A

Seminar report

On

Smart Fabrics

Submitted in partial fulfillment of the requirement for the award of degree
of Bachelor of Technology in Computer Science

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Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

Preface

I have made this report file on the topic **SMART FABRICS**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to ……..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

CHAPTER 1

INTRODUCTION

1.1 SMART FABRICS

The world is distinctly rising towards the new era, an era of smart and intelligent discoveries; problem solving and creativity − the smart automobile vehicles (cars, metro system), intelligent jets, smart homes and amongst from many of such aristocratic paradigms, the 'Smart and Intelligent Textiles'.Before going further, a clarification of the term and definition of smart and intelligent textile is essential. There is a substantive difference between the terms, 'Smart' and 'Intelligent', Smart materials or textiles can be defined as the materials and structures which have sense or can sense the environmental conditions or stimuli, whereas intelligent textiles can be defined as textile structures which not only can sense but can also react and respond to environmental conditions or stimuli . These stimuli as well as response , could be thermal, chemical, mechanical, electric, magnetic or from other source . According to the manner of reaction, they can be divided into passive smart, active smart and very smart
materials:

1. Passive smart materials can only sense the environmental conditions or stimuli; they are sensors.
2. Active smart materials will sense and react to the conditions or stimuli, besides the
3. sensor function, they also have actuation characteristics;
4. Very smart materials can sense, react and adapt themselves accordingly;
5. An even higher level of intelligence can be achieved from those intelligent materials
6. and structures capable of responding or activated to perform a function in a manual or pre-programmed manner.
7.

CHAPTER 2

MATERIAL

For years the textile industry has been weaving metallic yarns into fabrics for decorative purposes. The first conductive fabric we explored was silk organza which contains two types of fibers. On the warp is a plain silk thread. Running in the other direction on the weft is a silk thread wrapped in thin copper foil. This metallic yarn is prepared just like cloth-core telephone wire, and is highly conductive. The silk fiber core has a high tensile strength and can withstand high temperatures, allowing the yarn to be sewn or embroidered with industrial machinery. The spacing between these fibers also permits them to be individually addressed, so a strip of this fabric can function like a ribbon cable. This sort of cloth has been woven in India for at least a century, for ornamental purposes, using silver, gold, and other metals. Circuits fabricated on organza only need to be protected from folding contact with themselves, which can be accomplished by coating, supporting or backing the fabric with an insulating layer which can also be cloth. Also, circuits formed in this fashion have many degrees of flexibility (i.e. they can be wadded up), as compared to the single degree of flexibility that conventional substrates can provide. There are also conductive yarns manufactured specifically for producing filters for the processing of fine powders. These yarns have conductive and cloth fibers interspersed throughout. Varying the ratio of the two constituent fibers leads to differences in resistivity. These fibers can be sewn to create conductive traces and resistive elements. While some components such as resistors, capacitors, and coils can be sewn out of fabric, there is still a need to attach other components to the fabric. This can be done by soldering directly onto the metallic yarn. Surface mount LEDs, crystals, piezo transducers, and other surface mount components with pads spaced more than 0.100 inch apart are easy to solder into the fabric. Once components are attached, their connections to the metallic yarn may need to be mechanically strengthened. This can be achieved with an acrylic or other flexible coating. Components with ordinary leads can be sewn directly into circuits on fabric, and specially shaped feet could be developed to facilitate this process. Gripper snaps make excellent connectors between the fabric and electronics. Since the snap pierces the yarn it creates a surprisingly

robust electrical contact. It also provides a good surface to solder to. In this way subsystems can be easily snapped into clothing or removed for washing.

The traditional textile and clothing industry is loosing its jobs and capacity in the Nordic countries as well as in the whole EU. The industry needs more value added products compared to the low cost imports that are flooding the market. Intelligent textiles and wearable technology is a new and exciting research and development area that cross-scientifically implants new properties into the traditional textile products, such as monitoring biosignals through textile embedded sensors, automatic thermal regulation based on phase change or shape memory materials, transfer of signals by means of fibre optics, etc.

Several research institutes in the Nordic and Baltic countries have carried out R&D projects on smart textiles and wearable technology on their own for the past eight to nine years. In 2003 it was felt that by joining forces more resources could be brought into the projects to better qualify for international funding, and NEST – Nordic Centre of Excellence for Smart Textiles and Wearable Technologies was established. The members of the CoE are SmartWearLab and Kankaanpää Unit of the Institute of Electronics of Tampere University of Technology, IFP SICOMP, Swedish School of Textiles, Danish Technological Institute, SINTEF and the Faculty of Design and Technology of Kaunas University.

CHAPTER 3

WORKING

Several circuits have been built on and with fabric to date, including busses to connect various digital devices, microcontroller systems that sense proximity and touch, and all-fabric keyboards and touchpads. In the microcontroller circuit shown in Figure 1, a PIC16C84 microcontroller and its supporting components are soldered directly onto a square of fabric. The circuit uses the bidirectional I/O pins on the PIC to control LEDs and to sense touch along the length of the fabric, while providing musical feedback to reinforce the sense of interaction. Building systems in this way is easy because components can be soldered directly onto the conductive yarn. The addressability of conductors in the fabric make it a good material for prototyping, and it can simply be cut where signals lines are to terminate.

