



Knowledge Based Process Control System to Optimize Needle Performances for High Added Value Needle Punched Nonwovens

Contract no. COOP_CT-2005-018221
Co-operative research Project



FINAL PERIODIC ACTIVITY REPORT

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Content:

<i>Publishable Executive Summary</i>	3
<i>Section 1. Project Objectives and major achievements during the reporting period</i>	6
<i>Section 2. Work package progress of the period</i>	9
<i>Section 3. Consortium Management</i>	26
<i>Section 4. Other issues</i>	29
<i>APPENDIX 1: SME and RTD contribution and cooperation</i>	32
<i>APPENDIX 2: Plan for using and dissemination of knowledge</i>	42
<i>1. Exploitable knowledge and its use</i>	42
<i>2. Dissemination of knowledge</i>	45
<i>3. Publishable results</i>	52
<i>APPENDIX 3: IPR and Know-how Transfer Agreement</i>	53



Publishable Executive Summary



Project objectives

The process technology for the needling of the fibre webs is characterized by needle design, needle density per working width, stroke frequency, feeding and delivery speed. Fineness, design (amount and location of barbs) and strokes of the needles determine the degree of consolidation of the felt.

The performance and quality of the felt heavily depend on the number of fibres which are reoriented at each penetration of the needles without damage and on how many penetrations per unit area are made. The wear of needles strongly affect final performance and quality as the barbs wearing causes a much decreased reorientation of the fibers. This issue becomes even more important when processed reclaimed fibres or recycled material are used for different products in the automotive or other industries. The load acting onto every needle is then highly increased by the in-homogeneity of the delivered fibre web of recycled material. Impurities and thickenings lead immediately to massive needle breaks and the production must be terminated. Currently, quality control of nonwoven felt is limited to the visual control performed by an operator. Then, according to usual in house procedures, samples of felt are tested in local laboratories, in order to check web strength and permeability

The innovation idea of this project is to investigate simple measurable variables in connection with the needle performance. These measurable variables together with the application of the mathematical model relating nonwoven quality against needles tool abrasion, they will allow to predict the needle aging and breakage and resulting lost of nonwoven quality. A High-Speed Multi-Sensor approach is taken into consideration for development of an automatic *on-line* control system for needle-punching machine, that able to control in real time the performances of the needles, and to monitor and predict their aging.

On-line quality control of the product coming out of a the needle-punching line is a valuable add-on to production facilities; this allows to minimize the operator effort related to visual control of felt quality, thus saving a remarkable amount of costs in the daily work of workshop laboratory. It also helps in decreasing amount of nonwoven wasted because of a late *off-line* observation.

The MULTIsensor based nonwoven QUality Prediction System (MUQUPS) was developed under EC FP6 project no COOP CT_2005_018221: "Knowledge Based Process Control System to Optimize Needle Performances for High Added Value Needle Punched Nonwovens

Contractors

To reach assumed goals as above the Consortium is composed of three RTD performers skilled in:

- nonwoven technology: Sachsisches Textilforschungsinstitut e.V. from Germany,
- sensing technology: SKA Polska from Poland
- computer science technology dedicated to the control systems: D'Appolonia from Italy

and of five SME partners those involved in:

- nonwoven manufacturing: Speritex from Italy skilled in the production of filtering nonwovens, Geotextil Westsachsen from Germany skilled in the geotextiles and Konus Konex from Slovenia skilled in the artificial leather and belt conveyers production
- nonwoven manufacturing equipment development: Technoplant from Italy
- control and monitoring system development: CIM-mes Projekt from Poland

Results

After 26 months of research and development under NEEDLES project, a new tool for nonwoven quality “on line” monitoring was developed. . That application will allow to decrease costs of low quality production thanks to a more exact information on time to maintenance parameter, according to demanded level of production quality. It also allow a strong reduction of cost due to wasting of low quality nonwoven product which cannot be used and commercialized.

Last but not least, factor of elaborated solution is lowered requirement for laboratory quality control thus, decreases of laboratory man-hours cost and samples measurements costs

The most innovative functionality developed with MUQUPS system consists in the *on-line* prediction of the governing quality parameters for nonwoven, performed during manufacturing process. Innovation of that approach lies on the prediction of nonwoven quality loss acquired through direct and indirect evaluations of needles breakages and abrasions.

A multisensor technology was introduced and used for needle-board sensing (needle breakage) and consequent evaluation of its performances. That information has been correlated with manufactured nonwoven quality. Two possible measures to predict web quality have been applied: the first one uses a threshold of lost needles to detect lost needles pattern, while the second one uses a threshold to assess stitching density value.

Knowledge dissemination

An extensive knowledge dissemination was performed along the project duration towards the SME Consortium partners. Internal dissemination was indeed applied for all those pieces of knowledge highly sensitive against protection of IPR. On the other side, public information on the project objectives and non confidential results are accessible through project web-side at www.cim-mes.com.pl -> “Obliczenia analizy”-> “Needles” and www.dappolonia-research.com/needles. Also for public use product leaflet and poster were edited. The dissemination paper as well as technical paper have been prepared; they are however on stand for public presentation until the patenting strategy will be accepted by all Consortium Participants.



Figure 1. Product leaflet - cover

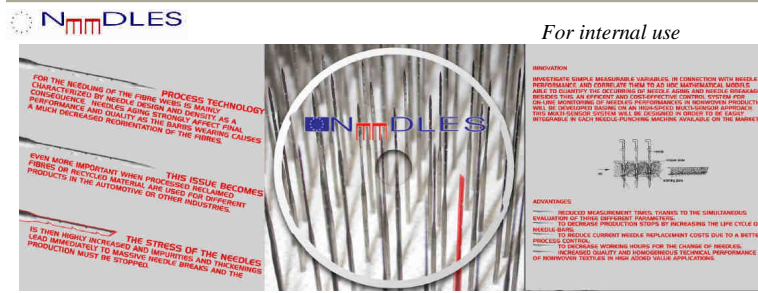


Figure 2. product leaflet – internal part



Figure 3. Product Poster.



Section 1. Project Objectives and major achievements during the reporting period

General Project Objectives

The main **strategic objective** of NEEDLES project was to increase the competitiveness of the European nonwoven textile sector by providing a cost-effective monitoring system able to optimally control the status and the performances of the needles in the needle-punching machine, during nonwoven textile manufacturing process.

The increase in the competitiveness was assumed to be achieved through an improvement of the quality of the produced nonwoven fabric. This is a benefit for the end-users, who are expected to save 40% of the needle cost, as well as to reduce the production of low quality textile fabric. Besides this, the expected life-cycle needle-bar shell increased by above 15 million cycles, thanks to the more precise “time to maintenance” periods implementation, while the working hours for needles replacing will be reduced of 30% and the occurrence of nonwoven defects has been evaluated to decrease by estimated 30%.

These reductions imply a decrease of nonwoven webs (mainly man-made fibres) annually landfilled due to unacceptable quality levels (at the moment around 19 millions of tons), with high impact on the environment. From a **societal** point of view the decrease in waste production (non-usable web and broken needles) will contribute to safety for the environment. Quality of life for the operators involved in needle replacement will also increase as today they are mostly visually identifying broken needles in the carrying bar.

To improve above socio-economical pre assumptions as well as to study the possible exploitation scenarios, Consortium Partners released for internal purposes their economic data. The feasibility study disclose the justified investment into considered monitoring system on the level of 35 k€, when 60% depreciation rate and 10% needle cost and 10 %manhour decrease costs are is considered.

Main **technical objective** reached during NEEDLES project was development of a “on line”, production monitoring system which allows to predict and to prevent critical defects in nonwoven production and “lost of nonwoven quality”. **The targeted performance in terms of accuracy was elementary needling area 8x8 mm², and in terms of production process parameters - in a range of 1500-2500 strokes per minute and with a production range from 1 to 20m/min.** The considered control and measurement system allows to introduce the new added value to the present state of art in the nonwoven machinery through its completeness of acquisition of parameters, which are crucial for the quality of nonwoven manufacturing. That is the variations of the needles load – the measure of needles degradation and needles presence/absence in the needle board – the measure of needle board degradation. The complex evaluation of considered parameters allow to evaluate “the time to failure” for needle board module. It is expected that the nonwoven machinery equipped with considered control system allow to decrease “low quality” nonwoven production dramatically. That feature is achieved through a multi-sensor approach, which is based on the combination of inductance or optic sensors and on the sophisticated data processing, where patterns of lost needles are identified and stitch density are calculated and prompted onto operator console in the real time.

As a consequence, the main **scientific and technological objectives** which shall be highlighted are the following:



- development of the high-speed multi-sensor subsystem able to monitor the status of the reference parameters;
- development of a cost-effective control system with an efficient user interface for monitoring the nowoven production on-line equipment.

Final Project achievements:

The results: monitoring methodology and monitoring system for nonwoven quality prediction during manufacturing process were tested in the laboratory environment, and evaluated in the industrial environment .

In the reporting period the following RTD tasks have been performed:

- Task 1.1: Investigation and analyses
- Task 1.2: Definition of the experimental needle abrasion and breakage
- Task 1.3: Analyses of relationship between process parameters and quality criteria
- Task 2.1: Mathematical model for nonwoven applications
- Task 2.2: Design of the control system
- Task 2.3: System development
- Task 3.1: Multi-Sensors Control Software Interface
- Task 3.2: Multi-Sensors Control software database
- Task 3.3: Automation and control software
- Task 4.1: Basic equipment and development
- Task 4.2: Prototype Installation and testing
- Task: 4.3: Software Installation and testing
- Task: 4.4: System adaptation and configuration control
- Task 5.1: In plant trials
- Task 5.2: System evaluation and demonstration
- Task 6.1 Protection of Intellectual Property Right
- Task 6.2 Marketing Strategy and Feedback
- Task 6.3 Training, Exploitation and Dissemination

The development related with NEEDLES project proceeding was effectively done with all Consortium contractors:

STFI, DAPP and SKA as RTD performers, which processes the research and development activities and CMS, GWS, KK, SPERITEX and TECP as SME partners which supplied Consortium with their deep knowledge about process to be monitored, design limitations resulting from the machine functionality and techno-economical limitations.

The Final Consortium Assembly took place in the last day of project duration i.e. November 14th, 2007 in D'Appolonia subsidiary located in Milan, Italy.



Problems encountered and corrective actions

Some delays in the prototyping of components which are fundamental for the integration of the sensing part of the detection system, namely plastic carcasses for coil sensors appeared. Due to these delays, Consortium applied for amendment for project extension by 8 weeks. The EC accept that application and final project duration was set to 26 months instead of 24 months.

Other scheduled activities were efficiently performed by all committed partners, the work was well mirroring the main project objectives and results are promising for further exploitation.



Section 2. Work package progress of the period

In the reporting period work package WP1 (continued according to the Consortium decision) and WP5 led by RTD Performer STFI, WP3 and WP4 led by RTD Performer DAPP and WP6 led by CMS were completed according to the DoW guideline.

