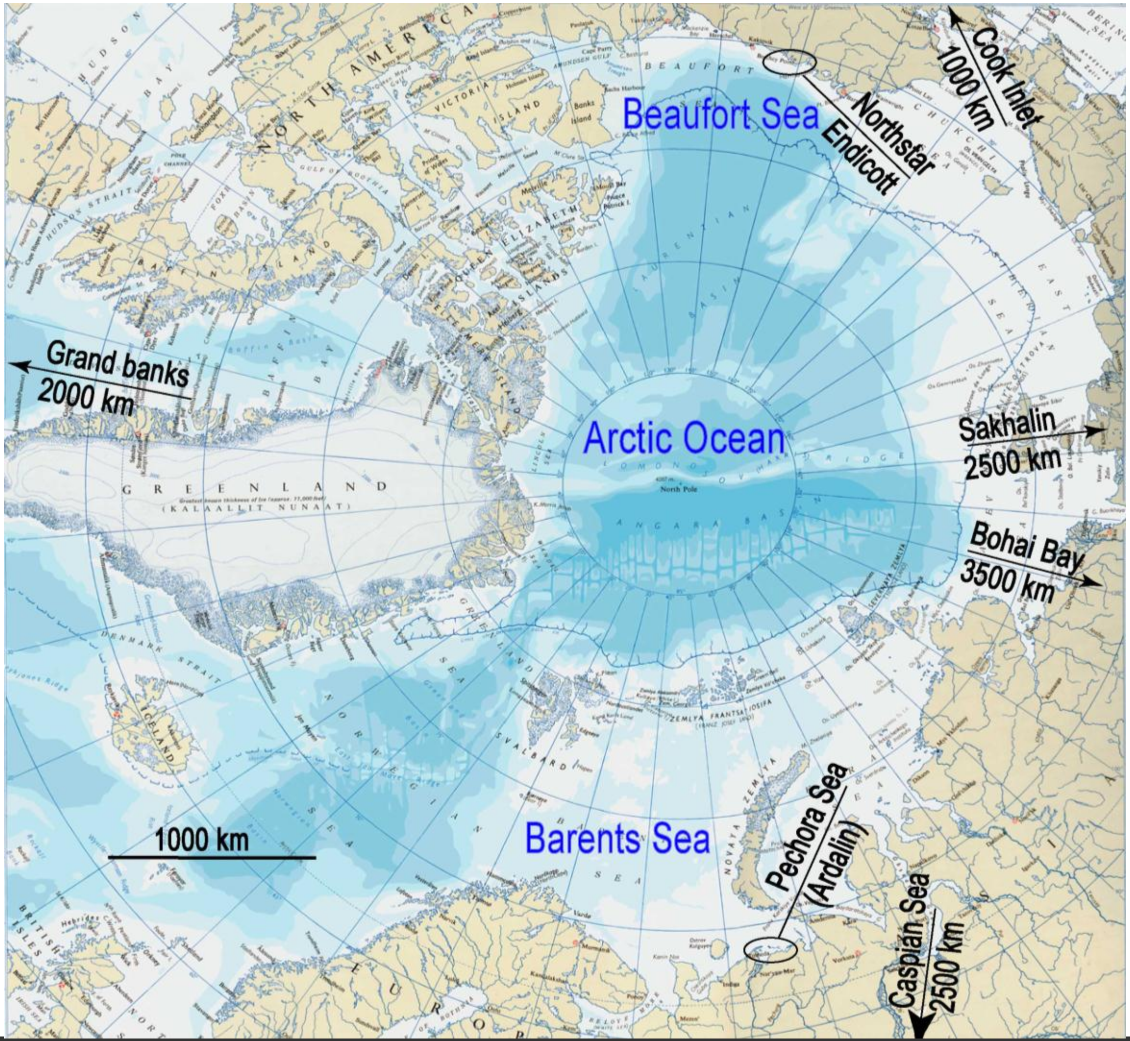
Verneutstyr i kaldt klima

Arne Haugan – Statoil

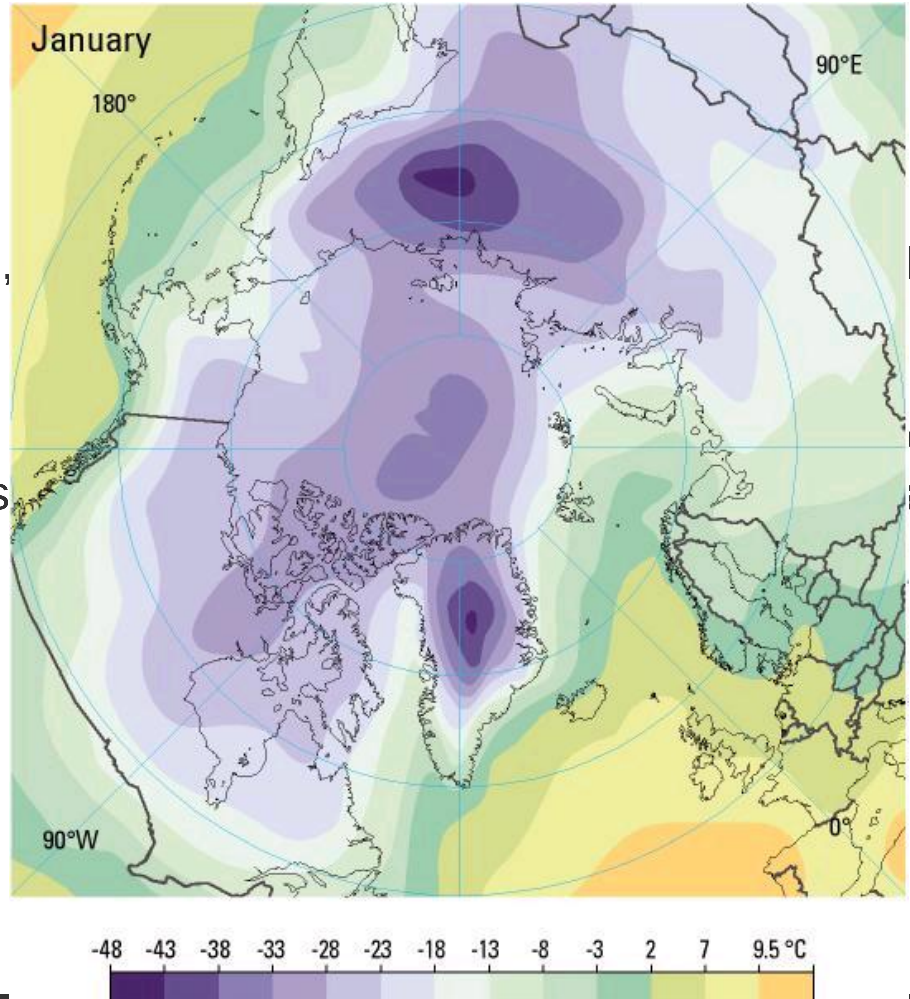
Presentasjoner hentet fra ColdWear: Sintef Helse, Sintef IKT, Sintef MK, NTNU, Statoil

Arctic challenges

- **Climate**
  - Weather
  - Ice / icebergs
  - Icing
- Physical Environment
  - low air temperatures
  - poor visibility
  - polar darkness
  - snow & blowing snow
  - occasional icing
- **Remoteness**
  - Field to infrastructure
  - Field to market
- **Personnel safety/health**