One kind of fabric keyboard uses pieced conductive and nonconductive fabric, sewn together like a quilt to make a row- and column-addressable structure. The quilted conductive columns are insulated from the conductive rows with a soft, thick fabric, like felt, velvet, or quilt batting. Holes in the insulating fabric layer allow the row and column conductors to make contact with each other when pressed. This insulation also provides a rewardingly springy, button-like mechanical effect. Contact is made to each row and column with a gripper snap, and each snap is soldered to a wire which leads to the keyboard encoding circuitry. This keyboard can be wadded up, thrown in the wash, and even used as a potholder if desired. Such row-and-column structures can also be made by embroidering or silk-screening the contact traces.

All-fabric capacitive keyboard.

Keyboards can also be made in a single layer of fabric using capacitive sensing [Baxter97**]**, where an array of embroidered or silk-screened electrodes make up the points of contact. A finger's contact with an electrode can be sensed by measuring the increase in the electrode's total capacitance. It is worth noting that this can be done with a single bidirectional digital I/O pin per electrode, and a leakage resistor sewn in highly resistive yarn. Capacitive sensing arrays can also be used to tell

how well a piece of clothing fits the wearer, because the signal varies with pressure.
The keypad shown here has been mass-produced using ordinary embroidery techniques and mildly conductive thread. The result is a keypad that is flexible,

durable, and responsive to touch. A printed circuit board supports the components necessary to do capacitive sensing and output keypress events as a serial data stream. The circuit board makes contact with the electrodes at the circular pads only at the bottom of the electrode pattern. In a test application, 50 denim jackets were embroidered in this pattern. Some of these jackets are equipped with miniature MIDI synthesizers controlled by the keypad. The responsiveness of the keyboard to touch and timing were found by several users to be excellent.

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Outsourcing of textile and garment production from the Nordic countries started already 15 to 20 years ago. At the moment most of the bulk production is gone. The same development is currently taking place in Southern Europe. In conventional products, where the price is the main means of competition, a textile/garment company cannot compete with the low cost imports. But there are two areas where the low cost producing countries in the Far East are not competitive: demanding high tech products and fashion items that need to be brought quickly to the market.

Intelligent textiles and smart garments are new research and development areas that appeared in mid 90s. It was felt by the industry that by creating high tech products cross-scientifically, i.e. by combining electronics and other high tech components to the traditional textile products it would be possible to design totally new type of textiles, which are not vulnerable to low cost imports.

The researchers of SmartWearLab, one of the partners to NEST, have been involved in research and development in smart textiles for 7 to 8 years. The first project was developing a smart snowmobile suit jointly with several industrial partners, such as Reima, Clothing+, Nokia, Polar Electro and Suunto. The research team wanted to demonstrate with the prototype that smart garments can be designed and different type of wearable technology can be embedded in them. The project demonstrated to the research teams that this kind of products can only be developed by a joint effort of a team of different kind of specialists.

3.1 OBJECTIVE OF NEST;

The objective of NEST is to bring the leading smart textile and wearable technology know how of the Nordic and Baltic region under one umbrella, and to carry out research projects with internationally recognized break-through results. By combining cross-scientifically textiles, clothing physiology, electronics, communications, material science and other research resources of the member Laboratories and Institutes, joint projects with ambitious goals will be launched. The aim is also to turn NEST into an information bank on intelligent textiles and wearable technology, which will be able to contribute to general R&D work carried out by Nordic companies. NEST and its partners will gradually develop a portfolio of projects that qualify for Nordic, EU and national funding.

The objective of NEST is also to expand beyond the Nordic region and be part of larger R&D networks. Several of NEST partners are already members of such organizations as Textranet (www.itv-denkendorf.de/textranet), a network of European Textile Research Institutes and AUTEX (www.autex.org), a network of Textile Universities of Europe.

The European Apparel and Textile Organisation EURATEX published a survival strategy for the sector in December 2004, the "European Technology Platform for the future of textiles and clothing – A vision for 2020" (www.euratex.org/.....). The objectives of the Platform have been defined as:

1. Pool and coordinate research excellence across Europe, involving industry,academic world and research policy makers;

2. Develop a long-term strategic vision for the future of the industry and to set-up a corresponding roadmap for a structured development from today's situation towards the future vision;

3. Significantly improve access to necessary resources and general research and innovation framework conditions.

EURATEX is doing concentrated lobbying in order to get the needs of the textile and clothing sector observed in the different research programmes, which will be published within the 7th Framework Programme.
TEXTRANET and AUTEX, the two European textile research networks, are defining the existing expertise and potentials. The strategically most important fields have been defined by TEXTRANET as:

- Innovative finishing processes including process intensification strategies;

- Innovative processes for surface and bulk modifications;

- Smart and intelligent textiles;

- Textiles for enhancing human performance;

- Barrier and functional textiles for technical applications;

- Supply chain management and mass customisation.