Workpackages objectives and progress

WP1 was completed with investigation in needling process for the identification and quantification of performance loss regarding to needle breakage. The relevant parameters for the needle-punching production processes and needle loom manufacturing equipment were identified. However, as the tool wear progress identification needs long time period testing and observations, during Technical Meeting held in Warsaw in April 2006 the Technical Committee decided to prolong the needle tool performance testing upto the end of project duration. It shall be also pointed out, that the testing follow up behind the limits of WP1 does not influence the budget premises. That decision does not conflict with monitoring system development, as the necessary data may be loaded to the data base system during all over time of project duration (as well as later according to the knowledge paradigm based approach). The survey from a sensor point of view was done in order to find the multi-sensor equipment that one best addressed to the identified requirements. Objective relations between nonwoven quality and needles wear were established. As the abrasion process for needles shall be observed in the long term and a number of fundamental research works had to be done for single needle punching force identification, according to the General Assembly (Technical Meeting) decision undertaken during 6-month meeting and confirmed on 12 month meeting see appropriate m.o.m, the WP1 duration was extended up to the end of the project. The result of investigation allowed to identify the relevant nonwoven quality parameters, those possible for observation or for recalculation and estimation. Also that investigation allowed to select proper sensor solution for expected monitoring purposes. Extensive investigations were supporting the possibility for direct and indirect single needle load measurement. The WP1 has resulted in Deliverables 1, 2 and 3 and in amendment for D2 – result of second year activity

WP2 activity covered assumed objectives. Starting with mathematical modeling and results of WP1, the suitable configuration and set-up of the chosen sensors were done. Based on WP1 research, classification of parameters relevant for mechanical properties were implemented into data structure and data base structure. Premises for knowledge self-learning system were included into software structure. Finally, the strategy for sensors type selection was approved. To verify the sensors selection and design decisions, the monitoring system preprototype were developed for laboratory testing purposes. WP2 was effectively closed with the design of the first preprototype of the control system for needle-punching process - Milestone 2, see also Deliverable 4 and the Deliverable 5 as physical model. The preprototype was extended with needling simulator device.

WP3 allowed to develop the software interface of the control system and its main routines. The software and data base solutions were implemented to recognize first patterns of broken needles – those decision making for production termination. Also the sophisticated interface between processing unit and multisensor device was elaborated. Non reportable



results consist of the software code see also - Deliverable 6, 7 and 8. According to DoW premises, under progress there is the development of algorithms for the comparison of measurements and the real time process control. The software and data base solutions were implemented to recognize first patterns of broken needles – those decision making for production termination. The option for stitch density evaluation was implemented according to results of Task 3.1, and 3.2 as well as study of WP1 results. Also the sophisticated interface between processing unit and multisensor device was elaborated. Finally the set of prototype software for monitoring system as well as a set of software to complete demands of testing routines were prepared. That includes the detection of broken needle on the Needle Board including the multisensor board identification, the evaluation and classification of lost needle pattern, if any, and the calculation of an appropriate stitch density characteristics. The software also accounts the possibility for identification and virtual observation of the every needle status (i.e. visualization of the needle damage) and log writing into data base. Last but not least, the additional software to simulate the behavior of multisensor boards were created – that allowed to test the monitoring software in virtual environment. Deliverables 6, 7 and 8 documents that segment of work.

The objective of WP4 was the integration of the developed sub-systems with the software codes into a basic prototype for system calibration and update. The monitoring software being tested on the pre-prototype has been implemented into industrially tested prototype. To facilitate the assembling procedures and testing process, for that phase the STFI research facilities were decided to use. Previous experiences of technological partners involved in manufacturing needle-punching equipment (TECP) was joined to RTDs knowledge to perform the integration of the hardware systems, the software installation, the calibration of the multi-sensor sub-system and the integration of the whole system in the production environment. According to the 12 month General Assemble Meeting conclusions, two type of MS boards were considered: the one based on inductance phenomena (MS-500-c) and one – on optic phenomena (MS-500-o). Necessary testing measurement platforms for mechanical, optoelectronic and electronic as well as testing program were prepared and implemented for tests.

As the result of work package 4, the set of hardware elements and components were created. The hardware and software were implemented in the production environment according to the experience of SME partners. Deliverables 9 and 10 documented that part of the project.

WP5 activity of that work package was focused on the multisensor monitoring system trial and performance observation. Tests were undertaken to observe the functional performance of monitoring system as an electronic device and as a tool for nonwoven quality observation. The undertaken activities were continuation of WP3 and WP4 in the industrial environment being able to access in the STFI production facilities. In 2007, three test series were undertaken. Tests were conducted in industrial environment during processing of nonwoven material. For testing purposes the geotextile were used. The solution was demonstrated to SME Partners. The undertaken test demonstrated the proper behavior of electronic components. Also presented GUI was evaluated as efficient one for industrial monitoring purposes. Deliverables 11 and 12 documented that part of the project.

Scope of WP6 was to facilitate and encourage the industrial and commercial exploitation of the project results and to define the measure to ensure that the SME proposers



will be able to assimilate and exploit the results of the project as well as the dissemination of the results. The dissemination plan and marketing strategy were prepared according to the feedback from end user SMEs. The web portal for project were designed and used for communication between Partners. Web site, set of leaflets, posters and articles were elaborated and distributed in between Partners. The plan for using and disseminating knowledge to transfer specific knowledge from the RTD performers to the SME participants was prepared. Also Number of scientific and commercial event has been participated. The investigation on competition were proceeded to consider project competitiveness as well as possible patent application. However, according to the Consortium commitment, the public release of project results was limited due to the IPR protection. Under that activity, preliminary techno-economical feasibility studies were done for exploitation purposes. Deliverables 13 – 19 documents that part activity.

The list of deliverables, those to be released in the reporting period, is provided below.

Deliverable No	Deliverable Name	WP N°	Lead Participant	Estimated Person-Month	Nature	Dissemination level	Delivery date
D1	Process parameter and relevant quality criteria for structure of data base	1	STFI	7	R	CO	t0+4
D2 + amendment	Defined correlation between Process parameter and relevant quality criteria	1	STFI	7	R	CO	t0+4
D3	Boundary conditions for needle ageing and breakage	1	STFI	7	R	CO	t0+4
D4	Preliminary design of the prototype	2	SKA	9	R	CO	t0+11
D5	Basic equipment prototype	2	SKA	12	P	CO	t0+11
D6	Intermediate release for the automatic/control software and interface	3	DAPP	4	O	CO	t0+9
D7	Multi-Sensors control software databases	3	DAPP	5	O	CO	t0+9
D8	Final release for the automatic/control software and interface	3	DAPP	8	O	CO	t0+11
D9	Prototype installation	4	DAPP	17	D	CO	t0+22
D10	Software installation	4	DAPP	18	D	CO	t0+22
D11	Report on results from the automatic control systems.	5	STFI	15	R	CO	t0+25
D12	Report on evaluation of the performance of the overall systems.	5	STFI	15	R	CO	t0+25
D13	Project web-site	6	CMS	3	O	CO/PU	t0+6
D14	Project and preliminary product leaflets	6	CMS	3	O	PU	t0+12
D15	Technical paper on "multi-sensor" approach for nonwoven applicat.	6	CMS	5	O	CO instead of PU	t0+23

D16	Dissemination paper on “multi-sensor” approach for nonwoven application	6	CMS	4	O	PU	t0+23
D17	International patent application for the needle-control system	6	CMS	5	O	PU	t0+24
D18	Plan for use and dissemination of knowledge – DRAFT version	6	CMS	5	R	CO	t0+12
D19	Plan for use and dissemination of knowledge – FINAL version	6	CMS	5	R	CO	t0+26
D20	Six-Month progress report	7	CMS	2	R	CO	t0+6
D21	Mid-Term progress report	7	CMS	2	R	CO	t0+12
D22	18 month progress report	7	CMS	2	R	CO	t0+18
D23	Final report	7	CMS	3,2	R	CO	t0+26

List of Milestones achieved during reporting period

Milestone no.	Milestone name	Workpackage no.	Data due	Actual/Forecast delivery date	Lead contractor
1	System requirements for structure of database according to needle-punched technology	WP1	15.01.2006	-	STFI
2	Design of the first prototype of the control system for needle-punching process	WP2	15.08.2006	15.09.2006	SKA
3	Needle automatic control software interface	WP3	30.11.2006	30.11.2006	DAPP
4	Performance of the optimised system for needle-punching automatic control	WP5	14.09.2007	14.11.2007	DAPP



Following, the work performed in the relevant WPs is reported in more detail.

WP1: Scientific Analysis and System Requirements Specification – WP leader STFI

That work package allowed to identify relevant parameters for the needle-punching production processes and needle loom manufacturing equipment. Also a survey from a sensor point of view were carried out in order to find the multi-sensor equipment which will better address the identified requirements

Task 1.1 – Investigation and analysis

Investigations & analysis of high added-value needle-punched nonwovens have been accomplished by quantifying the relationship between needle performance (abrasion, breakage) and quality parameters (tensile strength, thickness, weight etc.). The most relevant needle-punched nonwoven materials and its parameters have been selected by the three SME partners GWS, KK and Speritex.

During this investigation period the original SME partner D&G has been exchanged by the new partner Speritex. Therefore, to finish task 1.1 more time was needed. In October 2005 a questionnaire (see Attachment 1) was sent to all SME partners by STFI to collect all relevant product and machine parameters for analysis. Results are shown in Deliverable 1.

Furthermore, technical drawings of typical needle board were sent to the partners to identify single needle breakage and abrasion. The SME partners sent back their filled out questionnaire as well as set of new needles for first analysis during November. First results of evaluation are shown in Deliverable D3.

During investigation and analysis GWS, KK and Speritex have identified production parameters which can affect the quality of nonwoven fabrics. DAPP and STFI have supported them in the identification of production parameters with respect to the system integration phase.

Task 1.2 – Definition of experimental needle abrasion and breakage

Experimental needle abrasion and breakage has been defined in this task and testing concepts have been developed. The end-users have defined the most common defectiveness of nonwoven textiles in respect to their typical needle abrasion and breakage. The RTD performers STFI, SKA and CMS have defined the most common needle breakages from a system developer's point of view. (See Deliverable 3)

STFI has collected all these information and analyzed it in comparison with main requirements of the needle-punching machines. The relevant data regarding machine parameters, nonwoven characteristics and most common needle breakage and abrasion was collected from SME partners; GWS has been chosen to deliver pilot parameters to develop the mathematical model for sensor system design and development in WP 2. During further investigation and analysis the results of the other SME partners will also be integrated into the sensor system and then transferred to their relevant machine and product parameters.



