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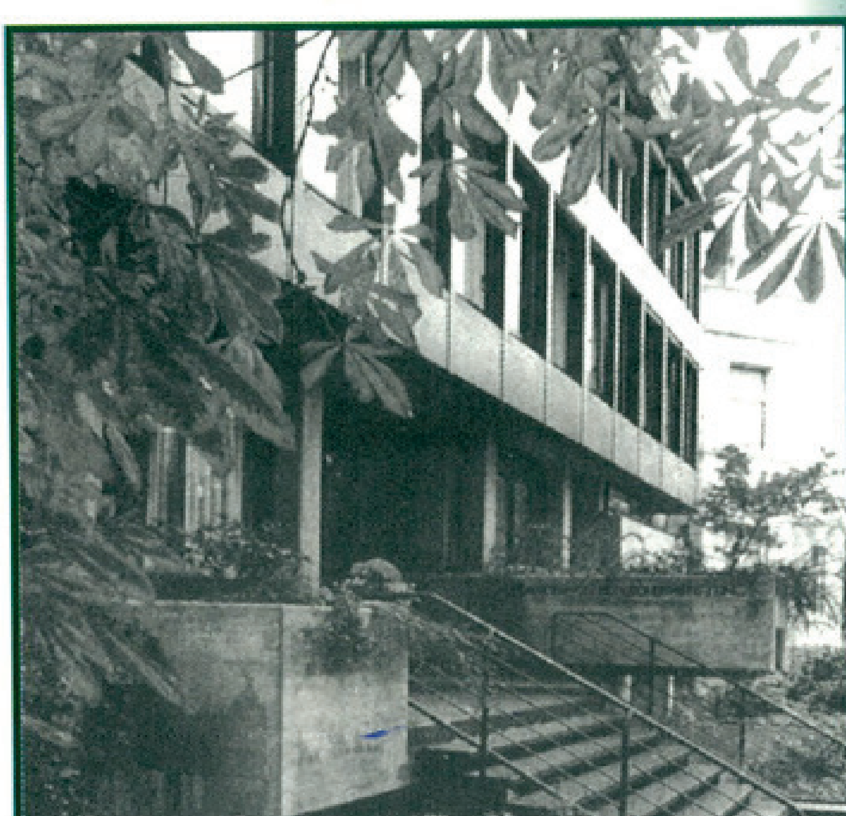
# Aquatic Sciences cum Enhancement of the Agro - industry

## Penang, Malaysia.
## 25th - 29th October 2007



## Abstrakt / Abstract

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By: Prof. Dr. P.M. Sivalingam
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# A Decade of Development of New Technologies and Technology Transfer at the Alfred Wegener Institute for Polar and Marine Research in Germany

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**Similar to most other Earth System Sciences, polar and marine research strongly bases on field campaigns which are to be supported by powerful large infrastructure facilities such as polar field stations, air planes, research ships and underwater platforms. Beyond, this kind of publicly relevant research requires sophisticated sampling and measuring equipment normally not available off-the-shelf. Thus, over the last decades, the Alfred Wegener Institute (AWI) gained experience both in the own development of specific technical solutions and the collaboration with private companies. Contrasting the early years, during which such partnerships mainly included procurement and facility operation, public private partnerships (PPPs) today become increasingly important in respect to the commercialization of results. After a brief introduction of the institute, examples are given for the development of polar and marine technologies, whereas a second part of the presentation is dedicated to the know-how transfer from other AWI activity fields such as marine biotechnologies.**

## The AWI and its Contribution to Large Scale Facilities in Present and Future

**The institute conducts research in the Arctic, Antarctic and mid and high latitude as well as coastal marine environments. The AWI coordinates polar research in Germany, and provides important infrastructures, such as the research icebreaker POLARSTERN, deep-sea observatories and land-based stations in the Arctic and Antarctic, acting within an international science network. AWI is one of 15 research centres of the 'Helmholtz-Gemeinschaft' (Helmholtz Association), the largest governmentally funded science organisation in Germany. About half of AWI's budget, roughly 110 Mio€ per year in total is dedicated to the operation of large facilities. The Antarctic research station NEUMAYER (70°39´S, 08°15´W) is occupied year round and represents the centre of German Antarctic research. The station (Fig. 1a) is currently rebuilt in close cooperation with a consortium of specialized companies with latest technical features for maximum environmental compatibility and security.**

**AWI actively supports procurement and management of large infrastructures on the European and international level. For example, the new research icebreaker AURORA BOREALIS (Fig. 1b), listed on the ESFRI roadmap is designed under the lead of AWI.**
**However, as the acquisition of public funding becomes more and more difficult, basic research has to face an increasing pressure of justification. Without doubt, climate**

**and ecosystem research is of high public relevance. In contrast to applied sciences, whose performance can be measured in the return-of-invest, we plead to develop indicators to measure the value of non-marketable research output in order to balance-out publicly relevant basic research and applied sciences in the high-tech strategies of the technology nations.**