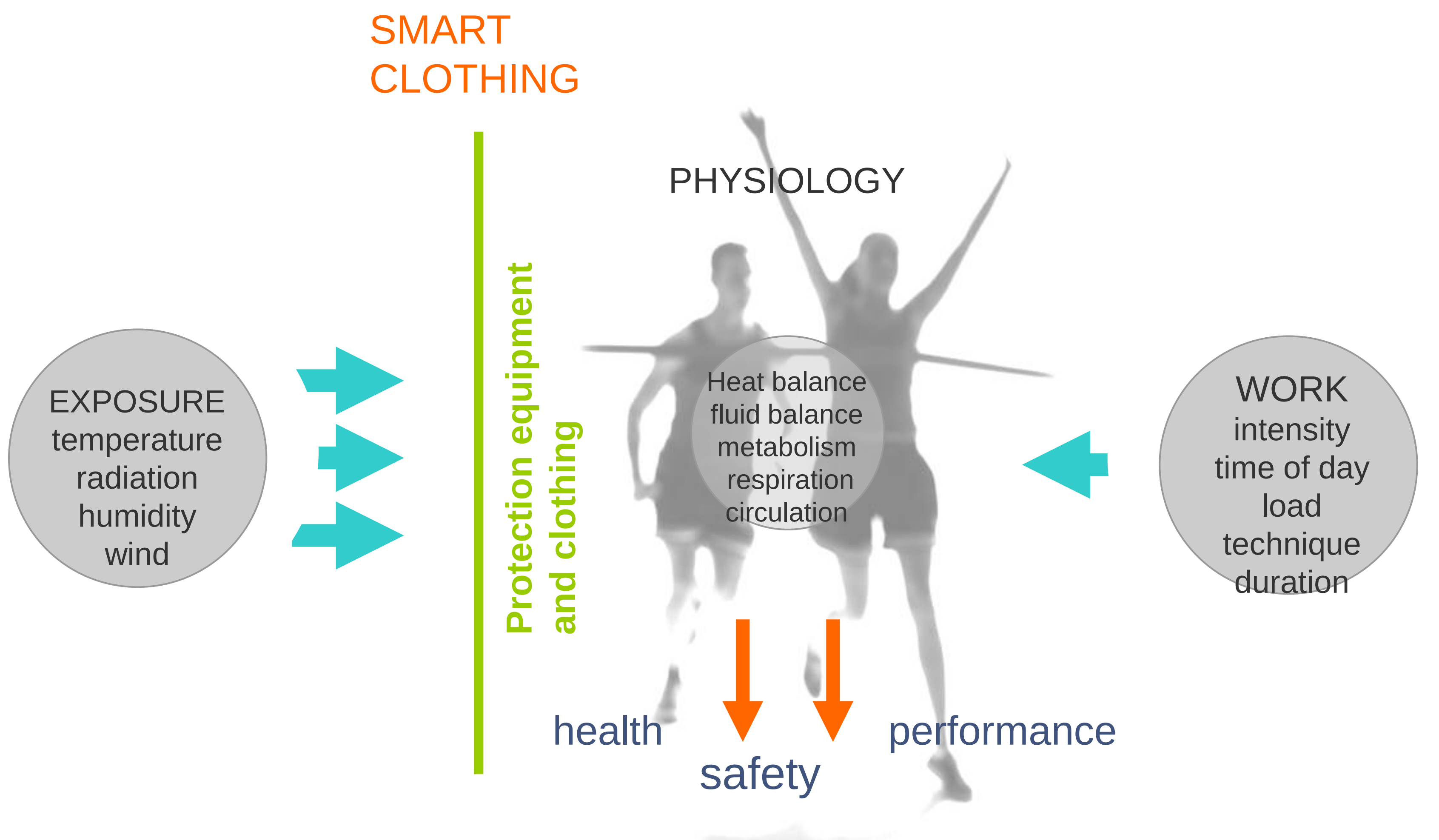
Cold climate and personal safety and health



The harsh (cold, lorth is a threat to work

Reduced work creased risk of human errors alth impacts.

Work physiology
Interaction between surroundings, body and work



ColdWear

Forskningsrådet
JANUS
NTNU Det skapende universitet
SINTEF
Statoil
SWIX SPORT AS
TOTAL
Wenaas

Statoil

Prosjektgruppen ColdWear

Prosjektleder: Hilde Færevik, Seniorforsker, SINTEF Helse, Fysiologi

Arbeidspakkeledere:

- Frode Strisland, Seniorforsker, SINTEF IKT, sensorteknologi og elektronikk i bekledning
- Arne Røyset, Seniorforsker, SINTEF MK, avanserte materialer for kaldt klima

- **Veiledere NTNU:**
- Professor Dag Breiby, materialteknologi
- Professor Randi Eidsmo Reinertsen, fysiologi

Styringskomiteen ColdWear

- **Styringkomite:**

- Styringskomiteleder; Randi Eidsmo Reinertsen, Forskningsjef, SINTEF Helse
- Rudie Spooren, Forskningsjef, SINTEF MK
- Dag Breiby, Professor, NTNU
- Lars Karlöf, R&D sjef, Swix Sport AS
- Arne Haugan, Discipline Advisor Statoil
- Arne Fonneland, Janusfabrikken AS
- Fred Karlsen, Produkt og markedsjef, Wenaas AS
- Henri Tonant Total

Referansegruppen ColdWear

- Finn Ove Gaasøy, Forsvarets logistikkorganisasjon (FLO)
- Rune Løvjomås, Seksjonssjef ved Forsvarets Vinterskole på Elverum
- Eldbjørg Markhus Brekke, Produktleder uniformer, Politiets Data og Materielltjeneste
- Carsten Bowitz, Fagsjef HMS, Oljeindustriens landsforening

POLITIET

The Norwegian Police

Norwegian Armed Forces

olf

OLF - The Norwegian Oil Industry Association

2008-2012: ColdWear
Textiles and clothing for improved safety, performance, and comfort in the High North

- Research at SINTEF and NTNU
  - ✓ Financed by NRC (“KMB” project: “kompetanseprosjekt med brukermedvirkning”)
  - ✓ Supported by industry partners: Statoil, Total, Wenaas, Swix Sport AS and Janus

- KMB project – competence building by
  - Publish at least 10 papers 10 papers in international refereed journals and 10 conference papers.
  - To educate 2 PhDs and supervise 10 master students that besides providing and documenting fundamental knowledge will constitute to an attractive recruitment base for the Norwegian textile industry and industrial players in the High North.
  - To provide the project partners a significant competitive advantage that will be realized by initiation of several industrial innovative spin-off projects that utilize ideas created in ColdWear.

ColdWear objective

ColdWear

- Create the knowledge and scientific background for developing new clothing solutions that enable a significant increase in performance in the cold and safety of operations in the High North

- Two cases studied:
  - Oil and gas workers in the North
  - Elite athletes
  - - Dette var som å gå naken - Nyheter - NRK Nyheter

Photo: Statoil

Photo: Swix Sport AS

Statoil

Main knowledge building areas in ColdWear

- How the interaction between environmental exposure, clothing, work load, and physiological regulatory system affect the worker (task 1, task 2)
- How to develop and integrate sensors in clothing that improve user safety without reducing comfort and work performance (task 3, task 4)
- How comfort and work performance can be improved by the use of stimuli-responsive materials that adapt properties to environmental changes (task 5, task 6, task 7, task 8)
- How to develop materials that provide a significant increase in performance because they add functionality that cooperates with the body's own regulatory mechanisms to provide optimal function (task 8, task 6)

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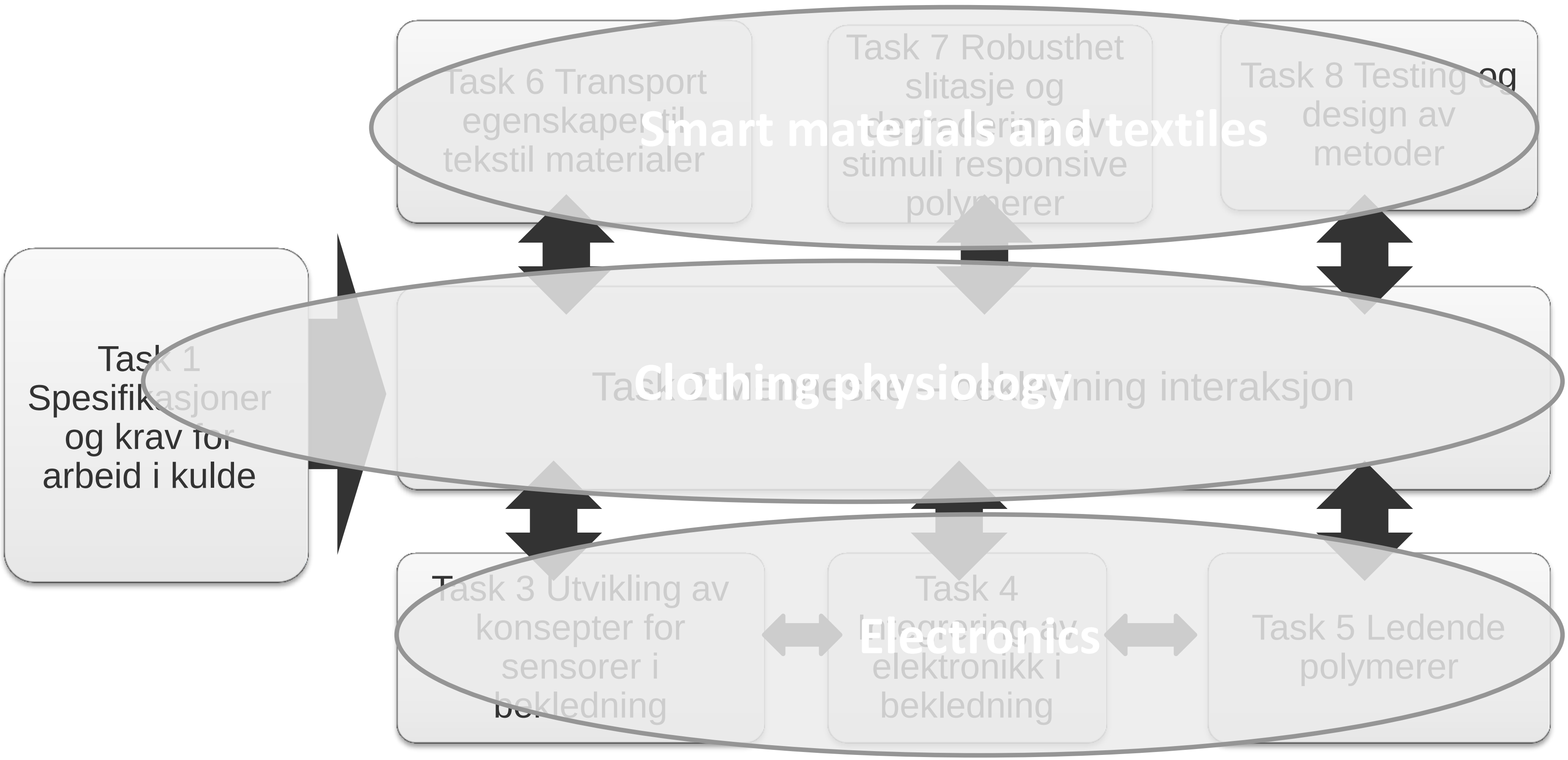
Overview of the ColdWear project