Task 1.2.1 – Laboratory trials

An experimental plan for needle breakage with defined conditions has been established. Lab trials with defined needle breakage in segmented partitions of one needle board have been accomplished and the influence on nonwoven quality has been measured.

Nonwoven materials were processed with defined parameters selected by the results of task 1.1.:

- a) nonwoven material parameters that are important (from end-user point of view), such as fibre material, fibre fineness, fibre length, nonwoven thickness and mass per area for standard products and products causing most processing troubles;
- b) needle parameters (from developers point of view), such as type & fineness of needles, number of stitches per area, needle penetration;
- c) process parameter of SME partners possibly used for experimental lab trials

Task 1.2.2 – Laboratory investigation on new and used-up needles

An experimental plan for well-defined needle abrasion was established based on suggestions of SME partners. New needles and worn out needles of the SME partner GWS were investigated and compared to acquire pilot data for the mathematical model. Abrasion of needle parts (needle barb, needle point, working blade etc.) and SEM pictures of new needles and worn out needles after different monitored processing periods at GWS were analyzed and evaluated. First results are documented in Deliverable D3.

Task 1.3 – Analysis of relationship between process parameters and quality criteria

During this task the partners have determined relevant quality criteria for the different products.

Textile testing of quality criteria has also been done. The most important industrial parameters that may influence the web quality have been identified (see Deliverable D2). KK, GWS and Speritex have given quantification of the defect acceptability respect to the effect of the final quality of fabrics, while STFI has helped in the quantification and acceptability of these defects. SME partners will define their requirements for their nonwoven products.



WP2: System Design and Development – WP leader SKA

The work package WP2 was aimed to evaluate the results of studies, experiments and partners experience in order to specify the most suitable configuration and set-up of the chosen sensors. The relevant multisensor control system for nonwoven needling machinery was designed, where Consortium knowledge was implemented.

The work of this package was started with the following activities:

- classification of parameters relevant for mechanical and filtering (end-use) properties and their sensitivity;
- self learning system and mathematical model for different nonwoven applications;
- system requirements for the detector and control system.

Final output of this WP will be the complete design and the first prototype of the control system for needle-punching process

Task 2.1 – Mathematical model for nonwoven applications

That task was started in the 4th month of project duration. The results of WP1 were discussed and compared with different mathematical models for

- nonwoven behavior while being needled,
- single needle mechanical behavior
- conditions for needle fixing system in terms of coupling forces and displacement.

In the modeling process the knowledge, that one extracted from the literature as well as the one gained from Project Participants was taken into account. Also design parameters possible to use for existing production equipment were considered.

The analysis of physical phenomena – those related with needling prompted to consider three additional factors while designing the monitoring system:

- possibility to define the single needle abrasion process by on-line observable variables
- significance of range of observable variable variation when considering the sensor sensitivity
- design space accessibility on the needle punching machine for possible mounting of sensing subsystem

The investigation results have shown, that the single needle abrasion process is possible to trace only in the laboratory environment; the “on line” measurement is not possible in the design space that one valid for existing needling machinery. The existing fixing system for needle in the needle board does not allow to sense the needling force as a measure of needle abrasion and temperature variation resulting from needle abrasion process is not large enough to trace it.

Thus contingency plan were applied. The temperature factor was not taken into account any more as a measure of abrasion. The needle abrasion was aggregated onto tool (needle board) abrasion level. The tool abrasion is to be observed through three observable variables:

- the aggregated needle force measured on the needle board mounting system



- the broken needle pattern observed with multisensor system based on the impedance sensors and possible optical sensors (LED or laser one) for every single needle in the needle boards

According to the detailed discussion between RTD performers and SME participants, the single side needling machine system was selected for the pilot version of control system. The detailed discussion is included in the Deliverable 4.

Task 2.2 – Design of the Control System

Following selection of sensor system, the control system was designed.¹ The design is scalable and portable, thus it was possible to install the considered system also on the preprototype unit. However it does include the features of design space for real needle-punching machine. The necessary design space was delivered by Project participant – the TechnoPlants.

The control system design incorporate three main subsystems: multisensor subsystem composed of the set of sensor devices, data acquisition and preliminary processing subsystem and monitoring (data presentation and visualization) subsystem.

The control system is designed to trace factors which cause the needle breakage and abrasion and which allow to predict such phenomena. The interrelation between observable parameters and production parameters those defined in the WP1 as a quality parameters for nonwoven product, it was assumed to be programmed in the software for needle tool abrasion detection and monitoring. The needle tool abrasion prediction on the ad hoc observation basis will allow to prompt needling machinery operator for early needle board replacement procedure.

However, an interrelation exists among stitch density, contact velocity, operating speed, impurity particles, etc. are not planned to be considered as a control parameters in the designed system.

Task 2.3 – System development

The achieved results were used by RTD Performers, CMS and TECP to design and to develop the preprototype. That prototype is used as a tool for sensing phenomena and data acquisition verification. RTD performers together with SME participants skilled in the machinery and control system design reached the point where the appropriate unit was designed and developed. In that phase of development, the prototype developed by CMS is the stand alone needling unit linked with appropriate sensing and data acquisition subsystems. The data is collected by commercial A/D converter unit and processed with PC subsystem.

¹ Control system in that case is to be understand as a monitoring system able to prompt operator for certain action out of considered system



WP3: Control Software – WP leader: DAPP

The objective of that work package was dedicated to the development of software interface for considered monitoring system hardware management purposes. Also the data structure responsible for needle breakage patterns storage and cognition were developed.

The multisensor control software was designed jointly by DAPP and SKA with careful assistance from CMS and STFI. Please refer also to Deliverable D4 for more details on the hardware equipment and on the software monitoring algorithms.

The development focused on the continuous monitoring of the needles abrasion status in the Needle Board, giving mainly details on needles presence/absence. During the same period a number of investigations and analyses were performed in order to verify the possibility of measuring the global force exerted by the whole needle-board. Initially a number of piezoelectric sensors were installed for test purposes on a needle-punching working machine in STFI. Results showed that there is no possibility of on-line monitoring with good approximation values of global force acting on the needle-board (through those sensors) see m.o.m dated 02.03.06., 30.03.07. On the contrary it was showed that this evaluation could be done using the developed system which is able to scan the status (presence/absence) of all the needles in the needle-board. This evaluation is useful for the detection of sudden and simultaneous breakages of a great number of needles.

It was assumed that the communication link between sensing points and processing unit will build up on the multiplexing functionality assembled into multisensor boards, A/D converter functional modules connected to the bus basing on the RS485 protocol and pooling procedure managed by developed software.

Considering the software development functionality, the monitoring software system gives the command which starts the measurement as soon as the operator demands for this. After this, a number of parameters which should characterize the process (maximum percentage of broken needles, output file, type of process, etc.) are set and following this the monitoring starts through a polling procedure (the software polls each module in order to verify the status). All the acquired information belonging to each module are then coupled together and used for the whole needle-board status evaluation.

The algorithm evaluates that each measured sample is the results of an average process among a number of values which comes out of different positions of the needle-board (corresponding to different height of the needle in the stripper-plate). The very first one is referred to the empty sensor and it has been used as reference value for each evaluation.

The monitoring system algorithm identifies each needle through an ID number and the address of the needle board to which it belongs. This information are sent to the central processing unit, which is collecting information from every module; thus, as already observed, it reaches a conclusion on the instant status of each needle-board.

Finally, once stored all the necessary information on the needles, the decision support tool assists in the evaluation, whether the needle-board is still in good conditions, or if due to needles breakage it needs to be redirected for maintenance procedure.



Deliverable 6, 7 and 8 were achieved with this development.

Task 3.1 – Multisensor Control Software Interface

The Multisensor Control Software Interface was designed by DAPP with strong feedback from SKA and with consultations from STFI and CMS. Joint task force originated from DAPP and SKA examined in Warsaw and in Genova the results in the sensor development and designed necessary software for data collection and preliminary processing from sensor boards.

The main goal of this task was to develop the multisensor control software interface, following requirements identified in previous WPs. To this purpose, a software for the data acquisition and processing, those from coil sensor pads and from the needle board reaction force sensors has been designed. That allows to know the status of the needles in the needle-boards at each required instant.

The design of user interface allows the operator to change selected measurements parameters. If needed, the visualization the status/history/features of needle tools abrasion is possible (for example for verifying the presence of random, troops or trails breakages). The user interface also takes into account the possible alerts which are switched on in case a breakage pattern has been detected. As it is well known, breakages pattern on the needle-board are the main reason for the decreasing of the non-woven quality level.

Task 3.2 – Multi-Sensors Control Software Database

The main goal of this task was the development of the multisensor control software database, following requirements identified in previous WPs. This database is foreseen for collecting all the acquired information on the needles, in order to have further elaborations of the acquired information.

At the present stage of development, this database is able only to collect data and to check the obtained results. As soon as the system will be more stable, it will be possible not only to store the information, but also to reach a conclusion on the status of the needles, basing on the statistics and history of needles in the needle-board (taking into account also other process parameters such as, nonwoven fibers, possible parameters changes in the machine, replacing for maintenance, etc.). The information, which is stored for each needle, it is composed of: address and coordinate of the needle, time of the first status change (from *new* to *bend*, or from *new* to *broken*), time of the second change (from *bend* to *broken*).

Task 3.3 - Automation and Control Software

The leadership of that task was kept by DAPP, while STFI, SKA and CMS were deep involved in the results evaluation.

Its main goal was the development of algorithms for the comparison of measurements and the real-time process control. That includes the detection of broken needle on the Needle Board including the multisensor board identification, the evaluation and classification of lost



needle pattern, if any, and the calculation of an appropriate stitch density characteristics. The software also includes the possibility of identification and virtual observation of the needle status (i.e. visualization of the needle damage) and log writing into data base.

The set of complex algorithms were designed to this purpose. Please refer also to deliverable D4 for framework of this development.



WP4: System Integration and Prototyping– WP leader: DAPP

The objective of this Work Package was the integration of the developed sub-systems with the software codes into a basic prototype for system calibration and update. The monitoring software being tested on the pre-prototype has been implemented into industrially tested prototype. To facilitate the assembling procedures and testing process, for that phase the STFI research facilities were decided to be used.

Necessary MultiSensor boards MS were designed jointly by SKA and CMS and communication and processing software (see activity of the WP3) were designed by DAPP. Considering the characteristic dimensions of chosen needling machine, the multisensor module of 500 needling inlet holes was selected.

The monitoring software allows to scan the set of Multisensor boards and it gives the result on the presence/absence of each needle. Besides this, coupling the information which comes out by each module of the board, the monitoring software is able to give a final conclusion on the existence of possible pattern breakages on the whole board.

Previous experiences of technological partners involved in manufacturing needle-punching equipment (TECP) was joined to RTDs knowledge to perform the integration of the hardware systems, the software installation, the calibration of the multi-sensor sub-system and the integration of the whole system in the production environment.