As can be seen from this, smart textiles and their applications are considered to form a central entity for the future of the industry.
Smart textiles and wearable technology solutions give added value to a large variety of products. Potential application areas:

Health care, e.g. patients' clothes with integrated sensors, which follow the state of the patient and give a warning signal if it gets critical. This can make home instead of hospital care possible for large numbers of patients, which is preferable both for the individuals and for the society;

- Protective clothing for extreme working conditions, e.g. fire fighters, where the sensors give warning signals when the heat stress rises to dangerous levels;

- Technical textiles, e.g. paper machine clothing with on-line measurement of changes in thickness and profile or filter materials which change properties due to slow contamination;

- Sport and leisure wear: similar solutions as for protective clothing can be applied;

- Military clothing: many application possibilities both for vital signal transfer (e.g. wounded soldiers) and for smart material solutions (ballistic protection, moisture barrier properties, etc.)

3.2 START UP:

In order to organize the CoE in an efficient way NEST applied for start-up funding from Nordic Innovation Centre. The funding was to cover start-up procedures, web page design, and a Road-Show seminar that would introduce NEST and its objectives in all the participating countries. The ultimate goal was to create

projects where industrial companies from various Nordic countries and the Baltic area could jointly with the NEST partners carry out research and development in the area of smart textiles and wearable technology.

The core members of NEST are research institutes without direct commercial ties to companies or industry. The partners were found by search of all possible research institutes in the Nordic countries and Lithuania, which somehow are connected to textile research. Once the partners were found the most efficient networking method for connecting the CoE to the industry was decided to be a set of Road Show seminars, that were organized in each member country.

As mentioned already, traditional textile and garment manufacturing has widely been relocated to lower cost areas from the Nordic countries. The only positive future that can be seen for the Nordic textile and clothing industry is to concentrate in high-tech, value adding products and concepts. The objective of NEST is to be a research and development vehicle that will contribute to these industries through research and development, and in thisway help each Nordic country to preserve jobs and companies in this industry and on long run also create new businesses for high-tech applications.

3.3 MILESTONES:

Once the Consortium agreement was signed between the parties NiCe was approached for start-up funding, which was granted for a period of one year (01.03.2004-28.02.2005). It was felt between the parties that in order to get to know each other and to understand the strong points of each participant, a kick-off meeting had to be organized. In this meeting the goals and activities for NEST were decided.

The Consortium felt also that the existence and objectives of NEST should be introduced to the industrial partners throughout the Nordic countries and Lithuania. The best way to do this was to organize Road Show seminars that went around all the member countries, starting from Denmark and ending in Norway. At these seminar NEST and its targets were presented, and high-level presentations were held on what the international level of intelligent textile and wearable technology research currently is. The seminars were

half-a-day events with presentations, a coffee break and time for discussion and questions at the end.

After each seminar the host member contacted all the participants to find out what are the most interesting areas for future projects. In order to guarantee the interests of the industry, the Seminars were organized in cooperation with national associations of textile and clothing industry. This was important as one of the aims of NEST is to be a platform of high tech knowledge for the textile and clothing industry and on long run to improve the competitiveness of the whole cluster.

Three key presentations were the same in each country, followed by local presentation of various topics of interest.

CHAPTER 4

APPLICATION

Temperature Sensitive Fabrics:

From protecting body from harsh temperature to start thinking for the wearer, clothes have come a long way! This is the next generation of textile- the smart fabrics- the electronic wearables! This can not only keep the wearer warm or cool but also dry, moisturized, free from bacteria, allergy, odor and stains and at the same time monitor the heart rate, blood count and oxygen! Fabrics are really going to give a tough competition to human intelligence!.Not only protecting human body against heat and cold, the fabrics are now accepting the role of regulating body temperature. These heat modifying textiles are mostly used to make outdoor

garments such as hats, beanies, windbreakers and jackets. There are many techniques for making such clothes, one of which is- treating the fabric with paraffins. As the body gets hot, the paraffins become more liquid to let the heat pass out and as the body gets cold, it solidifies so that it keeps back the heat with the wearer. Some other fabrics that are wired up, conduct electricity for monitoring body temperature. At the same time, the inbuilt mp3 player can entertain the wearer! The amazing part is that, when made from conductive yarn, they are machine washable, wear and feel like any conventional clothing. They are the first generation smart fabrics, and guess what, the second generation smart fabrics will be treated with Inherently Conductive Polymers (ICP) allowing the fabric to transmit energy to heat and cool the body

4.1 Health Monitoring Fabrics:

SNow regular visits for health related tests can be forgotten! Wear the Health Monitoring Electronic Wearables and stay free of worries. The most prevalent among these health smart fabrics are the microencapsulated fabrics, especially in the natural health sector. The clothings enriched with substances like vitamins, algae or nutrients along with other substances to delay ageing or for improving blood circulation or other such benefits are fast becoming popular with the masses. Medically beneficial electrically conductive smart fabrics are no far behind. These life vests can track heart rate, ECG and body temperature. Now the research results are claiming to have developed a smart fabric that could warn its wearer of allergens, by glowing in response. The other health-enhancing electronic clothings include fall-detecting smart shirt that uses a built-in motion-detection hardware to detect if the user has fallen and can't get up. Really useful for older people! Then there is underwear having sensors woven into the fabric to detect heart rate. Some

of them can even dial emergency number if they detect a problem. Now, that's called a real smart fabric!!

