something better out of it.

For example, Gunnar Myrebøe, Chairman of the Board at Ocean Farming AS, presented his company's idea of a future fish farm.^{1,2} Basically a round floating construction net, the fish are kept in big tanks in their natural water. It is divided into three main functions: 1) A vessel can connect to the farm to provide it with nutrition, hygienic tools, man force etc. which can stay on the farm for as long as seven weeks; 2) the vessel comes back and takes the fish; 3) for maintenance, the farm can be lifted up above the water surface. A very simple and logical design for offshore use but it is not implemented anywhere in the aquaculture industry (yet).

Overall, everyone was on the same page: the world's food industry needs to focus on fishery and aquaculture. The technology developed for it is basically already existing thanks to the oil industry but needs to be intelligently adapted and put to use. For Norway, expanding its fishing economy is highly important since it is hitherto been reliant on its oil business — which everyone knows we have to get away from eventually.

One last important note that I thought is incredibly important was made by Karoline Andaur from the *WWF*. Yes, we do need to expand aquaculture industry and yes, we have to make it economically reasonable by producing decent amounts. But no, we should absolutely *not* aspire to cover the population of 2050's need for nutrition with Norwegian salmon. It is far from sustainable to produce so much salmon and export it to the other side of the world, say Latin America, say Australia, say Southern and Oriental Europe, say Africa, where salmon is not in its natural habitat. Norway can realistically provide Northern and Occidental Europe with biologically, healthily grown salmon, maybe other sea food flourishing there. But there is no need to eat Norwegian salmon in the United States or in Colombia, nor in Italy or South Africa. The induced carbon footprint would be far from sustainable and should well be considered —no, prevented, if what we want to do with our oceans is to learn from our mistakes.

Arne Fredheim, *SINTEF Fisheries and Aquaculture*

Stig Omholt, *NTNU*

Ida Aursand, *Biomar*

Heather Jones, *Scottish Aquaculture Innovation Centre*

Gunnar Myrebøe, *Ocean Farming AS by Kongsberg Maritime AS*

Ove Løfsnæs, *AQS*

Bjørn Egil Asbjørnslett, *NTNU*

Karoline Andaur, *WWF*

¹ <https://www.km.kongsberg.com/ks/web/nokbg0238.nsf/AIWWeb/13D7E85087B372BEC1257F8F002D9A20?OpenDocument>

² <https://www.km.kongsberg.com/ks/web/nokbg0238.nsf/AIWWeb/7C0B0102D79C3321C1257F8C00219350?OpenDocument>

marine minerals

Deep sea mining was an exciting topic for pumping aficionados. Out of all topics discussed, it was seemingly the least sustainable. One might think: isn't this week supposed to be about saving the oceans and not further exploiting them? Extracting ores from the seabed is something much more intervening, almost encroaching in my opinion, to maritime life than offshore fishing farms floating at the surface. It is severely influencing the benthic environment and life and leaves tailings. Technology needs to be developed, that allows for industry to respectfully get the minerals to a surface vessel and transport them to land.

The challenges for technology are of myriad nature, externally as well as internally. By that I firstly mean factors impairing the system in its maritime environment. The pipes and mining tools need to be robust against harsh sea states and they need to balance out deep water and water surface positions. Abrasive material can attack the technology both from the surrounding water and ground and from its inside when pumped up. That leads to the internal challenges: what are influences of internal flow of water and the particles? Unlike with oil pumps, deep sea mining needs to transport solid, uneven, crumbling and dynamic particles. They might cause vibrations leading to bending and fatigue of the technical material—which obviously needs to be kept at a minimum. Technically speaking, opinions were again covering the scope from simply using and adapting the existing oil technology to learning from it but essentially developing something entirely new.