According to the 12 month General Assemble Meeting conclusions, two type of MS boards were considered: the one based on inductance phenomena (MS-500-c) and one – on optic phenomena (MS-500-o).

Necessary testing measurement platforms for mechanical, optoelectronic and electronic as well as testing program were prepared and implemented for tests.

Finally following configurations were integrated for testing purposes:

- MS 44 and MS 500 boards coherency testing wit electronic testing equipment – laboratory environment;
- MS 44 c and MS 44 o, linked through A/D converter with the processing unit (RS485 mode)– laboratory environment;
- MS 500 c (6 pcs)linked through converters with the processing unit(RS485 mode)– semi industrial environment;
- Hybrid solution of MS 500 c (6 pcs) and MS500 o 44 (1pc) linked through converters with the processing unit(RS485 mode)– semi industrial environment;
- Hybrid solution of MS 500 c (3 pcs) and MS500 o (1pc) linked through converters with the processing unit(RS485 mode)– semi industrial environment;

Task 4.1 – Basic equipment and development

Main objective of this task was the development of the basic equipment necessary to manufactures the multisensor system.

In particular, this task regarded the following main aspects:

- Design and development of the acquisition system:
 - o Investigation on coil/optical sensors;
 - o Design and development of the sensors modules;



- Integration of the modules on the needle-punching machine.
- Design and development of the monitoring software:
 - Design of the flow-chart of the monitoring process;
 - Design and development of the user-interface, both for what concerns the needle-board status visualization and for what concerns the global and local analyses looking for the existence of needle breakages patterns;
 - Design and development of the information archive which collects the status of each needle at each instant and which is the base of the database structure.

As it was decided during the research phase of the project (see WP1 and WP2), the temperature IR approach was neglected as not applicable for investigated case.

The acquisition electro-mechanic elements of considered monitoring system were develop by developer partners with support of RTD performers – those skilled in the monitoring system research.

Task 4.2 – Prototype Installation and testing

Main goal of the task was the integration of the developed prototype on the existing needling web loom. The integration process included two phases: the integration of system on model needling system for better understanding of design space premises and the system integration on to small industrial needling web loom.

Necessary measurement platforms for both solutions were considered including appropriate testing strategies.

Task 4.3 – Software installation and testing

The protocol communications has been finalized for RS485 protocol and consequently the acquisition features have been defined. A polling procedure has been applied for the multi-modules acquisition.

Besides this the pattern analysis algorithm have been tested in the virtual environment; the final version for industrial prototype were released. This solution has been installed in the testing unit for testing purposes.

Task 4.4 – System adaptation and configuration control

Main objective of that task was the system adaptation according to the industrial needle web loom demands. That activity had upgraded the model version of system upto prototype version. The prepared test procedures has been performed on the prototype. Main issues which have been found previously, they has been solved and final version of the sensor board communication software and converter configurations were developed.

As the result of work package 4, the set of hardware elements and components were created. The hardware and software were implemented in the production environment according to the experience of SME partners. Deliverables 9 and 10 documented that part of the project.



WP5: Testing and System Performance Evaluation – WP leader: STFI

Activity of that work package was focused on the multisensor monitoring system trial and performance observation. Tests were undertaken to observe the functional performance of monitoring system as an electronic device and as a tool for nonwoven quality observation. The undertaken activities were continuation of WP3 and WP4 in the industrial environment being able to access in the STFI production facilities. The tests were performed with joint team of STFI, SKA and DAPP researchers with technical assistance given from CMS.

Three test series were undertaken within STFI on the laboratory DILO needle machine. Tests were conducted in industrial environment during processing of nonwoven material.

The needle punching machine used for the tests is part of a laboratory line to process needle punched nonwovens in laboratory scale of working width 600 mm. The laboratory line consists of following parts: carding machine, cross lapper (both web forming units) and the needle punching machine (web bonding unit).

For the installation of the multi sensor system, it was a requirement to dismount the stripper plate out of the needle punching machine. This is easy to handle in case of machines with low working width but for machines with large working width up to 5 meter, the industrial integration of multi sensor system installation has to be pre-tested in dependence of each single needle punching machine (regarding to machine design and technical documentation).

All cables of multi sensor system are to be fixed at the stripper plate. The guiding of cables out of the machine has to be handled flexible because the stripper plate has to be adjusted in its position according to machine parameters. Furthermore, vibrations with different frequencies will occur in working mode of the needle machine.

The test program covered:

1. Installation of inductance sensor boards and optical sensor board
2. Installation of all controllers on the PUNCHING MACHINE machine
3. Static tests
4. Dynamic tests on variety of speeds and nonwoven processing speeds
5. Breakage pattern recognition

For testing purposes the geotextile were used.

The solution was demonstrated to SME Partners. The undertaken test demonstrated the proper behavior of electronic components. Also presented GUI was evaluated as efficient one for industrial monitoring purposes. Deliverables 11 and 12 documented that part of the project.



WP6: Innovation and Related Activity – WP leader: CMS

Scope of WP6 was to facilitate and encourage the industrial and commercial exploitation of the project results and to define the measure to ensure that the SME proposers will be able to assimilate and exploit the results of the project as well as the dissemination of the results.

The dissemination plan and marketing strategy were prepared according to the feedback from end user SMEs. The web portal for project were designed and used for communication between Partners. Set of leaflets, posters and articles were elaborated and distributed in between Partners.

The final version of plan for using and disseminating knowledge to transfer specific knowledge from the RTD performers to the SME participants was prepared. Number of scientific and commercial event has been participated. The investigation on competition were proceeded to consider project competitiveness as well as possible patent application.

However, according to the Consortium commitment, the public release of project results were limited due to the IPR protection.

Deliverables 13 – 19 documents that part activity.

Task 6.1 – Protection of the Intellectual Property Rights

The results of project was protected following rules listed in the Consortium Agreement. The knowledge dissemination was limited to that necessary for communication in the Consortium. The few public presentations were limited to general information about efforts undertaken for nonwoven product on line monitoring methodology. Finally the “Know How Transfer Agreement” for IPR transfer from RTD performers to SME Partners were signed within Consortium – see APPENDIX 3 for text of signed Agreement.

To protect IPR, the preliminary study on patent applicability was done – see Deliverable 17. The conclusion of that search was, that not revealed any document which would destroy the novelty of quality monitoring system in the nonwoven production process.

Task 6.2 – Marketing Strategy and Feedback

According to the results achieved during WP4 and WP5 the techno-economic feasibility study for conditions for project product possible marketing were undertaken. That was done with assistance of SME Partners to predict the possible period necessary for return of investment.

Task 6.3 – Training, Exploitation and Dissemination

In the first half of the project, dissemination of the information about the project remained limited to the distribution of publishable abstracts. According to that premise, the project leaflet and poster was issued. Also some communicates on few conferences and fairs were given as a general information i.e. on the main objective of NEEDLES project.



To satisfy the inside Consortium knowledge distribution, the web side was open for internal idea and rapports publication.

In the second part of the project, according to the General Assembly decisions, the dissemination was still limited for public area. However precise dissemination and exploitation plan was elaborated – see Deliverable 19. Also product leaflet and poster was edited and distributed in between Consortium Partners. For knowledge dissemination purposes, two papers are prepared for further edition in the technical journals or during conferences – see Deliverable 15 and 16. To start exploitation activity, also the announcement in polish local journal “Textile Review” was published.

For SME partners the product information and training CD was issued, where detailed description of GUI of monitoring system were presented – however that CD is still not released for public use unless IPR will not be protected.

Consequently, SME Partners when considering the knowledge and training factors, they are well prepared for prospected absorption of project results unless the investment factor will be on the acceptable level.

To extend the dissemination area onto public area and to market the project results, the dissemination and exploitation plan were developed – see also Deliverable 19.



Section 3. Consortium Management

The task objective was to provide Project Consortium with efficient project resources management. Scope of project management, that one precisely described in the DoW- §6.1, it was effectively exploited through project duration by Coordinator.

In particular sole contacts with EC during negotiation phase of the project as well as during its realization aimed onto administrative and financial procedures were well cared on. In particular two amendments: one related with Partner replacement – see Deliverable 20 - and one related with project prolongation were carried on.

An internal communication between partners were an object of careful attention and support. Resulting, the research, and development process was completed with sustainable participation and input from all partners. Also, dissemination plan as well as preliminary exploitation strategy were elaborated jointly; that was processed according to the limits of knowledge composed of project results and Partners experience.

As stated above, the management activities were focused onto proper level of direct and indirect communication line support between Consortium Partners.

That indirect relayed on the exchange of ideas, reporting and information through internet menaces (e-mail, web side, SKYPE conferences) and telephone conversations; that created semi-virtual project organization, where all partners could participate in everyday task activities.

That direct one stressed the need for direct conversations, workshops and collaboration activities on the level of consortium management bodies as well as on the level of “one-to-one” Partners joint collaboration. The number of General Assembly Meetings, Technical Meetings, Workshops aimed onto problem joint solution and unformal short meetings took place. Below there is the list of those most important:

1. October 4th, 2005 in Chemnitz in STFI premises for Kick of Meeting,
2. November 8th, 2005 Coordinator short visit in the Brussels DG to clear organizational and financial problems related with project coordination.
3. December 7th, 2005 in Genova in D’Appolonia premises and in Pistoia, where SME participant Technoplant has its production facilities,
4. January 11-12th, 2006 Management meeting in the CMS premises in Warsaw
5. February 8th, 2006 Management meeting in the CMS premises in Warsaw
6. March 2nd, 2006 in Chemnitz at STFI premises.
7. At the beginning of April 6-7th, the 6-month Technical Meeting, Board Meeting and Technical Committee Meeting took place in Warsaw.
8. May 8-12, the workshop took place in Genova with participants from SKA, DAPP, TechnoPlant and Speritex.
9. June 15th, 2006 informal meeting between RTD performers: STFI and DAPP took place,
10. June 30th, 2006 Coordinator had visited the STFI to agree on following activities on the parametric definition of abrasion process.



11. September 4-8th 2006 the workshop for SKA, DAPP and TECP took place in Genova and Pistoia
12. September 12-14th, 2006 the necessary test took place in Chemnitz under presence of all RTD performers.
13. September 26th, 2006 Coordinator had visited the STFI and GWS for project progress update
14. In October 12-13th, 2006 the 12 month meeting took place in Rome
15. January 21st, 2007, Board Meeting (CMS and DAPP) took place in Warsaw to revise the present state of art.
16. February 19-20th, 2007 the Technical Workshop took place in Warsaw for joint calibration of prototype multisensor subsystem and communication link between multisensor boards and processing unit. Also inductance approach and optical approach to the multisensor facility was once more evaluated.
17. March 13th, 2007 Coordinator short visit in the Brussels DG to clear organizational and financial problems related with project coordination.
18. Beginning March 30th, 2007 18 month meeting took place in Pistoia, where state of development were presented and dissemination – exploitation policy were discussed
19. June 4th, 2007 the exploitation meeting took place in Pistoia
20. July 5-6th, 2007 the workshop for SKA and DAPP in Genova in DAPP facilities
21. July 30...August 2nd, 2007: first series of industrial tests took place in STFI, where software-hardware conflicts were detected
22. September 2-6th, 2007: second series of tests took place in STFI; improvements for multisensor boards were investigated
23. November 5-7th, 2007: third series of tests took place in STFI
24. November 14th, 2007 Final General Assembly took place in DAPP facilities in Milano.