4.2 Emergency Fabrics:

Although the health monitoring fabrics are in a way emergency fabrics only, yet certain other developments in the field of smart fabrics are in the pipeline that can really be called Disaster wear! A system is being developed to monitor the wearer and the outside environment which can be helpful for rescue workers like fire fighters. Some projects are aiming at stretchable electronics by developing conducting substrates within the very weave of fabric, which will allow sensors to move with the body. Many researches are aimed at using optical fibers because of their potential flexibility and their capacity to use light both as an information carrier and a sensor in itself. It can find applications in oximetry – a smart non-invasive way to measure the oxygen content of blood. Some projects are targeting at developing sensors which can measure body fluids like sweat, too, which will be very useful in sport wears. It will be able to measure the conductivity, electrolyte level, temperature and pH of the users' sweat, all very useful indicators for sporting applications.

CHAPTER 5

SOME INTERESTING SMART FABRICS

There are certain clothings that not only are an important landmark in the world of smart fabrics but are also very effective in handling day-to-day problems that look small but in fact which are very typical and sometimes embarrassing too. The new generation of wool fabrics, the moisture wicking wool helps in keeping the body dry by pulling moisture away from it. They are extensively used in active sportswear. Silver is extensively added to the composition of the fabric itself.There are certain clothings that not only are an important landmark in the world of smart fabrics but are also very effective in handling day-to-day problems that look small but in fact which are very typical and sometimes embarrassing too. The new generation of wool fabrics, the moisture wicking wool helps in keeping the body dry by pulling moisture away from it. They are extensively used in active sportswear. Silver is extensively added to the composition of the fabric itself. Its not that the smart fabrics are only used in making clothing. Certain other products are also been made for the comfort of human kind. There are bags that have iPod controller built into the strap. Thus, the user can control music when even the iPod stays in the bag. Not only this, the bags keep the valuable items protected from thieves, weather, and bumps and scratches too! Then there are hi tech portable fabric keyboards that can be rolled up when not in use so that they fit into a pocket or a handbag! They are full size typing surface that can pair through bluetooth to smartphones, PDAs & other hand held devices to give the users a totally mobile office.

5.1 Future projects

After the Road show seminars each NEST member contacted the companies that participated in the seminar in order to find out research and project ideas. Several telephone meetings were held during autumn 2004 for defining the project ideas. The following project topics were agreed for further preparation:

(A) Textile sensors and actuators – this project has already been prepared and the application was filed into an EU funded IP-SME program in March, 2005. SINTEF is the project leader for this project. The project is as follows: NMP Integrating and strengthening the European Research Area Nanotechnology and nanosciences, knowledge based multifunctional materials, new production processes and devices FP6-2004-NMP-NI-4 3.4.4.4 Multifunctional technical textiles for construction, medical applications and protective clothing - IP dedicated to SME's Integrated Project SENSORS AND ACTUATORS IN FIBRES AND TEXTILE STRUCTURES Next generation of smart clothing for work, sport and leisure in cold climate Acronym: COLDWEAR The overall objective of the project is to develop technology for a new generation of protective clothing against the extreme conditions of cold and cold/wet environments through the implementation of sensors and actuators in fibers and textile structures. The developed "smart" solutions will be integrated into demonstrators and tested to optimize the regulation of the wearer's heat content and contribute to their protection, comfort and safety.

- Sensors in the textiles able to detect conditions (both in the environment and on the person) that bring along increased risk.

• Actuators to; o prevent accidents by sending out an warning signal when hazardous conditions have been detected and; o react by providing a change in structure that protects the wearer

As stated in the recently published "European Technology Platform for the future of textiles and clothing", the future of the European textiles and clothing sector will increasingly depend on the industry's ability to relentlessly innovate in its products and to focus its business operations on the constantly evolving needs of its customers. SMEs, the majority of textile and clothing manufacturers in Europe, generally do not have own resources to perform highly specialized product development projects, but rely on the services of research institutes and universities. An international consortium was established for this project with participants from different EU countries:

Participant no.	**Participant organization name**	**Participant organization short name**
1 (coordinator)	SINTEF Prof. Randi Eidsmo Reinertsen	SINTEF (RTD)
2 (leader)	Norrøna Sport AS, Norway Managing Director Jørgen Jørgensen	Norrøna Sport (SME)
3	Helly Hansen ASA, WorkWear, Norway Vegard Berg	HH (SME)
4	Mosjøen Veveri, Norway Managing Director Torgeir Markhus	Mosjøen Veveri (SME)
5	Norsk Fiberpels AS, Norway Managing Director Svein Ove Martinsen	Norsk Fiberpels (SME)
6	Dale AS, Norway Managing Director Jan Cleveland	Dale AS (SME)
7	L.Michael Oy, Finland Managing Director Lorenz Michael	Michael Oy (SME)
8	Nokian Jalkineet, Finland Tuire Erkkilä	NOKIAN (SME)

9	Swix Sport AS, Norway Erik Stensrud	Swix Sport (SME)
10	SmartWearLab, Tampere University of Technology, Finland Dr Harriet Meinander	SWL (RTD)
11	Institute of electronics, Tampere University of Technology, Finland Prof. Jukka Vanhala	TUT (RTD)
12	IFP Research AB, Sweden Pernilla Walkenström	IFP (RTD)
13	Shishoo Consulting AB, Sweden Prof. Roshan Shishoo	SHI (RTD)

Smart textiles and clothing, which use either interactive materials or integrated sensors and IC technologies, offer a totally new and added-value dimension to products. In protective clothing for work and leisure activities, smart solutions can substantially increase the protective, comfort and safety properties, thus have an impact on the work and leisure of the European citizen, and the competitive ability of European manufacturers.

Due to the climate in the Nordic countries in combination with the long coastlines, a culture of functional clothing for cold and cold/wet environments has developed. As a result, many Nordic companies have specialized in protective clothing against cold and wet for both outdoor winter work and sport wear, and follow the requirements of the respective EN-standards. However throughout Europe there is a need for such protection in a number of situations including, as an example, artificially cooled cold stores.

A multidisciplinary consortium with representatives from different types of companies in the supply chain and different technology expertise is necessary to successful develop smart protective clothing in defined conditions. Knowledge of textile and component materials, sensor technologies, ICT, and thermal physiology

can then be applied to industrially producible products, which can be marketed worldwide.

5.2 RFID technology in textile substrates – a project for embedding a transponder and an antenna in yarns, which can be woven into textile fabrics. Project is currently under preparation with SWL as the project leader.

RFID technology has made it possible to identify products from a certain distance by reading the data stored on a microchip. Data reading is done with a special reading device that creates a magnetic field around the tag, like between the gates at the store entrances that prevent stealing. A hangtag or a label attached to garments may be a smart label, which contains information regarding the size, color and style number, all of them necessary for identifying the product.

This information is normally displayed also in a written form both for consumers and the retailer to read. Smart labels enable product identification without actually pointing the reading device at something like a bar code. This is time saving in production, distribution and at the retail store.

Other ways of attaching microchips to textiles is by coating the chip and antenna to the textile or by weaving them directly into the textile structure. Conductive yarn connected to the microchip could be inserted into woven textiles as weft yarn at certain intervals. The yarn would be used as an antenna since with UHF-technology the antenna does not have to be a coil. Producing yarn that contains the conductive fiber plus the chip, for example as a core, is a challenge. Further challenges will be how to weave it into the structure and how to make it durable enough for dyeing, finishing and industrial washing.

Garments or home textiles containing such chips could be used by for example laundries that lease work wear or institutional textiles. When the textiles are returned back for washing they can be identified by the chip and returned back to

the correct user. Piracy is a serious problem also in the fashion trade. Many multi-national brands fight continuously against trademark copying. RFID based smart tracking technology can be used for protection against stealing or copying, since it can be hidden into the product. Controlling of deliveries, handling of returns and customer identification are other areas where the technology can be used.

5.3 Smart automobile interiors – a project idea that focuses on intelligent solutions in truck and car cabins. A meeting will be organized with the main Nordic technology players in this area in order to define targets for this project. IFP has the leading role in this project.

A large part of truck and car interior is made of fabrics and textile fibres, which can hide as well as contain electro-conductive fibres for signal transferring. Optical fibres could be used for illumination. It is possible to weave fabric of optical fibres and use it as light source. In this way the textile part of the cabin ceiling would light up. Air bags are good examples of textile safety devices in cars. Textiles could be used for other type of safety use, for example for shock absorbing.

5.4 Military applications – targets and activities within this project will be prepared jointly with the defence forces of Norway, Denmark, Sweden, Finland and Lithuania. Once the targets are defined the leader for this project will be decided.

Despite of national security issues the Nordic military forces already cooperate in research and development, and NEST could be a new Nordic network for enhancing such cooperation.

5.5 Executive Summary

The traditional textile and clothing industry is loosing its jobs and capacity in the Nordic countries as well as in the whole EU. The industry needs more value added products compared to the low cost imports that are flooding the market. Intelligent

textiles and wearable technology is a new and exciting research and development area that cross-scientifically implants new properties into the traditional textile products, such as monitoring biosignals through textile embedded sensors, automatic thermal regulation based on phase change or shape memory materials, transfer of signals by means of fibre optics, etc.