**On the other hand, the importance of technology transfer (TT) was recognized at the AWI, further developing appropriate instruments for efficient commercialization. In this respect, AWI is one of the leading research institutions on the field of marine sciences.**

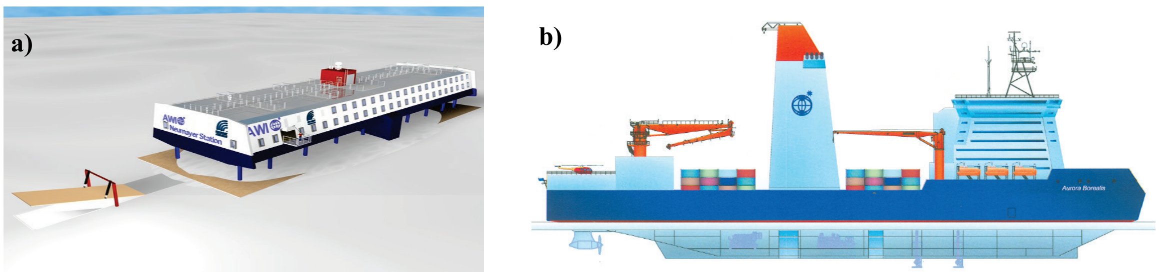


**Figure 1: Large scale research infrastructures: The Antarctic Station NEUMAYER III currently under construction is planned to be operable in 2008 (a). R/V AURORA BOREALIS will be a powerful research ice breaker with deep-sea drilling capacities (b).**

## New Instruments and Technologies for Marine and Polar Research

**Separating research and development into different departments potentially leads to alienation of these activities. Therefore, at the AWI technical developments are directly driven by and closely related to the scientific tasks. This includes technical solutions for sampling, in situ measurements, and direct observations of specific natural environments that are otherwise difficult to access.**

**Working in deep-sea and polar environments, technical engineers are challenged by low temperatures, high pressure, darkness, and extreme corrosiveness of seawater. Furthermore, techniques have to be environmentally compatible and samples must not be contaminated. Due to the difficult access to remote areas with extreme environments, measuring systems have to work reliably in autonomous mode, requiring special efforts in the minimization of size, weight and power consumption. Experience also showed that technical and operational robustness outrivals fancy high-tech solutions.**

**For instance, a bottom water sampler is briefly introduced (Fig. 2a). In contrast to state of the art samplers, this system allows sampling of the steep gradients in dissolved or particulate matter of the near-bottom zone above the seafloor. The device is rated for full ocean depth and has proven its suitability during numerous polar expeditions.**

A second example is presented from the field of advanced laboratory techniques. A specific cryo-chamber was developed to ease high resolution element analyses by laser ablation techniques (Fig. 2b). Samples such as ice and sediment cores as well as frozen tissue and food samples can be scanned for gradients in composition on a sub-millimeter scale.

As evident from the mentioned requirements, high development costs generally oppose low numbers of technical units needed in the scientific community. This relationship makes commercialization difficult in the field of marine and polar technologies. On the other hand, in view of the time consuming development, the resulting technologies should be disseminated efficiently. Thus, it is the philosophy of the institute to provide a marketable product to small and medium sized companies (SMEs) that is protected by intellectual property rights (IPRs: e.g. patents), so that they are able to enter these niche markets with a limited risk.

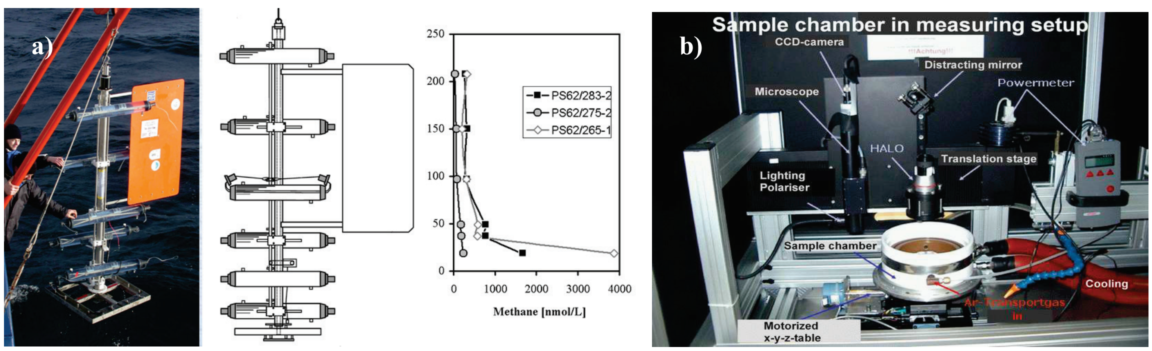


Figure 2: Examples of AWI-developed sampling and measuring techniques. Bottom water sampler for the sampling of near-bottom gradients (a). Cryo-chamber for laser ablation mass spectrometry (b).