LNG export terminal Melkøya, Hammerfest (70°N, 23°E).

- Every year, polar legislation requires closing the installation due to strong winds, high waves and temperatures that lead to icing of equipment and machinery
- The personal PPE used by Melkøya's 2300 employees must satisfy a number of requirements, including protection against unpredictable weather, constantly changing work intensity, safety standards, comfort and functionality
- The purpose of this study was to determine whether the PPE currently in use at Melkøya is adequate for cold protection and work performance.
- We hypothesized that the protective clothing used by petroleum workers at Melkøya today will not satisfy the requirements according to the IREQ model when exposed to environmental conditions simulating those of the harsh arctic environment.

SINTEF

SINTEF Technology and Society

Statoil

Work operations – LNG Melkøya

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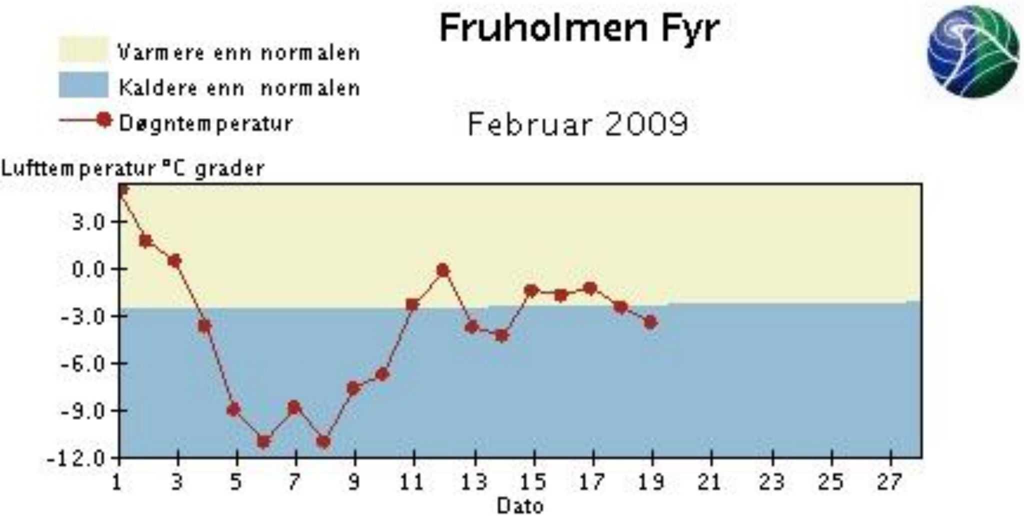
Climate challenges



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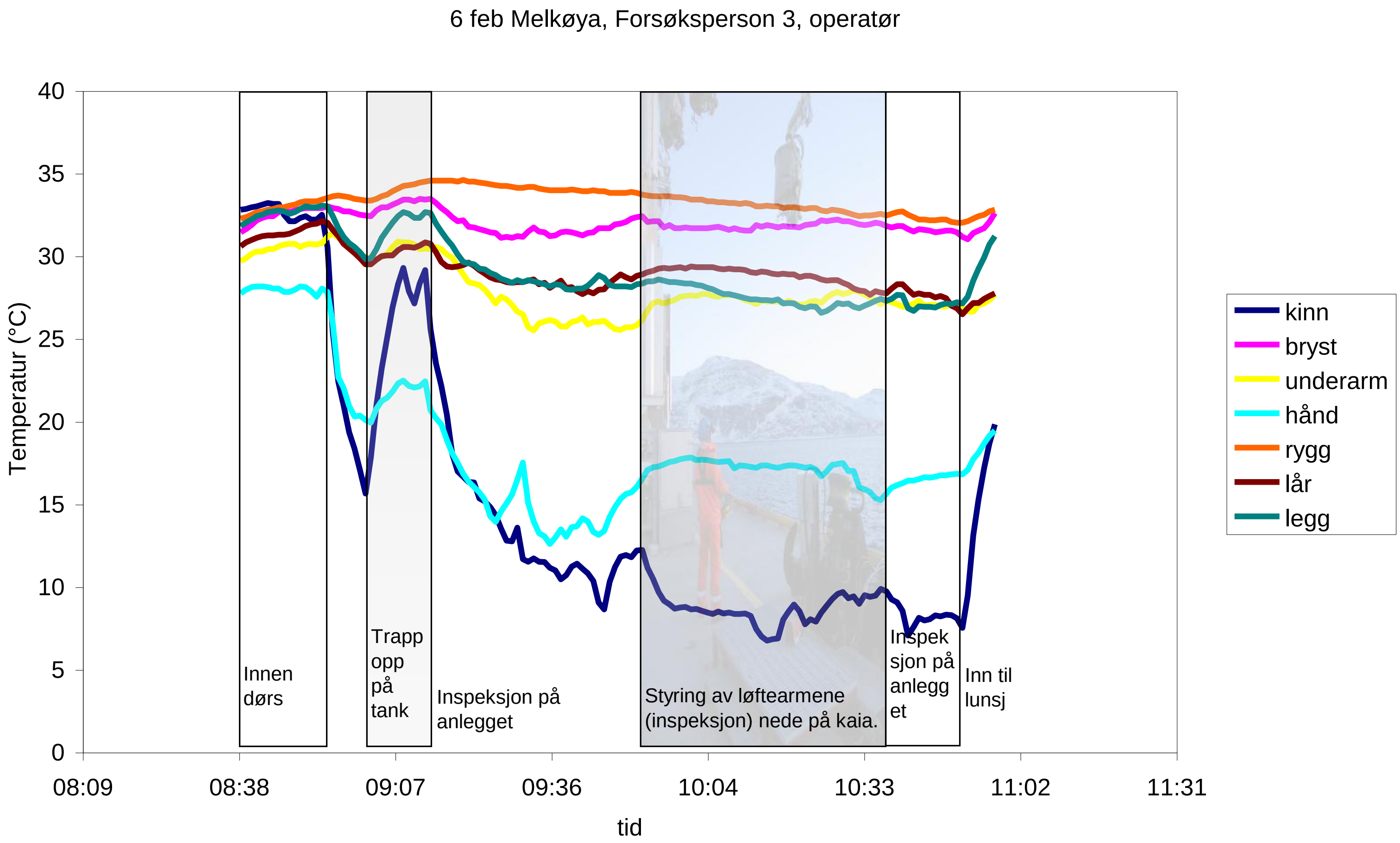
Temperatures subject 3 - operator



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Example of end users statements :

Utsagn:

- *"Det blir til at vi utsetter ting pga kulde og vind, vi går inn når fingrene ikke fungerer mer"*
- *"Vi gjør også arbeid som krever finmotorikk med små skruer og bolter (6mm), da tar vi av oss hanskene; har du prøvd nål og tråd med hansker!"*
- *Vi bytter på; når den ene blir blåfrossen på fingrene tar den andre over*
- *"I akutte situasjoner må vi ut uansett* vær"

Krav:

- Hanskene sikrer funksjonalitet i fingrene.
- Hanskene forringer ikke finmotorikk
- Hanskene beskytter mot kulde under alle slags arbeidssituasjoner og værforhold.
- Hanskene hindrer at man blir kald på hender og fingre ved finmotoriske arbeidsoppgaver

Conclusions field test Melkøya

- Skin temperature of the hand was below 15° C, cheek temperature below 8°C
- Interviews and objective measures showed that manual operations was challenging in the cold
- The clothing used did not provide sufficient protection to maintain thermal comfort for longer periods
- Low metabolic rate, interspersed with short high intensity periods

Manual performance in the cold

Effect of cold conditions on manual performance while wearing petroleum industry protective clothing.