Deliverables 10 – 23 and appropriate set Minutes of Meeting are tracing the WP7 activity.

According to the Consortium application done June 19th, 2007, the Project duration was extended with two months upto 26 months duration keeping line within presumed budget limits – see extended project Gantt chart below. That was caused by some delays in the prototyping of components which are fundamental for the integration of the sensing part of the detection system, namely plastic carcasses of proper quality for coil sensors were delayed in delivery.

The activities were followed as on the Gantt Chart.



Section 4. Other issues

The overall contributions of the partners of the project are described in the management report. Each partner has performed the work allocated at the beginning of the project as mentioned in the technical annex. The benefits that the SMEs will have with the results of the project are described in the draft of the “Plan for using and disseminating the knowledge”, deliverable D18 and 19.

Contribution of the group of SMEs and RTD Performers

The Consortium efforts for the project progress were undertaken in the way which allow to exploit full knowledge of Consortium contractors i.e.:

- STFI (RTD) as an expert for nonwoven properties and manufacturing methods
- SKA (RTD) as experienced developer on monitoring systems for mechanical systems
- DAPP (RTD) as an expert for monitoring system electronic and control system solutions
- CMS (SME) as an experienced developer of mechatronic systems and sensor devices
- TECP (SME) as a recognized player on the market of needling equipment producers
- GWE (SME) as an experienced manufacturer of geotextiles
- SPERITEX (SME) as an experienced manufacturer of filtering nonwovens
- KK (SME) as and experienced manufacturer of synthetic leather as well as nonwoven conveyor belts

In the considered research STFI were balancing their work with SME involved in the nonwoven production i.e. GWS, KK and SPERITEX, while DAPP and SKA joint efforts with SME involved in the needling machinery i.e. CMS and TECP. The intensive horizontal exchange of knowledge took place.

According to up today experience, it may be stated, that the benefit which SME experienced from RTD performers is the better identification of nonwoven quality level as a result of decrease of needle tool performance. Also the experience on the possibility of product quality prediction were well transferred to SME. Moreover, the innovative knowledge related to the multisensor approach for process monitoring and advanced software engineering related with knowledge management was transferred to SME – those involved into needling loom equipment manufacturing and control system development ie to CMS and TECP. The extended technology related with assembling process of microelectronic elements – those related with micro-coils assembling, material selection and optoelectronic parameters adjustments were transferred to the CMS – the SME involved in the control and monitoring system development.

Following, short resume of Consortium Contractors contribution onto project as well as balance of the work and resources between RTD performers and other contractors. More detailed scope of work for particular partners are enclosed in the Appendix 1.



1. CIM-mes Projekt sp. z o.o. – SME partner, Coordinator

CMS has played successfully the Coordinator role. On one side it played the consortium management role for proper organization of workflow, communication and knowledge exchange. On the other side it released its know-how for better understanding of design limitation and sensoric systems capabilities and features. That allowed to balance in the most efficient way the scientific knowledge and methodologies those mastered by RTD performers, the everyday practice of SMEs - nonwoven manufacturers and electromechanical systems design master hood of SMEs – those developing control systems and needling equipment. CMS was also significantly involved into technology development – particularly that related with mechanical and electromechanical components development and assembling procedures.

2. D'Appolonia – RTD performer

DAPP used to acquire the necessary knowledge to identify observable parameters for needling process. In the next step, it has used the acquired knowledge that from remaining RTDs as well as that from SME partners, to develop the prototype of control system (software and hardware configuration). The considered effort was paid by that RTD performer for development of communication software between multisensor boards and processing unit. Also the leading position in the processing software development was kept by that Partner and resulting algorithms for pooling concept, data base and pattern identification for further nonwoven product quality prediction were successfully done with it.

3. Geotextil Westsachsen GmbH – SME partner

GWS was heavily involved into supplying RTD performers (in particular STFI) with necessary production data, information about quality criteria those custom to the manufacturing practice as well as it delivered necessary nonwoven samples and needles samples for further laboratory tests. It make possible to make necessary test on needling machinery being in the manufacturing process. Their deep production experience allowed to focus the project onto those features of the system, which are important for industrial environment. Also, when the techno-economic feasibility study were under development, GWS disclosed some of necessary data for Consortium needs (SME partners involved in feasibility study); that allowed to decrease the margin of uncertainty for that study.

4. Konus Konex d.o.o. – SME partner

KK was involved into analysis of their nonwoven manufacturing process according to the recommendations achieved from RTDs (in particular from STFI). That analysis allowed to identify main causes of the decreased quality with decrease of needling tools performance. KK has delivered used and new needles for further observations of geometry variation (in particular to CMS and SKA). KK was also involved into feasibility study for investment of SME into monitoring system for needles abrasion.

5. SachsischesTextil Forschungs Institut eV - RTD Performer

For full project duration, STFI was hardly involved in the identification of nonwoven needling process by means of features those being able to measure with considered modeling system. STFI was involved into laboratory tests related with needling process identification as well as in the mathematical modeling. In particular the correlation between



needle abrasion and pattern of broken needles influence onto product (nonwoven) quality were an object of their activities. Moreover extensive effort was dedicated to acquire necessary opinions and technical parameters from SME partners – particularly those involved in the nonwoven production process. Finally, necessary semi industrial environment of STFI facilities allowed to process all necessary tests in the industrial scale.

6. SKA Polska sp. z o.o.

SKA was hardly involved in the development of monitoring system for needles performance detection. That included phenomena identification in close cooperation with STFI and CMS as well as on the basis of in home literature study and with help of mathematical modeling, selection of measurement method which allow to identify on line the needle tool features related with it's performance. The remarkable contribution from that RTD performer was done in the innovative solution of multisensor – inductance variation focused. It released the breakthrough input for microtechnology of multisensor boards production and assembly. SKA played the main role in the design and development of monitoring system prototype in joint efforts with DAPP and CMS. During that period of activity it could be observed also effective exchange of knowledge with SME partners – particular those skilled in the control and sensing system development - CMS as well as skilled in the manufacturing of production equipment – as TECP. SKA also leaded the testing procedures including testing software elaboration and testing programs preparation.

7. Speritex S.p.A

Speritex was involved into analysis of their nonwoven manufacturing process according to the recommendations achieved from RTDs (in particular from STFI). Also it has released their uptoday knowledge on the control procedures which are applied in their everyday practice. Also, when the techno-economic feasibility study were under development, Speritex disclosed some of necessary data for Consortium needs (SME partners involved in feasibility study)

8. TechnoPlants s.r.l.

TECP was actively participating in the design space analysis – that one necessary for considered monitoring system integration with existing needling machinery. The extensive exchange of information took place between those partners involved in the direct mechanical design process i.e. with CMS, SKA and DAPP. Also the market knowledge was released partly for preliminary dissemination plan for NEEDLES project. Finally it participated in the exploitation plan creation



APPENDIX 1: SME and RTD contribution and cooperation

Following there is brief description of Consortium Contractors contribution to the project and common benefits related with Consortium activity on the Needles project.

1. CIM-mes Projekt sp. z o.o. - SME partner, Coordinator

WP1

Objectives: For that work package, the main objectives were to investigate the object of control features and to synthesis the model for workflow organization for Consortium, which is geographically wide spread and with different functionalities model.

Activities and problems: Even formally CMS was not involved in the WP1, the extensive study of phenomena related with needling process was undertaken. The main activity was paid to the recognition of requested functionalities of considered monitoring system against technical possibilities of measurement of requested variables. Meanwhile the model of knowledge exchange and procedures within Consortium was elaborated.

Results: In relation with uptoday knowledge about sensing technology, considered process features and own experience, vulnerable sensing technologies were identify for further detailed evaluation while focusing onto sensor system development. Also the communication lines within Consortium were created.

WP2

Objectives : The further needling phenomena analysis with mathematical modeling. The laboratory tests evaluation. The selection of proper sensors, useful from technical point of view.

Activities and problems: Wide range of analyses were performed to check different approaches for mathematical modeling of the process. Extensive investigation on the multisensor applicability as well as selected multisensor manufacturing possibilities were undertaken. Finally the needling simulator were developed to support the monitoring system prototype testing and validation procedures. That activities were strongly integrated with RTD performers research results.

Results: An evaluation of developed ideas for multisensor applicability was done; recommendation for further research was limited to the inductance and optic sensors for needle breakage and piezoelectric sensors for indirect needling force was pointed out.

WP3

Objectives: To commit on the final solution of the control software interface, data base functionality and information processing software.

Activities and problems: Active participation in the development progressed by DAPP and SKA. Assistance for testing and validation procedures

Results: Commitment on the control software interface, information processing software and data base functionality.

WP4

Objectives: to integrate the developed and implemented sub-systems with the software codes into a basic prototype for system calibration and update.

Activities and problems: Contribution into multisensor system implementation and configuration with focus onto optoelectronic solution. Expertise on the plastic elements



development and mechanical aspects of assembling procedures. That was conducted in tied cooperation with DAPP, STFI and SKA.

Results: Commitment on the system integration upto industrially accepted level.

WP5

Objectives: The High-Speed Multi-Sensor approach performances evaluation and the technology and methodology will be demonstrated .

Activities and problems: Development of monitoring fixing system and assembling procedures. Assistance in the testing field development. Solving “ad hoc” problems arising during different testing phases. Finally participation in test procedures.

Results: The final successfully tests were processed in joint team with SKA, STFI and DAPP researchers.

WP6

Objectives: To facilitate and encourage the industrial and commercial exploitation of the results and define the measure to ensure that the SME proposers will be able to assimilate and exploit the results of the project as well as the dissemination of the results.

Activities and problems: The development of webside and leaflet for product and project purposes with concept exchange with DAPP. The knowledge dissemination and exploitation plan elaboration in joint undertakings with STFI, DAPP and TECP. Investigations on the feasibility of commercialization of project results in cooperation with TECP.

Results: The project web-side was released for general usage. The first project and product leaflet and posters were designed and released for Consortium partner use and for marketing purposes. The patent analysis was proceeded together with DAPP and with STFI knowledge of the procedures. The preliminary knowledge dissemination plan was prepared. The background for product feasibility of commercialization was prepared and committed with other Consortium Partners.

Further activity: Project results dissemination and exploitation according to dissemination and exploitation plans.

WP7

Objectives: Project coordination, project management.