<u>Innovations from the Field of Applied Marine Biosciences</u>

In contrast to the above mentioned research and development fields, results from marine biosciences are highly relevant in terms of commercial use. Whereas past research AWI activities focused on the comprehension of polar and marine ecosystems, the immense economic potential of applied marine biosciences was recognized and evolves rapidly. As a unique selling point AWI gets access to extreme environments via its powerful research infrastructures. This offers the opportunity to use specific natural resources and products such as low-temperature enzymes or rare plankton shells. As illustrated by the following examples, bio-innovations are not restricted to Polar Regions and remote deep oceans: coastal areas also offer a great potential for the exploitation of results:

The AWI not only accompanies the conception of off-shore wind power plants by ecological research within public private partnerships but also contributes innovative concepts for the secondary use of such areas for mari-culture between the arrays of wind power stations (Fig. 3). Due to its limited areas, the German North Sea coast suffers from an immense user pressure from all kind stakeholders, which this new concept aims to relieve to a certain degree.

A portfolio of patented techniques is under development including frames for algae and mussel growth, environmentally compatible antifouling solutions, and specific equipment for the under water inspection of the installed structures. This know-how is complemented by concepts for the re-population of decimated animals and by multi-gene probes for the efficient detection of toxic algae and pollutants in coastal waters. With the "Sylt Algae Farm", a spin-off was founded from the Wadden Sea Station List (Island Sylt), where macro algae and abalone snails are grown for the food and life science branches.

Furthermore, a recent patent application protects a new method of harvesting caviar without killing the sturgeon, which is currently under a final proof of technology. Whereas most of the natural sturgeon populations will die-out within the next decade, aqua-cultured animals need 5 to 7 years to produce their first suitable eggs and are today killed for one single caviar harvest. Without the need to change the aqua farms, the caviar production could be multiplied considerably by our technique.

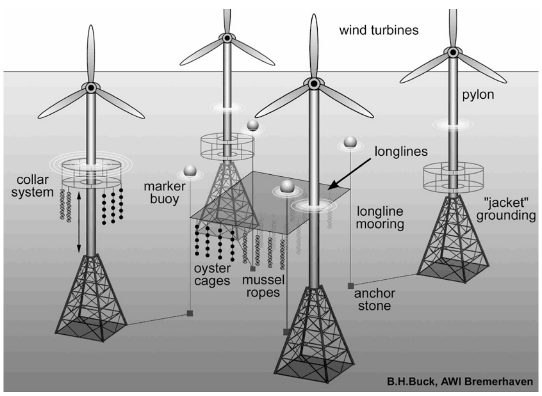


Figure 3: Off-shore wind power plants with aqua culture installations in-between (image by courtesy of B.H. Buck, AWI)

In view of declining oil and gas resources, exploration is expanded to more and more remote and problematic areas such as deep margins and Polar Regions. Recent AWI research led to the identification, cultivation of oil-degrading bacteria, even able to metabolize oil in ice-covered seas and under low temperatures. The composition of an appropriate "microbial cocktail" offers the opportunity to complement mechanical oil cleaning efforts by bioremediation in high latitude areas.

Last but not least, the thematic section of marine bionics is interesting to be mentioned as a final example: Basing on a worldwide unique collection of over 60,000 diatom samples and in-depth expertise in the mechanical and physical properties of diatom skeletons, AWI has developed methods of up-scaling nature's lightweight structures into technical dimensions. From this, a large variety of technical applications can be derived. With the development of an ultra lightweight car wheel from the circular diatom *Actinoptychus* (Fig. 4) exhibits an example for technology transfer from basic research to industry at its best.

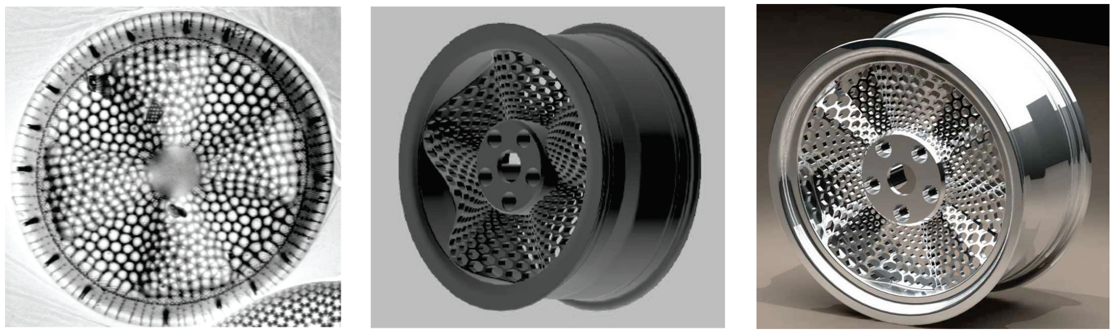

**Figure 4: Marine Bionics: Derivation of a lightweight car wheel from diatom structures.**

**We conclude, that, although technology transfer is young at the AWI and its structures are still to be optimized, the large potential of this multidisciplinary institute was recognized and an increasing number of exiting transfer projects is carried out. With this presentation we try to make evident that technology transfer not only is a nice add-on to a basic research institute but is essential for the sustainable use of earth's resources in alignment with economic responsibilities.**