Authors:

Øystein Nordrum WIGGEN 1,2, Sigri HEEN 1, Hilde FÆREVIK 2, Randi Eidsmo REINERTSEN 2

Accepted in Industrial Health

The aim of this study was to investigate manual performance and thermal responses in test persons wearing standard protective clothing for petroleum workers when they were exposed to a range of temperatures relevant to the prevailing environmental conditions for petroleum industry in northern regions.

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Methods

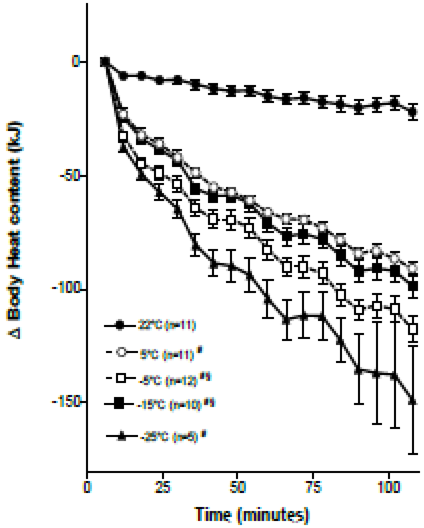
Tactile sensitivity

Purdue pegboard

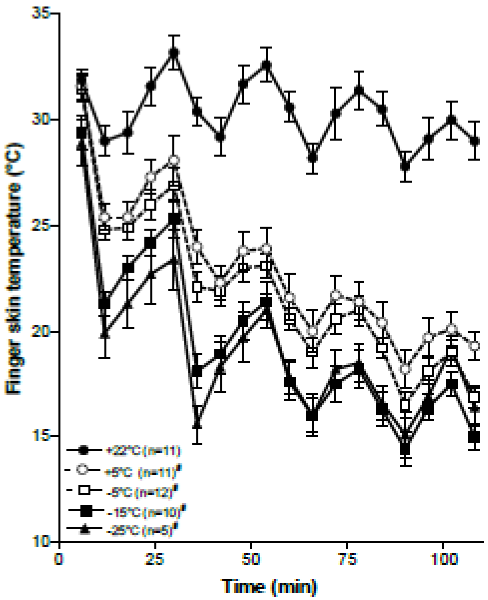
The Complete
Minnesota dexterity

Hand strength

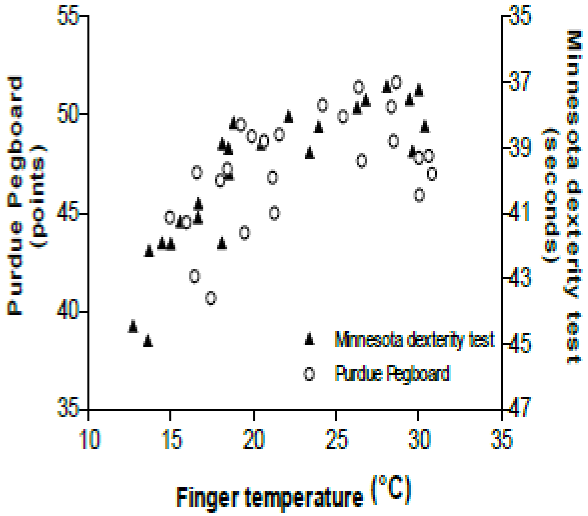
Change in body heat content (H_b) and finger temperature



Body heat content



Finger skin temperature



Correlation between finger temperature and manual dexterity independent of ambient temperature and time

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What is SmartWear?

Technologies for and applications of clothing textiles with added functionality and tailored properties, based on the application of multi-functional materials and/or integrated instrumentation.

physiological monitoring – SINTEF Health Research
temperatures, ECG, blood pressure, respiration and moisture

integrated instrumentation – SINTEF ICT
sensors, actuators, electronics, communication and information

functional materials – SINTEF Material and Chemistry
adaptive materials, protective materials, absorption and release

SmartWear main focus:
Smart cold protective clothing

Core competence SmartWear in SINTEF

Materials

- Transport properties of textile materials
  - Heat and moisture is absorption and transport in textile
  - Adaptive stimuli responsive polymers which change moisture properties due to environmental change
  - Both state-of-the-art commercial textile materials and materials coated at SINTEF will be investigated
- Robustness and degradation mechanisms of stimuli-responsive materials
  - Better understanding of robustness, wear resistance and long term degradation mechanisms which are major obstacles for the implementation of new stimuli-responsive polymers in clothing.
- Testing and design methodology for textiles with stimuli-responsive materials
  - develop new methods and tools that allows for better design and prediction of macro-scale performance of clothing incorporating stimuli-responsive materials
  - The methods developed shall be based on a thorough understanding of the physical properties of the materials, and how they interact with the body and environment

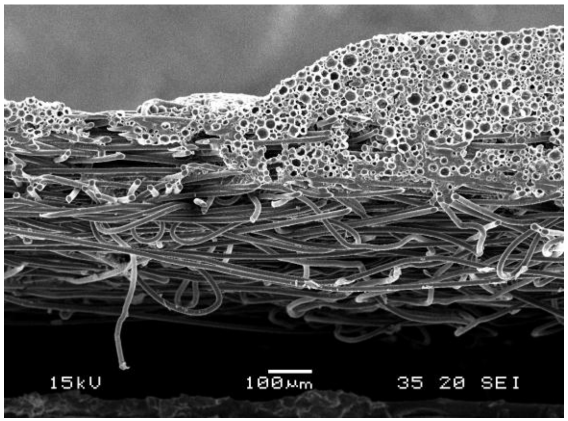
Phase Change Materials (PCM)

- One of the most important developments in the field of thermal adaptable technology over the past decade has been the incorporation of phase change materials (PCMs) into clothing.
- Characterised by their ability to absorb energy (heat) when they change form a solid to liquid state and to release heat as they return to the solid phase
  - Salthydrate (Glaubersalt)
  - Paraffin-wax (PCM-microkapsules)

The PCM microcapsules can be contained with the fibre itself ...

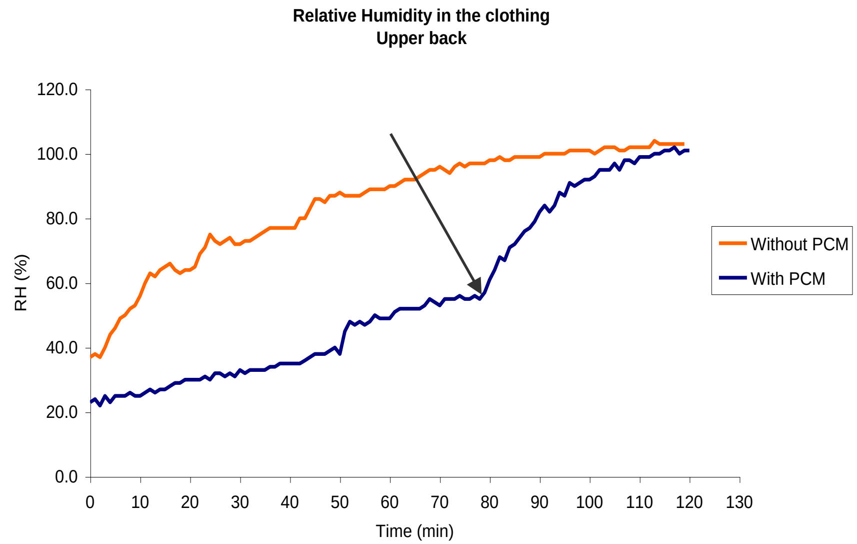
Source: Outlast

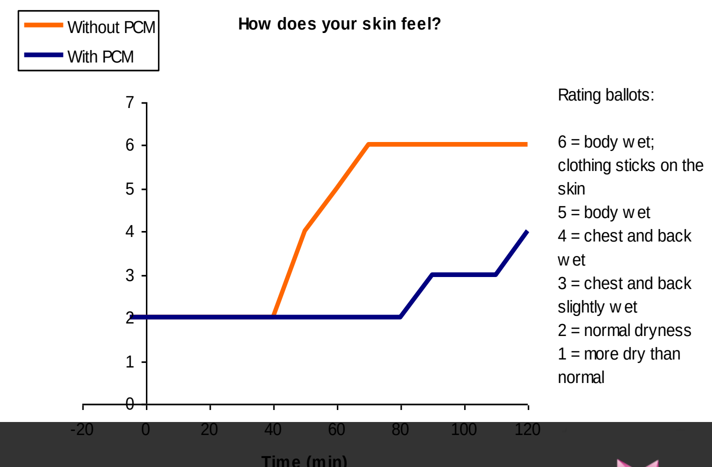
The interaction between phase change materials and physiological effector mechanisms