Jens Laugesen, Chief Specialist for Environmental Monitoring at *DNV-GL*, very well summarized the environmental impacts of deep sea mining: direct destruction of seabed habitat, sediment disturbance and plume discharges, pollution by surface operations of vessels, thermal and light pollution, noise and vibration, disposal of tailings either causes large occupied areas on land or changes the topography in the sea. In order to keep these influences as low as absolutely possible, new technology has to be developed that causes a minimal destruction of the seabed, that uses an environmentally friendly transport vessel not operating on conventional methods. And most importantly, the industry needs to find an ethically acceptable form of disposal which might well be the hardest task. Mining generates among the biggest surplus materials in relation to what is actually produced and used in the end.

Steinar Ellefmo, *NTNU*

Tor Huse Knudsen, *NTNU*

Johann Rongau, *Technip*

Pedro Madureira, *EMEPC*

Ivar Fossum, *Nordic Ocean Resources*

Lars Jacob Hiim, *State Secretary at the Norwegian Ministry of Trade*

Jens Laugesen, *DNV-GL*

Lene Buhl-Mortensen, *Institute of Marine Research*

Felix Janssen, *Alfred-Wegener-Institute*

maritime transport & ocean innovation

There were numerous, incredibly inspiring presentations of research hubs, projects and initiatives.

JPI Oceans is an initiative aiming to connect and coordinate marine and maritime research among all EU Member States and Associated Countries. Its head of the secretariat Kathrine Angell-Hansen, who comes from the *Research Council of Norway*, explicitly called for a broader network between European states, sharing their knowledge and approaches in order to design a sustainable and efficient technological network in the ocean surrounding our continent. Standing alone, barely any European country can establish itself in a big fashion in the global marine and maritime market. «Take science out of the drawer and put it out there,» were her exact words: a call for a public-private partnership, a call to hold on to a political movement and raise the public's awareness for the oceans.

One example of well used resources and internationally joint research is the *University of Porto's Underwater Systems and Technology Laboratory (LSTS)*. Portugal, with its aquatic area much larger than its terrestrial, has opened a laboratory where professors and scientists from all over the world contribute to creating an ocean observatory. By using more autonomous technology in underwater research, researchers learn more about life and dynamics of the ocean and can therefore assist in protecting it.

Smart Maritime is a project of *MARINTEK*, *NTNU* and several business partners with the goal of making maritime transport more sustainable and of turning the Norwegian maritime sector into a world-competing one. In order to achieve it, professors and contributors come together in different work groups: feasibility studies, hull and propeller optimization, power systems and fuel, ship system integration and validation, environmental and economic due diligence. Further divided into sub projects and following this order of research, *Smart Maritime* hopes to find technologies and ways to reinvent the shipping industry.

Autonomy and automation is another very important step in reinventing the marine and maritime industry.

In order to make maritime transport more attractive and competitively viable for day-to-day use, the safety level needs to dramatically increase and the CO₂ emission has to be reduced. The modern way to approach that is by reducing human errors and digitalizing shipping. In this topic, there were plenty of distinct opinions. Besides a greener sustainability of chemical nature, it can also only come from fewer losses and fatal errors on the sea. To date, most accidents out there are human mistakes. So the logical conclusion is automation. Like any other area where men have

already been replaced by machines, the irony sets in: the human's tasks are shifted from minutely and accurately understanding, controlling and operating a system to watching a machine do it. But if the machine fails—which it will—the worker suddenly has to intervene within seconds. Can he or she do that when 99 % of the time one was not challenged and won't that lead to even more casualties? Can the industry afford that risk, on the sea, thousands of miles away from land and therefore hours before humans could take control in the event that they should need to? Many advocated for a maritime future where men and machines will evenly coexist for a much longer time than in any other industrial area.