Several research institutes in the Nordic and Baltic countries have carried out R&D projects on smart textiles and wearable technology on their own for the past eight to nine years. In 2003 it was felt that by joining forces more resources could be brought into the projects to better qualify for international funding, and NEST – Nordic Centre of Excellence for Smart Textiles and Wearable Technologies was established. The members of the CoE are SmartWearLab and Kankaanpää Unit of the Institute of Electronics of Tampere University of Technology, IFP SICOMP, Swedish School of Textiles, Danish Technological Institute, SINTEF and the Faculty of Design and Technology of Kaunas University.

NEST was granted start-up funding from the Nordic Innovation Centre. At the kick-off meeting the objectives and the principles of networking were decided. Road Show seminars were held in all the member countries for introducing NEST to industrial companies and other research institutes. The seminars were a great success with 50 to 150 participants. The seminars presented the objectives of NEST as well as highlighted the current level of international smart textile research. The members of NEST have also participated in several international conferences.

After the seminars the industrial company participants were contacted in order to find out which R&D areas they are interested in and whether they would be willing to participate in joint projects. Textile based sensors and actuators, textile embedded RFID technology, intelligent automobile interiors and military applications were identified as areas of highest common interest. A project

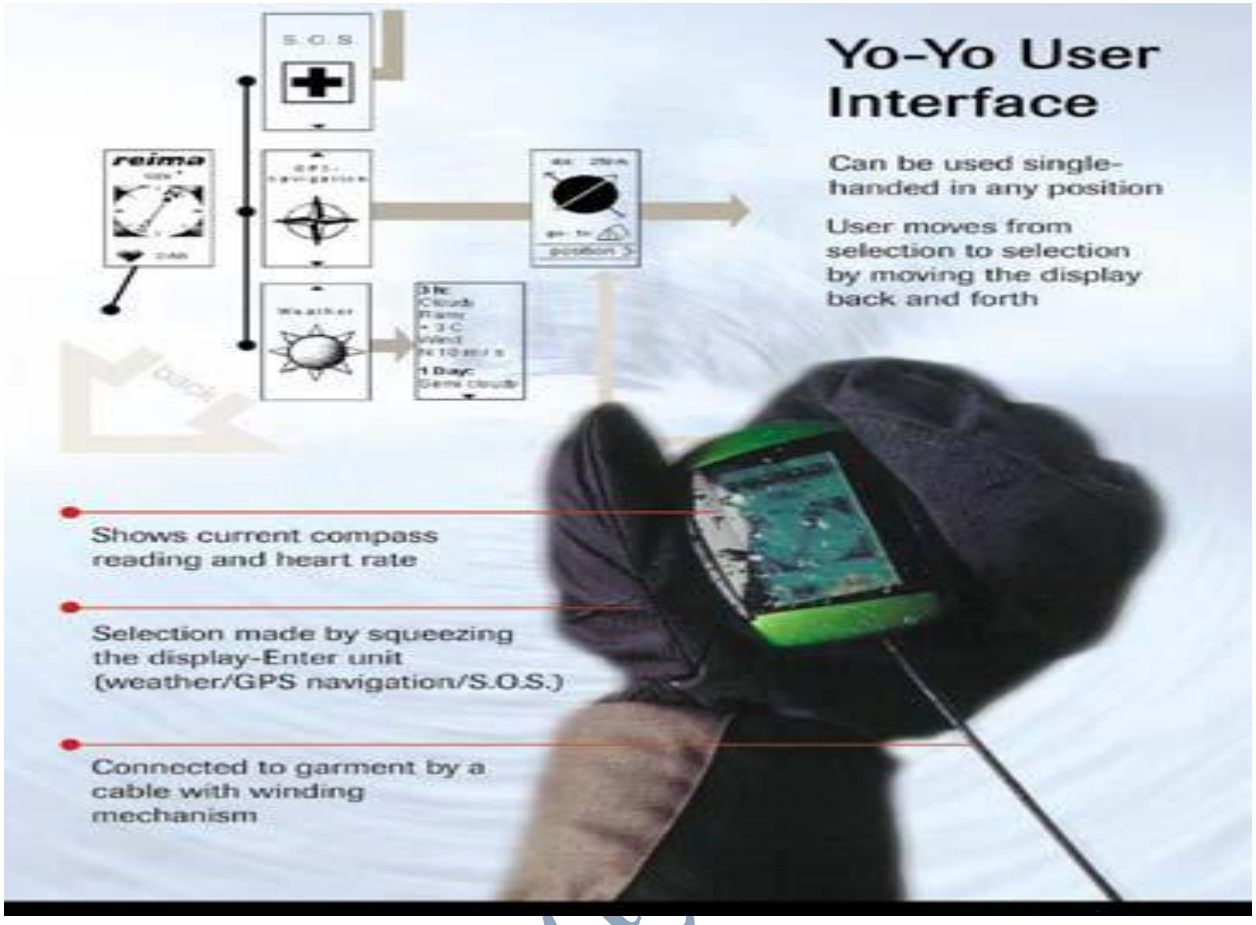
proposal on sensors and actuators has already been filed in for EU funding. The other projects are currently under preparation.