Scanning electron microscope (SEM) picture PCM,
Effect 60kJ/kg,
Foto; SINTEF Materials and Chemistry

1. The amount of PCM needed ?
   - body heat production
   - the cooling/heating capacity
2. The location of PCM?
   - Body





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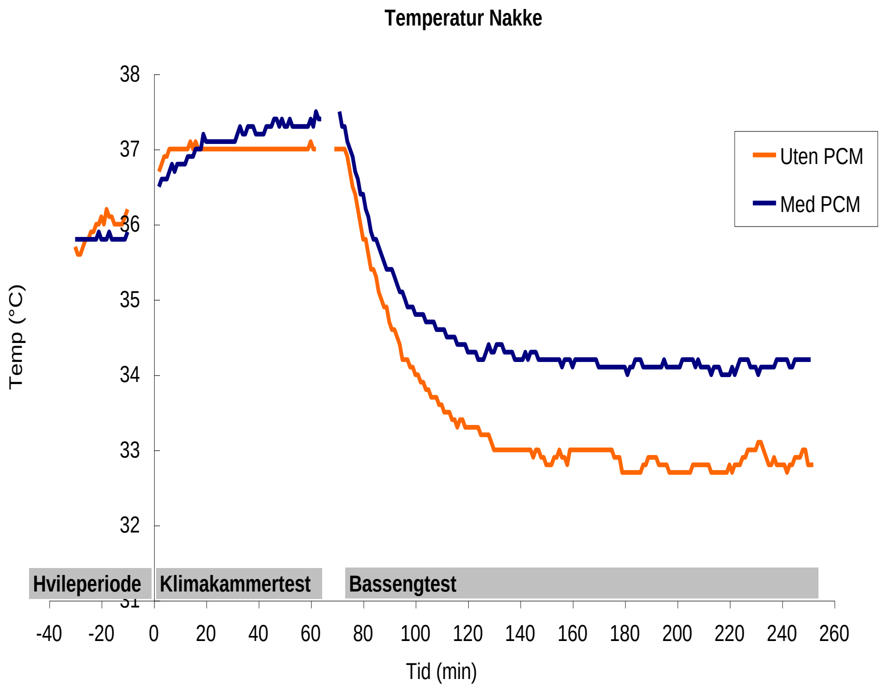
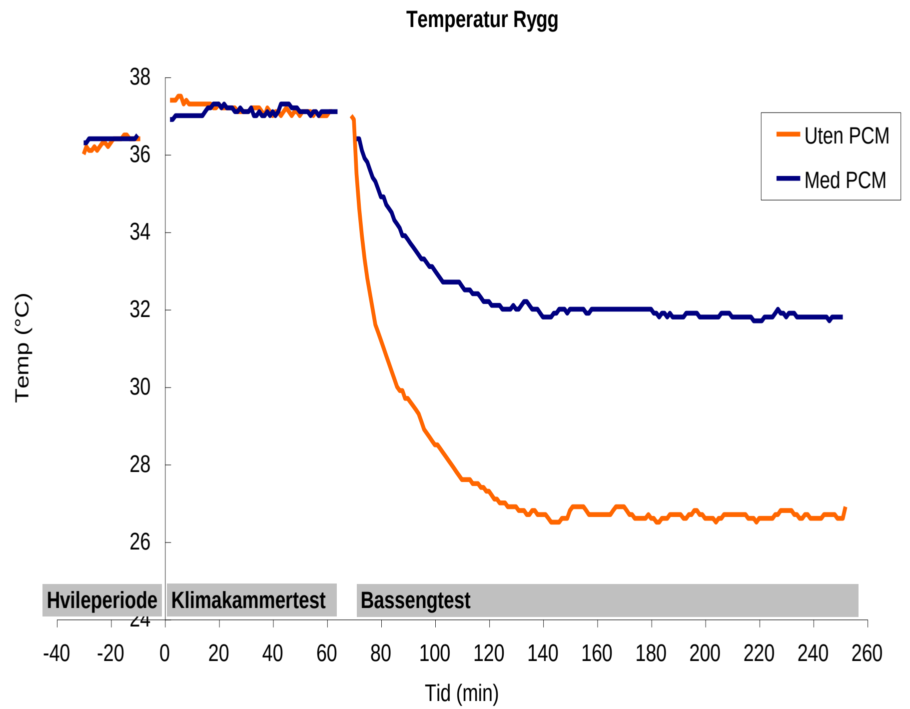
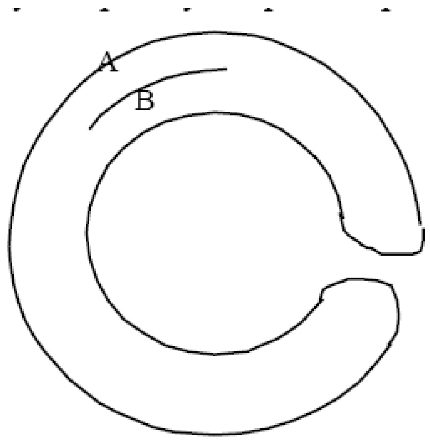
Phase change materials in cold water





Stimuli responsive materialer kan gi skreddersydde egenskaper

- Adaptiv isolasjon,   A og B har ulik varmeutvidelse

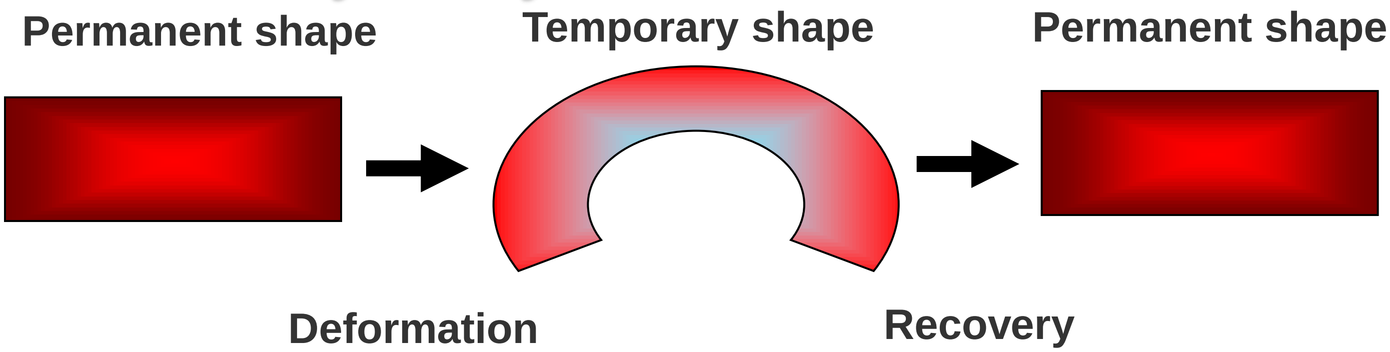


Fiber Cross Section: A & B are two polyme
(outer and inner components) in a hollow bi
component fiber.

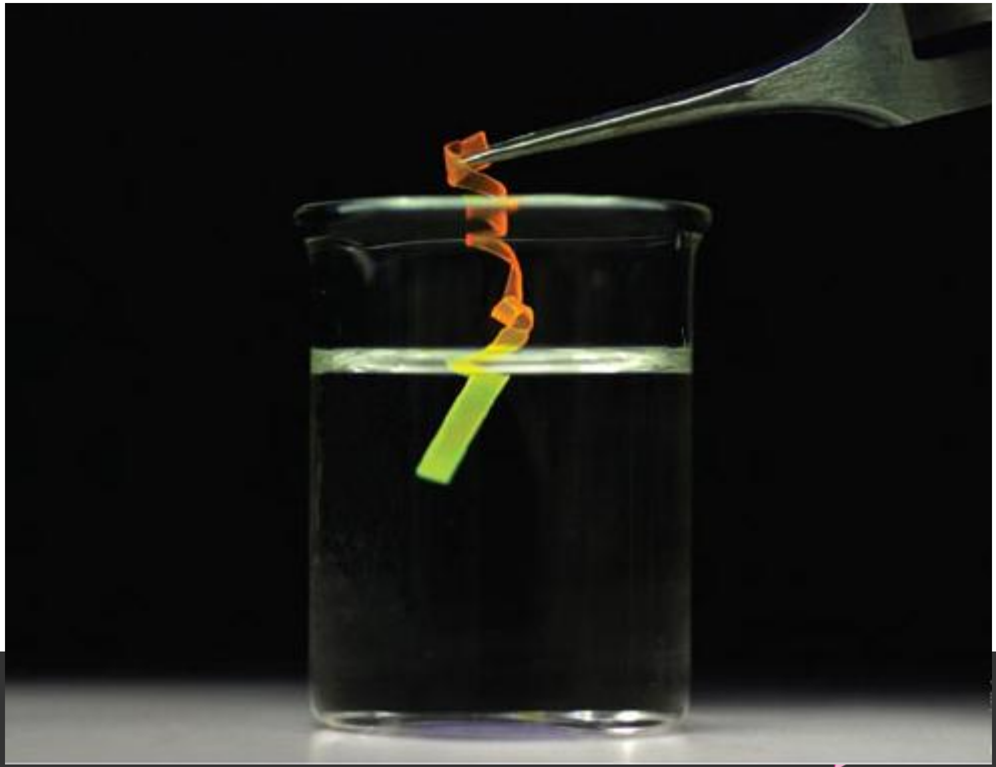
Koch,

Georgia Tech.