Activities and problems: the management of the status of the project from an administrative point of view, the technical research management of the project.; application of technical resource within the project and among the partners and RTD performers, establishing exploitation mechanisms

2. D’Appolonia – RTD performer

WP1:

Objectives: Main objective of WP1 for D’Appolonia was the identification of the relevant parameters, from a system developers point of view, for the needle-punching production processes and needle loom manufacturing equipment. Outcomes of this WP1 were fundamental for highlighting the necessary technology to be used for needle-punching process monitoring.

Activities and problems: During WP1 DAPP participated in the identification of production parameters with respect to the system integration phase.



Results: Main result for DAPP was the identification of the parameters (force exerted by the needle-board while punching, presence/absence of the needles, etc.) which were used as base for the development of the system.

WP2:

Objectives: Main objective was the final design of the needle-monitoring system.

Activities and problems: Taken into consideration outcomes of WP1, DAPP worked for the development of a multi-sensor system able to monitor the addressed parameters. Main activities which have to be highlight were: critical analysis of the system requirements, sensor evaluation, design of the electronic of the monitoring system.

Results: The design of the first prototype of the monitoring system for needle-punching process is the main result achieved in the reference period.

WP3:

Objectives: This WP was focused on the development of the software interface of the monitoring system and on its main routines.

Activities and problems: DAPP was involved in this activity as main developer, together with SKA and STFI. This WP also concerned the definition of the datastructure/database containing needle-board information and needle breakage patterns.

Results: Main results were the developed algorithms for the monitoring of presence/absence of the needles in the needle-board, the user interface to be used in the final monitoring/elaboration sw, data-structure of the information to be collected and used in the database.

WP4:

Objectives: integration of the subsystems, optimization of the software interface in order to be fully compliant with system requirements

Activities and problems: involvement in the integration of the final multisensor system, communication testing of the multisensor equipment, procurement of necessary equipment for industrialization of the coil board (plastic support)

Results: The integration was successful.

WP5:

Objectives: demonstration of the developed prototype

Activities and problems: assistance in the integration and arrangement of the multisensor equipment for in-filed testing; support in finding solutions for “ad hoc” problems arising during different integration phases.

Results: The final successfully tests were processed in joint team with SKA, STFI, CMS and DAPP researchers .

WP6

Objectives: To facilitate and encourage the industrial and commercial exploitation of the results and define the measure to ensure that the SME proposers will be able to assimilate and exploit the results of the project as well as the dissemination of the results.

Activities and problems: The development of website and leaflet for product and project purposes with concept exchange with CMS. The knowledge dissemination and exploitation plan elaboration in joint undertakings with CMS, STFI and TECP.

Results: The project web-site was released for general usage. The first project and product leaflet and posters were designed and released for Consortium partner use and for marketing purposes. The patent analysis was proceeded together with CMS and with STFI knowledge of the procedures. The preliminary knowledge dissemination plan was prepared.

Further activity: Project results dissemination and exploitation according to dissemination and exploitation plans.



3. Geotextil Westsachsen GmbH - SME partner

WP1

Objectives: to obtain production feature of constant product quality; to get a tool, which allow to influence the product quality on a proper and safety way.

Activities and problems: Selection of main group of products and main product in this group; identification of relevant product parameters; extensive testing periods to get main influences between production and product (together with R&D-performer namely STFI)

Results: Identification of all relevant parameters (technology, production, product) those necessary for data base creation; better understanding of needle abrasion process

WP2

Objectives: To identify the needs for quality prediction – those pragmatic for SME nonwoven manufacturers (unique quality parameter over the whole production time); to identify appropriate features for the first prototype (how to measure, what is to measure, what could be the outlet information of such a system)

Activities and problems: Support for the RTD activities related with definition of a mathematical model; validation of the WP1 results through direct investigations on technical equipment; technical design of prototype for the monitoring system - consultancy

Results: improved quality parameters, based on results of WP 1; predication and statement of requirements for the installation of multi-sensor system on a production machine

WP4

Objectives: easy integration of the developed and implemented sub-systems into a basic prototype for system calibration and update

Activities and problems: Support for the RTD activities in the testing activities with care focused onto geotextile production features; samples delivery, process data delivery, in particular the close testing cooperation with STFI and CMS

Results: achieved know how and better understanding of the prospected quality prediction system features

WP5

Objectives: the system trial and performance demonstration; to transfer from RTD the know-how on functionality, reliability and potential of the developed system in a needle punching machine and in a complete nonwoven production line

Activities and problems: Support for the RTD activities in the testing activities with care focused onto geotextile production features; samples delivery, process data delivery, in particular the close testing cooperation with STFI

Results: know how from RTD performers and better understanding on correlation of missing needles and partly broken needles against nonwoven product quality; evaluation of commercial advantage concerning needle control system; know-how on functionality of the system and it's prerequisites for installation, which have to be handled with own equipment and staff

WP6

Objectives: dissemination and exploitation activities conditioned with IPR Know-How is protection

Activities and problems: participation in the feasibility study elaboration and in the IPR processes



Results: know how on IPR issues to be solved

Further activity: Project results dissemination and exploitation according to dissemination and exploitation plans.

4. Konus Konex d.o.o. – SME partner

WP1:

Objectives: To identify the quality relevant process parameters.

Activities and problems: Production parameters were collected and defined for needling process of each single product we produce. The main point which was focused, it was the needling affect to the quality of needle-felt. According to the needling parameters we also followed the needle abrasion after a certain working hours

Results: The correlation between needling process parameters and the density of nonwoven and the nonwoven strength for the first needling machine.

WP2

Objectives: To identify the production observable process parameters, which could be mapped into monitoring subsystem. To identify direct and indirect process parameters those being helpful for nonwoven quality on line evaluation.

Activities and problems: The needling machine was selected for observation. The needle boards were observed, while during progress of working hours the needles in selected areas of boards decreased their performance; needles from observed areas were picked up for further investigation on their abrasion due to classify the parameters relevant for mechanical properties.

Results: The variation of mechanical properties for selected needles during their life time were observed.

WP5

Objectives: to obtain the knowledge of quality monitoring system performance; to evaluate the feasibility of approach for internal needs

Activities and problems: supply of samples, release of knowledge on internal strategy for quality prediction, participation in testing programming.

Results: demonstrations of the advanced technology and methodology developed during the research work

WP6

Objectives: dissemination and exploitation activities conditioned with IPR Know-How is protection

Activities and problems: participation in the feasibility study elaboration and in the IPR processes

Results: know how on IPR issues to be solved

Further activity: Project results dissemination and exploitation according to dissemination and exploitation plans.

5. Sachsisches Textil Forschungs Institut eV - RTD Performer

WP1:

Objectives: Identification of the relevant parameters for needle-punching production referring to the special conditions in the production of the SME and further development of



the basic knowledge in the field of needle punching process, quality of needle punched products.

Activities and problems: Analysis of nonwoven production processes and nonwoven product parameters; investigations on needle abrasion, verification of needle abrasion using optical and mechanical ways; research on the influence of needle absence on product quality and on use of this influence as basic correlation for the control system, development of static laboratory system to determinate penetration forces of single needles (problem: not exact measurable, high deviation), further development onto a multi-needle-system for better simulation of practical conditions. Static laboratory system to determinate penetration forces of single needles (problem: not exact measurable, high deviation), further development onto a multi-needle-system for better simulation of practical conditions. After consultancy with SME partners and other RTD performers, the contingency plan was applied to select indirect measure method for the single needle penetration force measurement.

Results: Basic correlations between process parameters as basic input for a control system (penetration force as function of needle absence/stitch density, penetration force as function of using time of needles were identified; basic correlations between penetration force and the weightiest product qualities (for geotextile nonwoven as the main product of GWS) were formulated as well as definition of arrays for this product qualities. Also as a result of the design space examination for needling machinery, the problem was identifying: for today there is no design solution for direct measurement of single needle penetrating force.

In following period of project activity there is expected the confirmation of detected basic correlations or adjustment on selected products for other SMEs

WP2

Objectives: Formulation of correlation with mathematic formulas as theoretical basis for control software development.

Activities and problems: Mathematical formulation of identified correlations

Results: Basis correlations between measurable values (by the multi-sensor system), the needle abrasion (absence and life time) and product quality criteria

WP3

Objectives: participation in the final formula implementation in the control software.

Activities and problems: consultations and contribution to DAPP, SKA and CMS efforts for final formulation of system functionality and formulas for nonwoven quality prediction.

Results: know-how on developed system configuration and formulas applied.

WP4

Objectives: to committee in the monitoring system integration coherence with industrial environment.

Activities and problems: assistance and consultation about design space for needling web loom, assistance and consultation in the integration scheme elaboration for monitoring system

Results: know-how on developed system integration capabilities with needling web loom.

WP5

Objectives: to get the evidence of functionality of the developed system within an industrial needle punching machine respectively in a complete nonwoven production line and to evaluation of the reliability of the developed system



Activities and problems: Supply and preparation of a needle punching machine, preparation and support for system integration, selection of sample material and needles, execution of sample trials with simulated needles breakages in different geometrical shapes and different amounts/numbers, first trials for long-time behavior of the systems, textile-physical testing and evaluation of the trials on product quality

Results: identified correlation between the nonwoven product quality and missing needles in different geometrical shapes / amounts/numbers clearly shown in lowering/reduction of strength, evidence of functionality of the developed system within an industrial needle punching machine respectively in a complete nonwoven production line

WP6

Objectives: research results dissemination through technical paper and presentations on conferences; research results exploitation: support of SME for IPR strategy and application of developed technology.

Activities and problems: SME consultation for dissemination and exploitation strategy, Support of SME for IPR strategy; Presentation on conferences (see dissemination table Deliverable 19)

Results: Signed IPR and Know-How transfer agreement; Agreement about submission of patent

Further activity: Further and ongoing dissemination activities: **publishing after IPR protection** and presenting technical paper on conferences, especially on Nonwoven fair INDEX 2008 and paper on EDANA nonwovens academy 2008 in STFI; prospected Presenting of developed system online working in needle punching production line on EDANA nonwovens academy 2008 in STFI facilities – see also Dissemination and exploitation plan – Deliverable 19.

6. SKA Polska sp. z o.o. – RTD performer

WP1

Objectives: During that work package, the main objective was deep literature research to find premises for building of mathematical models, analyses of needling machines design and current nonwoven research results reviewing.

Activities and problems: SKA used its knowledge about needle-punching process and related phenomena. Also design space concerned mechanical design of typical needle-punching machines were investigated.

Results: A set of articles and other scientific results were found, what increased Consortium knowledge about current state-of-art and it helped to evaluate the limits of design. A design space for multisensor system was determined as well as limitations and design boundary conditions. Results achieved from research undertaken by Consortium partners were deeply analyzed; conclusions were very helpful for process and phenomena modeling as well as for sensor design and verification of preliminary assumptions.