Due to the seminars the CoE received wide media coverage throughout the Nordic and Baltic region. Articles appeared in industry magazines, newspapers and there were TV and radio interviews. The aim of NEST is to continue promoting the network by research papers and articles about future projects mainly through web page and other publications.

Despite of the successful first year, a lot of work is still needed. A database will be created around smart textile and wearable technology solutions. Web page will be up-dated and renewed continuously. Future communications between the members will be done through meetings and telephone conferences, which in fact were excellent and efficient ways of communicating when NEST was established. In the future NEST will contribute to Nordic well fare by encouraging SMEs and research institutes to work together in the area of smart textiles and wearable technology.

5.6 Background

The total number of jobs lost in the EU textile and clothing industry during the past 14 years is 1.3 million, mainly due to fierce import competition in traditional product categories. The textile and clothing sector in the Nordic countries has for years suffered under severe competition from low cost imports from Eastern Europe and Asia. This has resulted in a number of closures of industrial operations or in transfer of technology and manufacturing to the low cost countries. Companies with standard products have been hit the most.



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The Road Show seminars proved to be very successful in terms of participation and media coverage. Each seminar had an audience between 50 and 150, both from industry and from research institutes. (See programs in Annex). Before each seminar and during the seminars NEST was promoted through various types of media (trade magazines, daily news papers and even TV).

The members of NEST participated also in international scientific conferences and presented research papers in:

• 'New Generations of Wearable Systems for eHealth – Towards revolution of Citizens' health and life style, Pisa, 11-14 December, 2003

• ‘New Technology and Smart Textiles for Industry and Fashion’, London December 1-2, 2004

• ‘Smart Fabrics 2005’, Barcelona 7-9 February, 2005

the future projects will be presented together with scientific and popular papers to be written on the projects. Also access to the knowledge database will be available through the web site once the future projects produce such information.

Due to limited funds it has not been possible to organize meeting between the partners, beside the kick-of meeting and the Road Show seminars. But several telephone conferences held during the year turned out to be a very practical and efficient way to discuss the targets and activities of NEST.

Danish Technological Institute established a knowledge platform in Denmark regarding intelligent textiles based on textile magazines, conference papers and supplier information. All the seminar participants were visited in order to identify further activities in the field. So-called idea generation workshop "New Smart Textiles" were offered to interested textile and clothing companies.

Smart and intelligent textile. There is a substantive difference between the terms, Smart and Intelligent, Smart materials or textiles can be defined as the materials and structures which have sense or can sense the environmental conditions or stimuli, whereas intelligent textiles can be defined as textile structures which not only can sense but can also react and respond to environmental conditions or stimuli. These stimuli as well as response, could be thermal, chemical, mechanical, electric, magnetic or from other source.[1]

Smart Fabric has several meanings. Smart fabrics are ones which can change/react automatically to their surroundings. Smart fabrics (-or intelligent textiles) are being developed to be able to sense what is happening to the wearer or its immediate surroundings. An example of this would be its capacity to know when the wearers heart rate spikes or drops unexpectedly, then being able to send such information to a paramedic of some description. A very common type of smart fabric is Gore-Tex, called a smart fabric because of its material properties to let water or moisture flow in one direction and not the other. There are two more modern types of smart fabrics, one using nanotechnology such as carbon nanotubes or fireproof treatments, the other a combination of electronics and conductive fabrics for sensing a persons vital signs. Examples of these include Zephyr Technology BioHarness, that can also be built into a shirt or bra strap. Biological monitoring technology has also been adopted by mainstream consumers in the form of the Numetrex Adidas heart rate monitoring garments, which combine with smart fabrics with advanced knitting technologies.

The promise of smart fabrics is that every day clothing will be able to perform the task of comfort and protection more effectively or add internet connectivity to allow people to be looked after when something goes wrong.

Integrating intelligent textiles into clothing is an exciting new field, which opens up a vast arena of applications. With revolutionary advancements occurring at an unprecedented rate in science and electronics the possibilities offered by wearable technologies are tremendous. As the technologies become more refined so that complex systems can be embedded unobtrusively in everyday clothing they will soon be more and more commonplace in commercial products.

Part one of “Intelligent Textiles and Clothing” is dedicated to phase change materials (PCM), part two explores the emerging field of shape memory materials (SMM) in some detail, the third section deals with chromic materials (colour change) and conductive materials. The final section of the book looks at current and potential applications.