Shape Memory Polymers



A material that "*remembers*" its shape and can be returned to that shape after being deformed, by the application of heat



Task 3 & Task 4

To create knowledge on how to integrate sensors in clothing, and thereby improve user safety without reducing comfort and work performance

- Task 3 - Development of sensing technologies
  Packaging of sensors in textiles for cold environments.

- Task 4 - Integration of *electronic systems* in clothing

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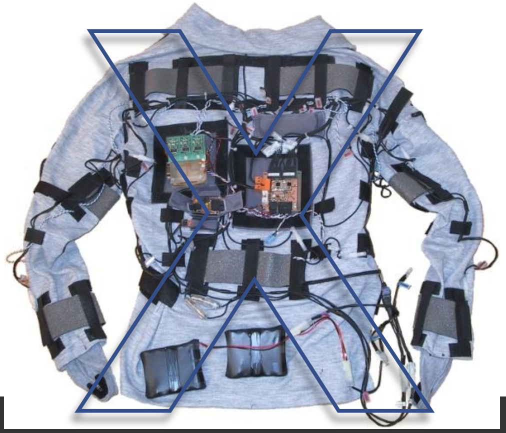
State of the Art – Smart Textiles

- All electronic devices needs (most of) the following items:
  - Power (battery, controlling circuits etc)
  - Main circuit (microcontroller, sensors, memory, internal clocks ++)
  - Transmission to other device or display(wire or wireless)
  - Additional sensors
  - Other electronic elements (switches, condensators etc)
  - Conductors to connect all the elements

  - How can we make it better than this? ☺



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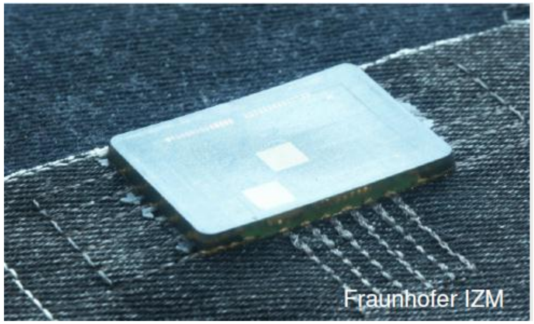
State of the Art – Smart Textiles (Cont.)

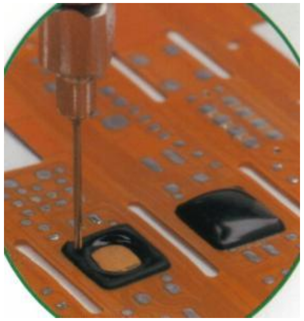
Interconnect and packing of electronic components on textiles

- Hot Melt, Glob Top, Transfer Molding, Stitching, External encapsulation

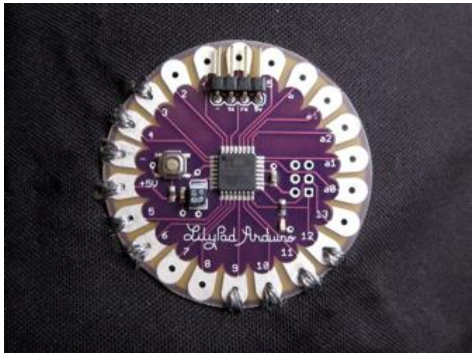


Hot Melt

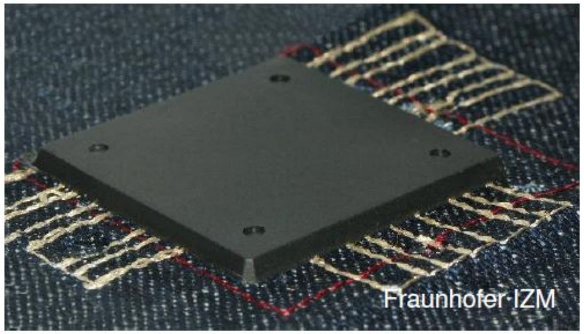
External encapsulation



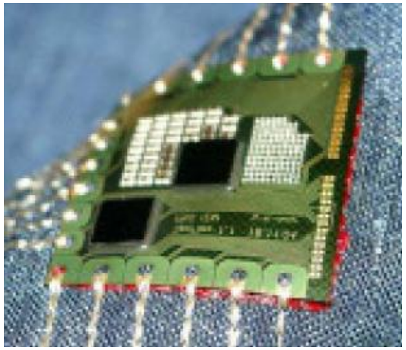
Glob Top



Stitching



Transfer Molding



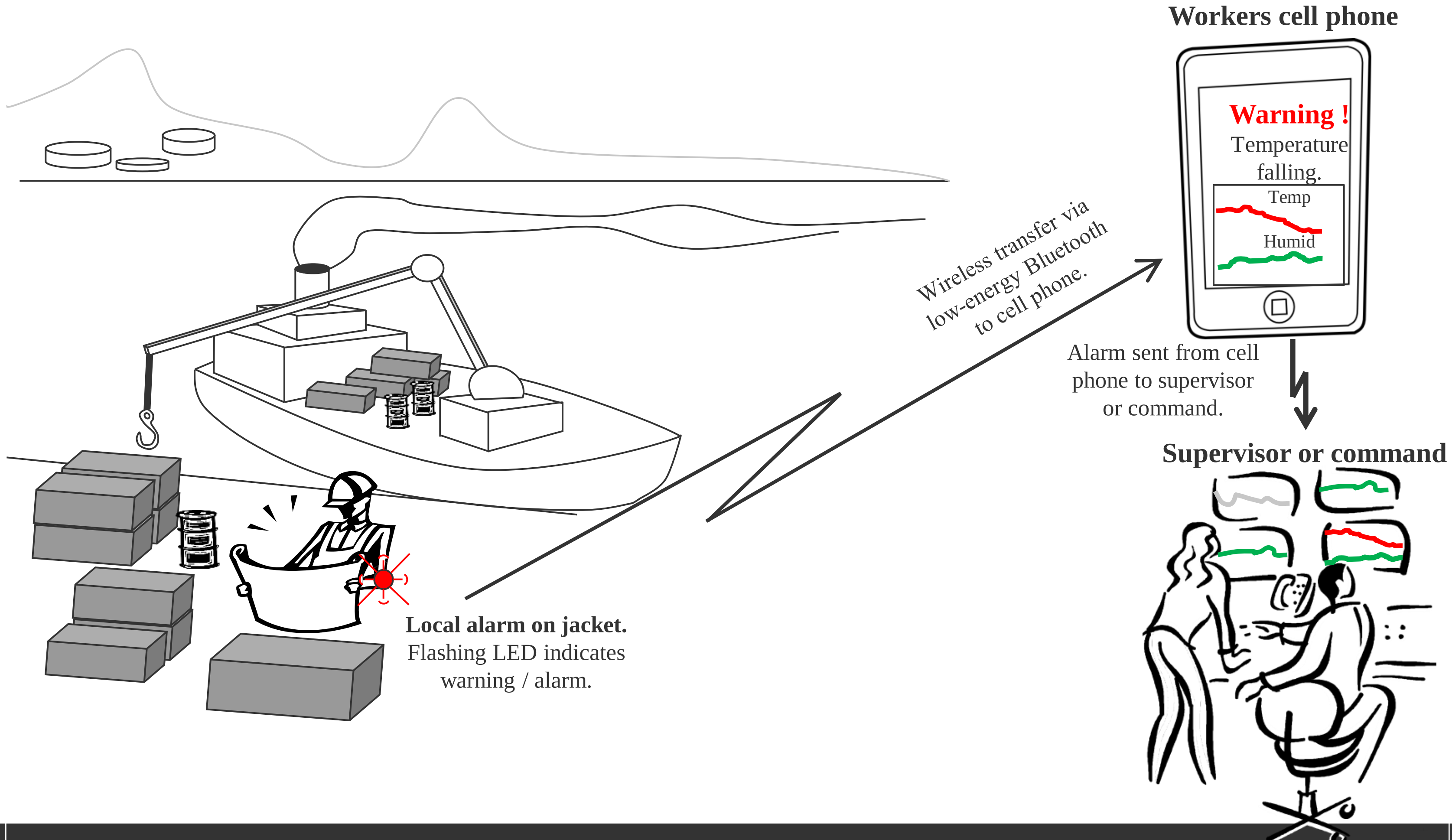
Demonstrator

Real time monitoring of oil workers in arctic climate
using low energy Bluetooth communication