Underwater robotics, on the other hand, is an area where autonomy will soon mean a drastic increase in sustainability. Currently, underwater operations like maintenance of drilling sites etc. are done in a very static manner: drive a big vessel from on-shore to off-shore, send down a robot that awkwardly and restrictedly operates switches and pipes at the ocean ground, send it all back. Meaning for the push of a button or tightening of a screw, a few hundred, thousand miles of carbon footprints are left behind. In addition to the aforementioned *LSTS* in Portugal, an incredibly beautiful and intelligent idea has evolved from this transporting unnecessary: *EELUME*³. Realizing that all we really need down there is an attachment to grip switches and turn them, to tighten screws and to push buttons, this group of people has developed an eel-inspired robot that illuminates the darkness hundreds of meters deep with two small red lights (hence the name). It is controlled from land; when needed it can be told which tool to attach to its nose, what to do with it, where to swim to from its base station where it otherwise chills. Able to move flexibly in all directions, this somewhat spine-tingling futuristic robot is actually the simplest answer to a lot of questions and really incarnates the beauty of innovative engineering. It replaces a vessel polluting atmosphere and water, putting people in danger while going out to a rough ocean and robots impairing a greater part of oceanic environment. Let's just hope it doesn't get too autonomous and we encounter this red-eyed snake while diving ourselves.

Kathrine Angell-Hansen, *JPI Oceans*

Torger Reve, *Norwegian Business School*

Siri Pettersen Strandenæs, *Norwegian Business School*

Bjørn Haugland, *DNV GL*

Per Magne Einang, *MARINTEK*

Pal Aamaas, *Global Maritime Knowledge Hub*

Kanna Rajan, *International Chair at NTNU*

João Sousa, *University of Porto*

Maria João Ramos, *University of Porto*

Martin Ludvigsen, *NTNU*

Tore O. Sandvik, *Sør-Trøndelag County Authority*

Jonas Jahr Støre, *Stortinget*

Ingrid Schjølberg, *NTNU*

Cecilie Mauritzen, *NIVA and Pedro De La Torre, NTNU*

Asgeir Sørensen, *NTNU AMOS*

Tor Berge Gjervisk, *FMC*

Christian Collin-Hansen, *Statoil*

Kristin Y. Pettersen, *Eelume*

WHY I THINK THE OCEAN WEEK IS IMPORTANT AND WHY I WOULD ATTEND AGAIN

Overall, I think that the Ocean Week is absolutely cardinal for anyone interested in ocean technology. It was an incredibly inspiring and motivating week, personally leaving me with many impressions and ideas. While sometimes also overwhelming and frustrating—because how am *I* supposed to ever come up with cool things like this?—, the kindness, passion and approachability of all speakers and participants convinced me to put aside that doubt.

Secondly, I believe that the conference is of importance for the industry outside of Norway. Norwegians have already understood that their focus needs to shift to a more sustainable use of the oceans which was passionately presented by the Labour Party's candidate for prime minister in 2017, Jonas Gahr Støre and *NTNU*'s rector, Gunnar Bovim. But as a student at a German technical university I unfortunately cannot say the same. There was not a single person in Berlin who knew what sustainable ocean technology really means—frankly including myself. When reading the program, I was not mainly interested in the aquaculture part. I still do not want to focus my own education and future research solely on this topic but rather deep-sea robotics and renewable energies. Yet it was so wonderful and important to learn so many new and interesting things about this very relevant sector. I am filled with even more questions now: what will even happen to us if we replace ourselves with machines in the maritime and all other technical sectors? Won't that leave many, many people without jobs? And will those then even be able afford to eat the fish we so intelligently will have produced sustainably offshore? The week leaves me with so many more frustrating realizations about how much more work there is for our generation to do, sometimes I would rather get away and use the time to turn off my conscience and explore corals before they are gone.

³ <http://eelume.com>

But at the end of the day, I kitschily want to see it as my duty to raise awareness for these topics at my university. The *Nordic Water Network* is the perfect platform for this, especially because one also learns about the various opportunities for PhD positions and jobs. Let's hope that next May many more students will join me in spreading serotonin in Trondheim, but please with a session devoted to renewable energies offshore —and no plastic cups!