WP2

Objectives: Main objective of this WP was to design sensors, to develop and test prototypes and to design needle-punching monitoring system.

Activities and problems: Wide range of analyses were performed to check different approaches for mathematical modeling of the process. That allowed to verify initial assumptions both for experiments and simulations, sensor design and development for final



application, development of functional prototypes, to define assumptions and requirements for monitoring software. A wide range of possible approaches for multisensor monitoring system were analyzed in terms of laboratory experiments, simulations and related phenomena analysis.

Results: A set of mathematical models were built up to cover a wide range of needle-punching related phenomena and nonwoven and needles mechanical behavior. Performed experiments undertaken with these models allowed to understand more the complete process and it gave a number of premises for sensor design. Arguments for and against particular sensor solutions were documented. Most suitable sensors fulfilling all requirements for multisensor monitoring system were selected. Functional prototypes of selected sensors were developed and tested.

Further activities: Design assumptions, premises and requirements are still being verified against current research results. Few additional aspects of already studied phenomena are still under research as potential area of use. Built prototypes are being extensively tested. After that, they will be up-scaled to fulfill full-scale prototype requirements. Additional functional prototypes are under development.

WP3

Objectives: Objectives of this WP concerned design of monitoring software, which covers both computer side software and electronics firmware.

Activities and problems: Activities covered defining requirements for monitoring software, data acquisition system, measuring techniques and database according to previous research, analysis and experimental results.

Results: In co-operation with D'Appolonia and STFI general and detailed structure for monitoring system was defined. That included: selection of measuring techniques and algorithms for particular sensors, logical functionality design: computer- and electronic-side of the software, data acquisition structure development and hardware, design of synchronization and monitoring cycle algorithms, database structure and management design, assumptions and requirements for graphical user interface.

Further activities: Further activities will cover prototyping and experimental verification of selected solutions and optimization of algorithms.

WP4

Objectives: integration the development of monitoring system components with the software codes into a basic prototype for system calibration and update.

Activities and problems: multisensor system development for industrial environment; hardware and software configuration. Design, testing, calibration of sensors, multisensor boards and communication lines. Development of software for multisensor boards testing purposes; laboratory version and industrial version. That was conducted in tied cooperation with DAPP, STFI, CMS and TECP.

Results: Commitment on the system integration upto industrially accepted level

WP5

Objectives: The High-Speed Multi-Sensor approach performances evaluation and the technology and methodology will be demonstrated.

Activities and problems: Testing schedule and program creation. Measurement platforms assembling in the industrial environment. Modification of hardware and software according to the industrial environment demand. Assistance in the testing field development. Solving "ad hoc" problems arising during different testing phases. Results reporting. System performance evaluation for both inductance and optoelectronic solution.

Results: The final successfully tests were processed in joint team with CMS, STFI and DAPP researchers.



WP6

Objectives: research results exploitation: support of SME for IPR strategy and application of developed technology.

Activities and problems: Support for SME IPR strategy; support for feasibility study.

Results: Signed IPR and Know-How transfer agreement;

Further activity: SME supporting in exploitation plan according to exploitation and dissemination plans

7. Speritex S.p.A – SME partner

WP1

Objectives: Main objective of this WP for Speritex was the identification of the relevant parameters focused onto nonwoven quality and needling tools wear process, from a non-woven manufacturer point of view.

Activities and problems: During this WP Speritex had identified production parameters, which may affect the quality of nonwoven fabrics, according to their experiences. That contributed onto quantification of the defect acceptability, with respect to effect of final quality.

Results: Main result was the identification of manufacturing parameter those influencing the quality of the final non-woven product.

WP2

Objectives: Main objective was to assist RTDs in the final design of the needle-monitoring system prototype with nonwoven manufacturer knowledge.

Activities and problems: During this WP SPERITEX helped the Consortium thanks to their long experience as non-woven manufacturer.

Results: The participation in the design procedure of the first prototype of the monitoring system for needle-punching process is the main result achieved in the reference period.

WP5

Objectives: to obtain the knowledge of quality monitoring system performance;

Activities and problems: supply of samples for filtering components, participation in testing programming.

Results: demonstrations of the advanced technology and methodology developed during the research work

WP6

Objectives: dissemination and exploitation activities conditioned with IPR Know-How is protection,

Activities and problems: participation in the feasibility study elaboration and in the IPR processes, data delivery for technoeconomical conditions of nonwoven manufacturing.

Results: know how on IPR issues to be solved

Further activity: Project results dissemination and exploitation according to dissemination and exploitation plans.



8. TechnoPlants s.r.l. – SME partner

WP1

Objectives: Main objective of this WP for TECP was the identification of the relevant parameters, from a needle-punching machine manufacturer point of view, for the needle-punching production processes and needle loom manufacturing equipment.

Activities and problems: During this WP TECP participated in the identification of production parameters which can affect needle-punching process.

Results: Main result for TECP was the identification of the manufacturing parameters which could be monitored for the present and future evaluation of the needle-punching.

WP2

Objectives: Main objective was the final design of the needle-monitoring system prototype.

Activities and problems: During this WP TECP helped the Consortium thanks to their long experience as needle-punching manufacturer. They gave schemes and information useful for the mechanical integration of the chosen sensors, together with suggestions on the final applications of the multi-sensor system.

Results: The design of the first prototype of the monitoring system for needle-punching process is the main result achieved in the reference period.

WP4:

Objectives: support in the definition of the necessary activity and phases for the subsystems integration

Activities and problems: sharing of know-how and expertise in manufacturing needle-punching equipment in order to perform the integration of the final multisensor system, the software installation and the calibration of the whole system, once included in the production environment

Results: Commitment on the system integration up to industrially accepted level

WP5

Objectives: to obtain the knowledge of quality monitoring system performance as a part of needling web loom equipment;

Activities and problems: consultancy on the assembling procedure for multisensor boards, participation in system redesign for industrial environment conditions

Results: demonstration of the monitoring system performance and assembling features for prospected integration with needling web loom

WP6

Objectives: dissemination and exploitation activities conditioned with IPR Know-How is protection,

Activities and problems: participation in the feasibility study elaboration and in the IPR processes, data delivery for techno-economical conditions of nonwoven manufacturing.

Results: know how on IPR issues to be solved

Further activity: Project results dissemination and exploitation according to dissemination and exploitation plans.



APPENDIX 2: Plan for using and dissemination of knowledge

1. Exploitable knowledge and its use

The exploitable knowledge results - MULTIsensor based nonwoven QUality Prediction System - MUQUPS - are primarily directed towards Consortium Partners and their future business. However the prospected one is given in tabular form below.

Exploitable Knowledge	Exploitable product(s)	Sector of application	Timetable for commercial use	Patents or other IPR protection	Owner & Other partner(s) involved
<i>Multisensor based nonwoven quality prediction system</i>	NEEDLES system	<i>Nonwoven industry</i>	<i>2009</i>	<i>2008</i>	CMS, TECP
Methodology for on-line analysis of the needles status	On-line analysis algorithms	Needle-punching industry	2008, available methodology	Jointly with specific application	CMS, end-users
Design of the sensor pad	Sensor pad	Needle-punching industry	2008	Jointly with specific application	CMS, TECP
Design of the control system	Control system	Needle-punching industry	2008	Jointly with specific application	CMS, TECP

The innovation of that approach is related with prediction of nonwoven quality through direct and indirect evaluation of needles breakage and abrasion.

Concluding, the exploitable knowledge is:

- Nonwoven quality assurance system
- Needle breakage prediction in the needle punching machine
- Needle punching cost reduction

A description of key exploitable results is provided below:

- Multisensor based nonwoven quality prediction system: this result summarises all the previous ones. CMS and TECP will be world-wide distributor of the NEEDLES system, being able, in agreement with the other producer partners, to define new marketing relationship and licensing.
- Methodology for on-line analysis of needles status: this result is relevant for a new concept of on-line analysis of the needle-board. The perspectives of applications are



mainly in needle-punching textile sector. The knowledge of STFI was and will also be of great importance for the understanding of the crucial parameters which have to be monitored for this evaluation. CMS and the end-users partners, Speritex, GWS and KK will be directly involved in the benefits arising by these new methodology;

- Design of the sensor pad: this result is relevant as an innovative sensor pad was used for monitoring needles status in the needles-board. A new technology has been introduced with the support of SKA and DAPP. CMS and TECP have been and will be directly involved in this development and in the benefits arising from this;
- Design of the control system: this result is relevant as the whole control system has been developed for on-line analysis of the needle-board status. TECP gave its support thanks to their knowledge in mechanical design for their respective areas of knowledge;

The project results (knowledge contained in MUQUPS subsystem) are planned to be exploited through direct production and assemble activities undertaken by Consortium partners or spin off created by Consortium SME partners. Also the indirect exploitation through sublicensing is considered.

To avoid the unexpected events related with commercial sensitive information of MUQUPS, Exploitation Committee decided not to distribute publicly any scientific and technical information except that of general character, since IPR will be not preliminary protected.

Project results will be exploited through **MUQUPS** monitoring subsystem delivery composed of multisensor board for “on line” broken needles observation, signal processing unit and appropriate software for nonwoven quality prediction, appropriate data base and GUI.

Results will be exploited through delivery of **MUQUPS** equipment and licensed software. In some cases it may require needle board to be upgraded in order to allow precise measurements. Equipment will be designed for needle boards manufactured by consortium partners under classified technology conditions. Further on, results will be made available to other parties upon business relations with other European needle punching equipment manufacturers. For that case, the necessary system modification related with design space will be under classified formula agreed with prospected Contractor. Solutions will be made available both for new needle punching equipment as well as for machinery presently used by nonwoven manufacturers.

Commercialization of project result will begin in Germany, Italy, Poland and Slovenia. Further on proposals will be made to parties having their registered headquarters in European Union.

Problem of potential obstacles is grouped as follows:

- the existence or development of similar or competing technologies / solution elsewhere. According to present investigation and patent clearance study performed, Consortium believes, that there are no competing technologies and solutions present on the market – see Deliverable 17.
- third party rights (e.g. patents belonging to competitors), standards,...



Consortium has performed a study which is enclosed in deliverable D17. Study is regarding patent clearance of this project and product. It is a base to define any third party rights related directly to the project.