SINTEF ColdWear Sintef – Coldwear project

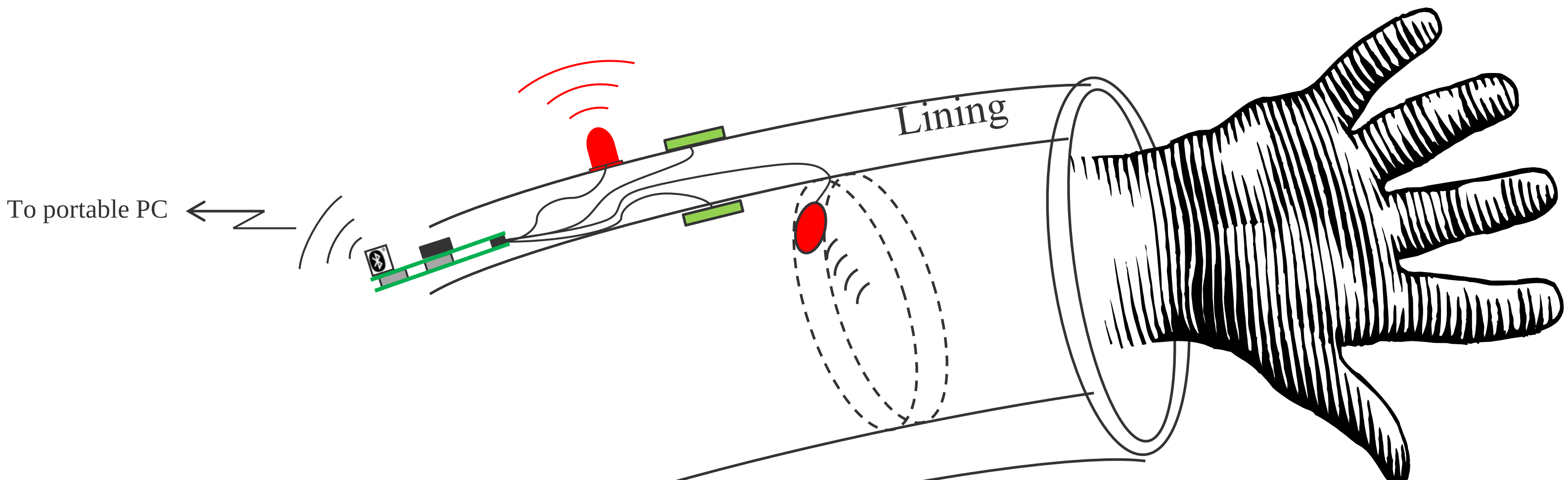
Bachelor thesis:.
Group K.10.11: Jean Wanuke Mukuta, Lena Skjoldal, Hågen Kyllo.
Oslo University College. Finished May 31 2010.

Principle overlook



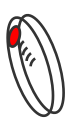
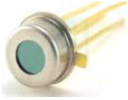
Location of parts

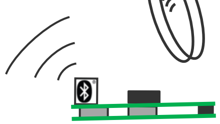
Cross section of lower left arm



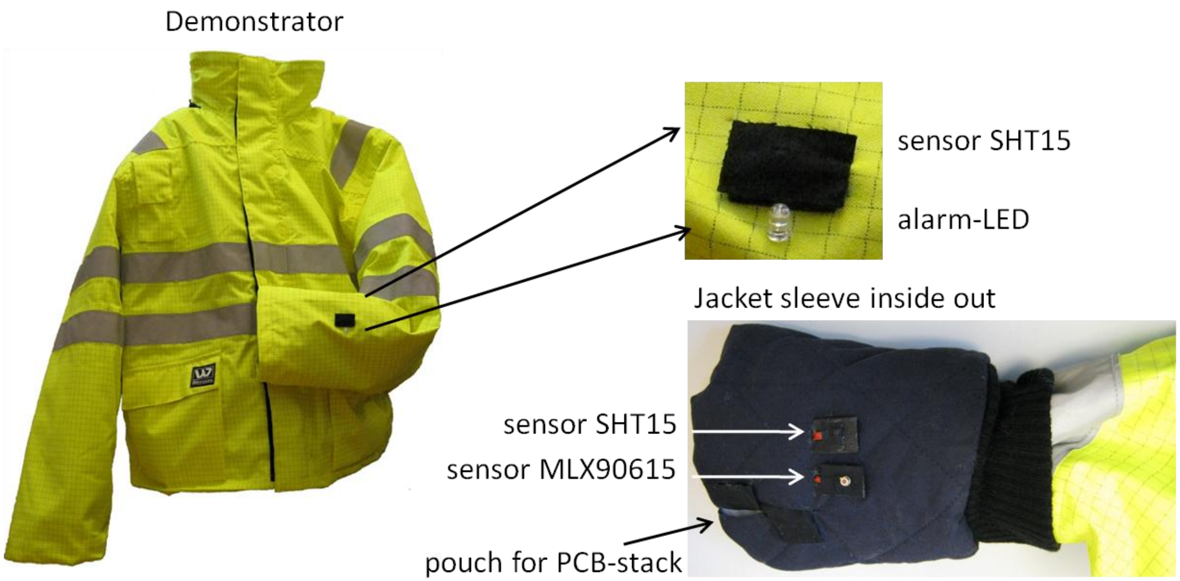

LED: alarm indication


Temperature and humidity: Sensirion SHT1x

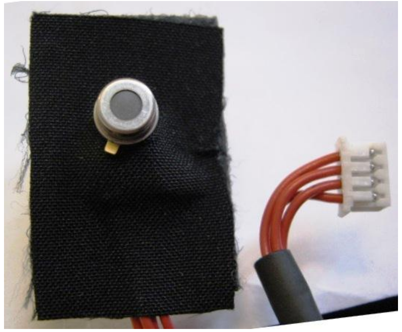


IR skin temperature sensor: Melexis 90615.
Attached to the inside of the jacket sleeve.



PCB-stack: Texas instruments BLE EB and PCB with ATMega169, battery and sensor reception.