“Intelligent Textiles and Clothing” draws on knowledge from a number of disciplines, including electronics, textiles, telecommunications, biotechnology and medicine. The chapters represent an outstanding panel of international experts bringing a wealth of information together. This is an essential guide for all electrical, textile and biomedical engineers as well as academics and fashion designers.

Smart fabrics coating and laminates

coatings and laminates allow for the introduction of smart functionalities for textile products. They are suitable for a wide range of textile applications and can contribute to improving product performance. This pioneering book will be a valuable reference and stimulus for developing and improving coated and laminated textile products. The first section of the book covers the fundamentals of coatings and laminates. Themes range from coating and laminating processing and production techniques to testing and quality assurance. The remainder of the book covers different types of smart coatings and laminates such as intelligent weatherproof coatings, phase change coatings and nanotechnology based coatings.

Fabrics Testing

The textile industry is becoming an increasingly competitive environment. Differentiating products is therefore important and this can be facilitated through improving quality. Testing can be used to improve product quality and achieve compliance to international, regional or retailer specific standards. This book provides a welcome and much needed review of the current range of tests available for fabrics. The reader is presented with a systematical review of topics, ranging from how to test fabric structure to the testing of intelligent fabrics. A valuable resource for researchers, professionals, academics and students within the textile field.

Surface modification of textiles

The surface of textiles offers an important platform for functional modifications in order to meet special requirements for a variety of applications. This book will provide the reader with fundamental issues of surfaces and their characterisation, it will also explore the exciting opportunities for surface modification of a range of different textiles. Introductory chapters review some important surface modification techniques employed for improved functional behaviour of textiles and the various surface characterisation methods available. Further chapters examine the different types of surface modification suitable for textiles, ranging from the use of plasma treatments, physical vapour deposition to the use of nanoparticles. Concluding chapters discuss develop surface modification strategies for various applications of textiles.

Interior textile

This book provides an overview of the advances that have occurred within the interior textile sector. The reader will gain an understanding of the technical,

functional and aesthetic properties of interior textiles, the understanding of which, can assist in selecting the most appropriate fabric. Introductory chapters provide the fundamental principles of interior fibres; Describing the types, structures and requirements. A second set of chapters reviews the main developments in the industry, such as recent environmental perspectives affecting the industry and developments in flame retardant textile materials. A third set of chapters conclude with applications and case studies including a chapter on textiles for carpets.

Polyesters and Polyamides

Polyester and polyamide continue to account for the vast amount of synthetic fibre usage. Current developments are leading to continued improvements in the properties and performance of these fibres. This important book begins with a review of the chemical and physical properties of each fibre and their manufacture. Part 2 analyses how the functionality of polyester and polyamides can be improved. The final sequence of chapters provides examples of how the fibres are used in applications such as sports and automotive products. This book is an essential reference for anyone involved in the research or development of polyester and polyamide fibres.

Advances in Wool Technology

Advanced research into wool science is leading to a better understanding of the properties of wool. Consequently wool is increasingly being seen as a high performance fibre, with new modifications and applications. Advances in wool aims to present a comprehensive account of these innovations. Part 1 includes advances that have occurred in the production of wool. Chapters include the progress in wool spinning and the role of enzymes for improved wool production. Part 2 reviews new wool products and applications. Topics include brighter wool, intelligent wool apparel and wool for medical textiles. This book is a valuable reference and a stimulus to improve wool and its end performance.

Advances in Carpet Manufacture

Carpets remain an important sector for the textile industry. This comprehensive book will provide an overview of the latest developments and innovations that have occurred within the carpet industry. Chapters include key topics such as the types of textiles used for carpets and the structure and properties of carpet fibres. Subsequent chapters discuss the developments in carpet manufacturing methods, woolen carpets and the advances in textile sports surfaces. An interesting case study on handmade carpets is also provided. Advances in carpet manufacture presents current research from leading innovators from around the world and is a valuable reference for those wishing to improve carpet and its end performance.

CONCLUSION

NEST has proven to be very successful in bringing together research and product development know how within the Nordic region. Setting up the CoE and networking its members was supported by Nordic Innovation Centre. This made it possible for the various members to meet and agree about strategic targets for the CoE. As described above, NEST is actively preparing R&D projects that involve industrial partners in various Nordic and Baltic countries.

During the first 'kick-off' year a wide media coverage was achieved in all countries. As result NEST is now well known by the industrial companies as well as by various research centres in the whole EU area. The textile and clothing industry associations in the Nordic countries have also shown interest towards NEST – in fact most of the Road Show seminars were supported by them.

Of course, NEST is not ready. Beside launching projects more effort will be needed in order to establish a high quality knowledge bank on smart textiles and garments. This database will serve both industry and research. High level publicity and promotion will also be maintained. The aim is to write scientific and popular papers of the future projects. The current web site will also be renewed and up-dated continuously.

As described above NEST has resulted in new initiatives in the participating Universities and research centres, for example in Lithuania, Norway and Finland. These will contribute to the domestic research and industry and will encourage SMEs to participate in national and international research and development in the area of smart textiles and wearable technology.

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