Third party rights may indirectly influence the project whenever designed equipment and software is applied to needle punching equipment manufactured by parties other than consortium members. Consideration of third party rights will then be necessary to undertake design modifications of the needle punching board as well as design modifications of monitoring equipment. That modification will be done under agreed technical classified conditions

- analysis of any (potential) non-technical obstacles

Consortium believes that there are no-important non-technical obstacles will not influence the project in a significant manner today. However consortium feels that additional studies should be performed in order to evaluate potential obstacles posed by:

- cost of monitoring subsystem installation related to expected advantages of it's use;
- new techniques of faulty nonwoven production use, which may decrease cost of it's utilization

Knowledge arising from the work on Project according to the Cooperative Research Specific Provisions - §1 and 2 of Article II32 being the Annex 2 of the Contract, **it is the sole and joint property of SME Partners.**

After IPR's are secured, Consortium members will be ready to:

- to allow the publishing of articles and presentations to the nonwoven experts,
- offer equipment and licensed software to the market,
- offer further development dedicated to needle punching equipment manufactured by parties external to the consortium,
- discuss further Research and Development with external research centers

Consortium has initiated it's activity on patent application now – see survey on patent in Deliverable 17. Project Coordinator will undertake an effort to apply for patents regarding technical solutions resulting from the project. Project Coordinator will perform consultations with Consortium members in order to define contents of such application.

2. Dissemination of knowledge

The Consortium recognizes the need to transfer the technology to a wider industrial community by offering manufacturing and distribution licenses and establishing joint-venture agreements all over Europe and the World to expand supply capability whilst generating royalty revenues. Consortium considers approaching EDANA, (European Nonwoven Textile Association) for support on sustainable development of project results.

Since NEEDLES project is co-funded by the European Commission, the major obligation for Consortium is to make results available for European industry community. In order to fulfill this obligation, Consortium has elaborated a business solution, which allows manufacturers of needling equipment to:

- apply the solution in their new equipment;
- apply the solution in modernization of equipment manufactured earlier;
- involve other parties, registered in European Union, to work together with the Consortium on further development of this project

Following table is summarizing Consortium current and future knowledge dissemination efforts.

No	Planned or actual dates	type	type of audience	Partner responsible (involved)
1	2007	Database	Beneficiaries of his project	CMS
2	2005-7	Internal Consortium meetings	Consortium members	CMS
3	tentative	Press/Radio/TV Release	General public	
4	tentative	Media briefing	Higher education	
5	2006 --	Conferences	Beneficiaries of his project	STFI, DAPP, SKA
6	2006 --	Exhibitions	Nonwoven manufacturers, Equipment manufacturers R & D Centers	CMS, TECP, KK, Speritex, GWS
7	2007	Publications	Technical Higher education	CMS
8	2006	Project web-site	General audience Privileged audience Consortium members	CMS, DAPP
9	2006	Posters	Beneficiaries of his project	CMS, DAPP
10	2006	Flyers	Beneficiaries of his project	CMS, DAPP
11		Direct e-mailing	Beneficiaries of his project	All
12	2007	Film/video	Beneficiaries of his project	SKA, CMS
13	2007	On Site inspections	Nonwoven manufacturers, Equipment manufacturers	TECP, STFI



Dissemination of knowledge is organized on two platforms:

- Project; dedicated to promote theoretical bases, research achievements, new technical solutions and further development and limited with IPR and patent formulations;
- Product; dedicated to promote product design, product properties and feasibility of product implementation.

Dissemination efforts are generally dedicated to:

- Consortium members;
- Other Project Beneficiaries;
- Project stakeholders;
- General public.

Consortium will continue to promote NEEDLES project result within the community of nonwoven manufacturing industry in order to allow European companies to keep competitive advantage resulting both from quality and manufacturing cost. Solutions and applications will be offered directly by Consortium members to the market according to the CA.

Below some meaningful elements of dissemination plan will be shortly described.

The data base was collected and presently it is released for use of Consortium Partners.

Considering internal Consortium meetings, it is agreed that in the postproject phase, the Consortium would meet every one quarter a year to agree on actual level of dissemination and exploitation activity of Partners.

Presentations of project results have o form of either conferences presentations, seminars, workshops or editorials. Presentations of both project and product have begun in the 6th quarter of project duration and it will be accompanied by distribution of flyers and leaflets as well as collection of data regarding beneficiaries. Consortium will expect a feedback that collected from participants of conferences in order to refine the product. Analysis will be performed and integrated in a short report or MoM. Information regarding the role of European Union support will constitute an integral part of every presentation.

Conferences		Project activities								Post project activities								Partner
		2006				2007				2008				2009				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
	Conferences and workshops																	
1	Workshop 2006-06-20			1														CMS
2	NAOMITEC 2006-09-28				1													CMS
3	AUTEX'07 conference in Tampere; STFI							1										STFI
4	Man-Made-Fibres Congress Dornbirn/Austria Sept.2006/2007/2008				1				1						1			STFI
5	International Nonwovens Conference Hof/Germany Nov.2006/2007/2008					2									2			STFI
6	Bautex- STFI-conference for textiles in construction Chemnitz Jan.2008												3					STFI
7	m-tex conference Automotive textiles, Chemnitz Germany June 2008													2				STFI
8	EDANA Nonwoven Research Academy Chemnitz Oct.2008															2		STFI

According to the more custom for SME way of dissemination process, Consortium members are pursuing opportunities to present this product during exhibition of the following nature:

- National within home countries of consortium members;
- Local organized by various societies related to nonwoven industry
- Organized by Consortium members

Exhibition of project product will be accompanied by distribution of flyers and leaflets as well as with collection of data regarding beneficiaries.

Exhibitions	Project activities									Post project activities						Partner	
	2006					2007				2008			2009				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		16
1	"Micronora" 2006-09-28, Besancon																CMS
2	Powtech																KK
3	APLF Hongkong																KK
4	Consumexpo Moscow																KK
5	MACEF Milan																KK
6	Ambiente Frankfurt																KK
7	Houseware Chicago																KK
8	PLMA / Interclean Amsterdam																KK
9	Lineapelle, Bologne 04.07																KK
10	Science & Economy MTP 2007, Poznań																CMS
11	Techtextil Frankfurt June 2007																KK, STFI
12	Techtextil Rossija																KK
13	SHK Moscow																KK
14	ITMA Munich Sept. 2007																STFI
15	PLMA Dubai																KK
16	Techtextil Rossija																KK
17	INDEX International Nonwovens Exhibition Geneve/Switzerland April 2008																STFI
18	Achema																KK

Publications of Consortium Partners will be presented in home countries of Consortium members and will regard following issues:

- New technical solutions applied in this project;
- Design features of the product;
- Needle punchboard lifetime extension achieved;
- Feasibility of product use;



It is assumed, that in that period of time, the knowledge to be disseminated will achieve the status of unclassified knowledge after IPR protection process is proceeded.

On the chart, the R&D activities (WPs duration) are matched with WP6 knowledge dissemination activities assumed duration. are listed within the period of duration of an appropriate WP. On the right hand side of the table suggested participants for pointed WP6 activity are suggested.

The final detailed plan for knowledge dissemination plan are presented in the Deliverable 19.

	WPs - WP6 cross-relation	Research and Development (quarters)								Post project - implementation activity (quarters)								Partner
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
	Task/activity																	
	WP1 - Scientific Analysis and System Requirements	■																
WP6:	Existing knowledge evaluation - innovative aspects				■	■	■	■	■	■	■	■	■	■	■	■	■	
	WP2 - System Design and Development		■	■	■													
WP6:	WEB side design; rules for inter. document & knowledge circulation			■	■	■	■	■	■	■	■	■	■	■	■	■	■	
WP6:	WEB side -public documents/project info		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
WP6:	Feasibility study for new equipment and upgrade of an old system					■	■	■	■	■	■	■	■	■	■	■	■	
WP6:	Nonwoven SME manufacturers DB creation					■	■	■	■	■	■	■	■	■	■	■	■	
	WP3 - Control Software			■	■													
WP6:	project Leaflet release					■	■	■	■	■	■	■	■	■	■	■	■	
WP6:	Debate about intellectual property aspects of project development					■	■	■	■	■	■	■	■	■	■	■	■	
WP6:	Investigation on possible patent application						■	■	■	■	■	■	■	■	■	■	■	
	WP4 - System Integration and Prototyping					■	■	■	■									
WP6:	internal consortium training on the solution features					■	■	■	■	■	■	■	■	■	■	■	■	
WP6:	workshops/country scale						■	■	■	■	■	■	■	■	■	■	■	
WP6:	Conferences - project presentation							■	■	■	■	■	■	■	■	■	■	
WP6:	Journal presentation - editorial							■	■	■	■	■	■	■	■	■	■	
	WP5 - Testing and System Performance Evaluation							■	■									
WP6:	Seminar and conferences - solution presentation									■	■	■	■	■	■	■	■	
WP6:	Fairs and exhibitions - solution presentation										■	■	■	■	■	■	■	
WP6:	Plan for pilot production								■	■	■	■	■	■	■	■	■	



3. Publishable results

According to the demand for IPR protection as well as prospected patent application, there is no exploitable results released for publishing purposes.

However, ready to publish technical and dissemination paper are prepared – see Deliverables 15 and 16.; those will be published as soon as the IPR and commercial rights would be protected. Also a project poster was published in the polish technical journal: “Textile Review”.



APPENDIX 3: IPR and Know-how Transfer Agreement

Knowledge based process control system to optimize needle performances for high added value needle punched nonwovens

Intellectual Property Rights and Know-How Transfer Agreement

In between:

1. D'Appolonia SPA, via San Nazaro 19, Genova, Italy; represented by Giampaolo Vaccaro or his authorised representative
2. SKA POLSKA SP. ZOO, Plac Litewski 2, 20080, Lublin, Poland; represented by Mr Marcin Bukat or his authorised representative
3. Saechsisches Textilforschungsinstitut E .V., Annabergerstrasse 240, 09072, CHEMNITZ, Germany, represented by Mr Hilmar Fuchs or his authorised representative

Herein after referred to as Consortium RTD Performers and

4. CIM-mes Projekt sp. z o.o., GRZYBOWSKA, 87, 00844, Warsaw, Poland; represented by Krzysztof Grabowiecki or his authorised representative
5. Geo Textil Westsachsen GmbH, Zeitzerstrasse 47, D-08451, Crimmitschau, Germany; represented by Mr Gabriel Mantzouridis or his authorised representative
6. KONUS-KONEX d.o.o., MESTNI TRG 18, 3210, SLOVENSKE KONJICE, Slovenia; represented by Mr Savo Grilj or his authorised representative
7. Technoplants S.r.l., Via Carbonaia 25, 59100, Prato, Italy ; represented by Mr Marco Gualtieri or his authorised representative
8. Speritex S.p.A., Via Masserano 22, 13862 Brusnengo (BI), Italy; represented by Mr Nicola Rodrighiero or his authorised representative

Herein after referred to as Consortium SME Partners

The Intellectual Property Rights of knowledge arising from work carried out under the project according to the Contract COOP CT 2005 018221, Annex II Art II.32, §1 and 2 , and Annex III Art. III.5 :

- Methodology for on-line analysis of needles status:
- Design of the sensor pad:

is solely and unconditionally transferred from Consortium RTD Performers to Consortium SME Partners. RTD Performers have the right to use their contributed knowledge and know-how raised within the project and documented within deliverables of the Project for their own research, but under no circumstances for commercial activities.