Integrated electronics



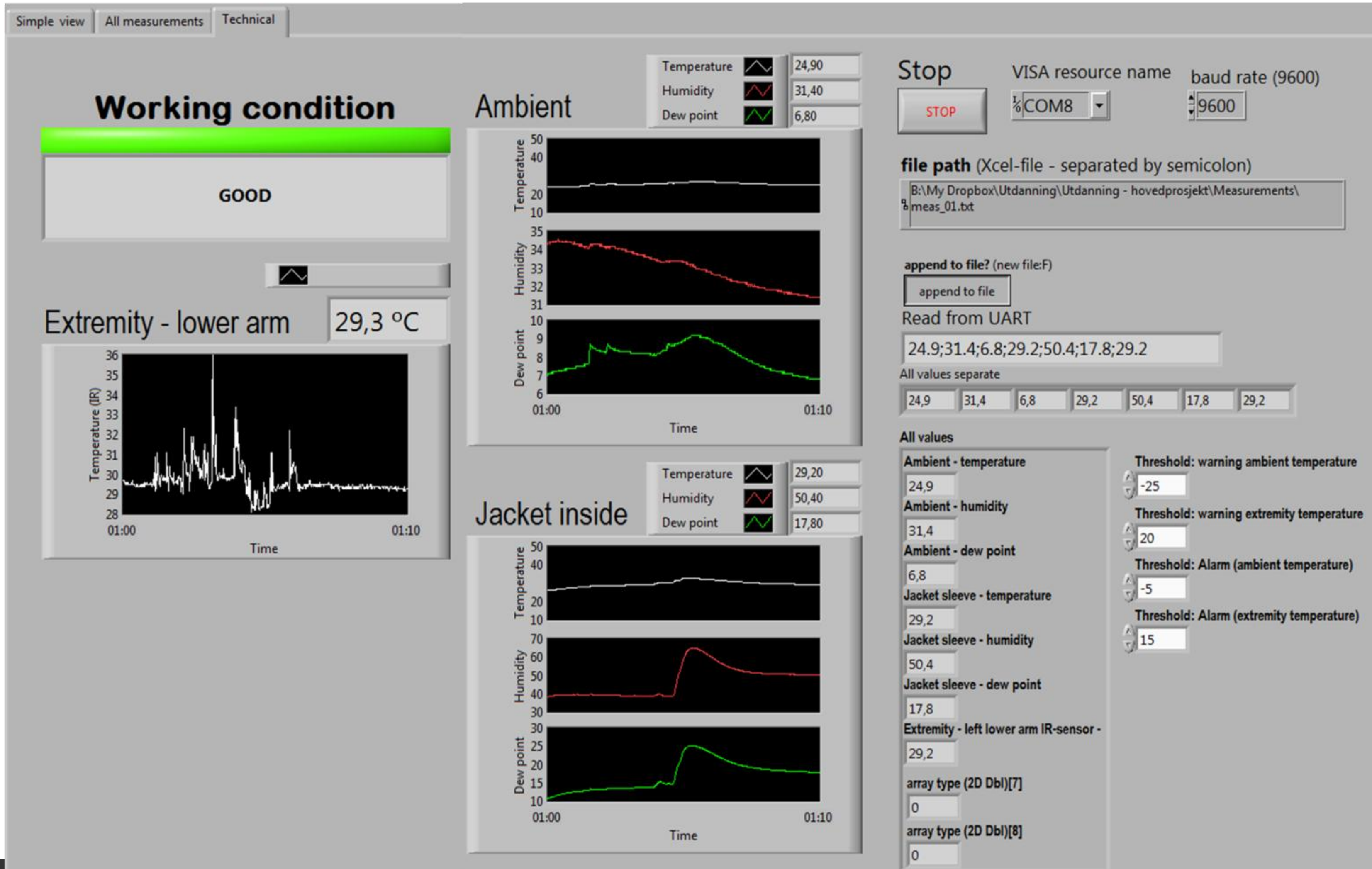
SHT15 Measures temperature and humidity. From that it



MLX90615 measures

Handheld device

Front panel on the handheld device.



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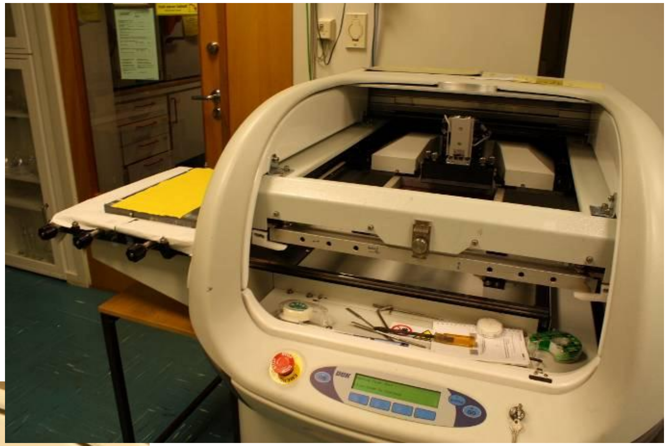
Screen printing of Conductive Polymer Inks

Two commercial conductive polymer inks were selcted

•Polyanniline Based Panstat from Panipol

•PEDOT:PSS based Orgacon

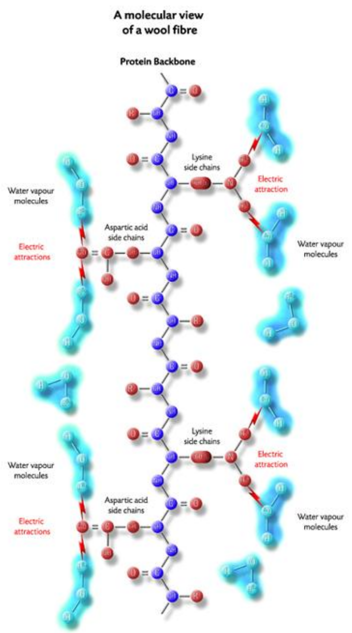


Screen obtained from DEK-screen printing specialists UK

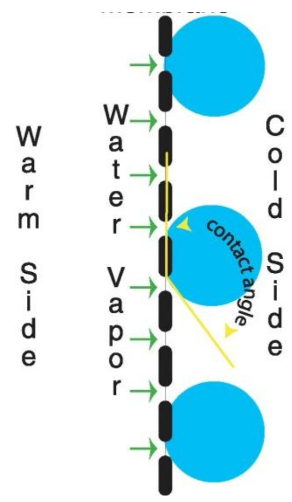
ColdWear
Task 6: Transport Properties of textiles

Task 6

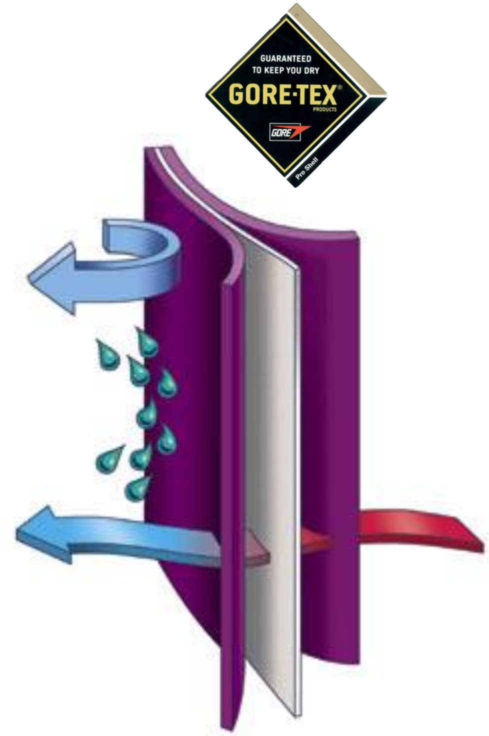
This task is concerned with understanding how heat and moisture are abosrbed and transported through textiles.



Natural Fibres



Microporous membranes

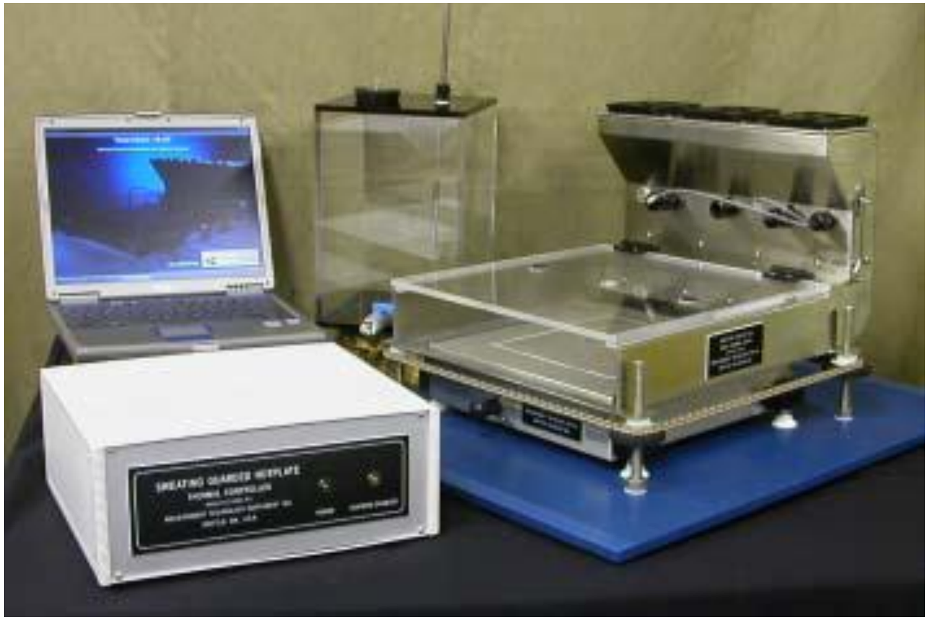


Hydrophobic/hydrophllic membranes

The Sweating Guarded Hotplate

Sometimes referred to as a skin model, the SGHP mimics the temperature and moisture of skin to measure :

- thermal resistance
- evaporative resistance



These values indicate a materials insulation and ‘breathability’ performance.

A convenient tool for assessing the screening performance of a textiles.

Valuable to be use in conjunction or as an alternative to physiological measurements.

Interaction between NTNU students and SINTEF

Industrial design students
Material students
Physiology students

Hege Torsvik: Master theses: Desinging work wear for the oil and gas industry

SINTEF

SINTEF Technology and Society

Statoil

Thank you

Presentation title

Presenters name

Presenters title

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