



CONTRACT No. COOP-508340

EMERGPAPE

**DEVELOPMENT OF A FULLY INTEGRATED IT SOLUTION FOR THE  
PAPER INDUSTRY BASED ON EMERGING OPTO-ELECTRONIC AND  
SENSORY TECHNOLOGIES**

## **PUBLISHABLE FINAL REPORT**

**Period covered: from 01/09/2004 to 31/08/2005**

**Start date of project:01/09/2004**

**Duration: 24**

**Months**

**Project Co-ordinator organisation: MONDRAGÓN SISTEMAS DE LA  
INFORMACIÓN, SOC. COOP.**

1.	Overall Technical and industrial objectives.....	3
2.	Contractors involved .....	4
3.	Expected results .....	4
4.	Achieved results .....	4

# 1. Overall Technical and industrial objectives

Paper industry is a key element of the European industry, which generates an annual turnover in excess of Euro 400 billion, providing direct employment for over 260.000 people and indirect employment for around four million. Paper is produced in hundreds of different grades – each has to meet certain requirements (some paper buyers impose special requirements). For a small to middle size paper mill this means that the product variety could be exhausting and the paper mill bottom line result often depends completely on the efficiency of the adjustment procedure at grade changes. Even if a manual laboratory makes the final examination of paper for delivery, this will not help very much to improve the efficiency of the paper mill. The mill production personnel have to trust in on-line instruments.

The scientific/technological objectives consist of integrating existing QCS and DCS solutions in a total IT system and developing advanced subsystems to be integrated on it, based on emerging opto-electronic and sensory technologies: (1) An improved detector technology for basis weight sensors allowing fast sampling and higher sensitivity; (2) A new optical design of an IR based Moisture gauge allowing high-frequency sampling; (3) A new detector for measuring X-ray absorption in mineral compounds within the paper or in coating layers with faster sampling and higher sensitivity exploiting emerging silicon detector technology; (4) A new material for the caliper measurement head, which can endure the heavy abrasion forces in the contact with the paper; (5) A new sensor based on NIR technology able to measure coating layers, chemical compounds in the paper and amount of binding forces between the cellulose fibres in the sheet based on front edge photo diode technology; (6) A new sensor based on super fast cameras and FPGA technology for image processing for surface analysis of paper webs in full speed (7) An improved induction-heated caliper control actuator for improved CD thickness control; (8) A knowledge based information system that automatically uses new data for updating the mill condition thus improving preventive maintenance; (9) Introduction of a robust process control techniques based on dead-time compensated controllers and feed-forward links which could be introduced to small-middle size paper mills; (10) Improved access to all mill data through open protocols and thin-client concepts in accordance with recent Microsoft Window standard.

The major economic and industrial objectives are:

- A significant cost reduction in the paper manufacturers (small and medium paper mills)
- Cumulative profits from the sales of the expert system to reach 4,9 million euros, 4 years after project end.
- Increase even more EU competitiveness against USA enterprises in the paper production industry market.

The major social and environmental objectives are:

- Elimination of labour intensive and monotonous inspection tasks in lab.
- Reduction of the exposure of the operator to work in hazardous environments.
- Elimination of operator stress and error caused by the need for great attention to detail and raw material variability.
- Reduction of water consumption in paper mills, facilitating the sustainable development. Currently, water consumption in European paper mills is over than 80 million m<sup>3</sup> per day.

## 2. Contractors involved

PROJECT CO-ORDINATOR: B1 MONDRAGON SISTEMAS DE INFORMACION S. COOP (MSI)

*Contact details:*

Ama Kandida, 21 (DENAC) 20140 ANDOAIN (Gipuzkoa), SPAIN

Represented by Mr. Juan Carlos Irazusta

PARTNERS:

- A1 WEBRAY AB
- A2 OY WALTTI ELECTRONICS LTD.
- A3 BAPCO A.I.E.
- A4 DIGITAL ENGINEERING PROCESS SWEDEN AB
- A5 EL SENSOR AB

RTD PERFORMERS:

- B2 SWEDISH PULP AND PAPER RESEARCH INSTITUTE AB (STFI)

## 3. Expected results

The expected results are:

- A standardised system will offer an affordable price making total QCS/DCS solutions available even to small mills
- Improved supervision of production through "data mining" and wide spread information
- On line measurement and estimation of all essential paper parameters for better quality control
- Reliable sensors with less need for calibration and long-term stability yet higher sensitivity
- New innovative sensors for measurement of paper features yet not available for online systems
- New cross directional actuators and control system with higher performance and less energy consumption
- Control loops based on best practice and robust controllers will improve paper machine performance

## 4. Achieved results

Accordingly, these are the main results achieved in the whole project:

1. Design and development of sensors based on silicon and IR moisture.

The developments that are included in this part are:

- i. **Basis weight sensor** with silicon technology to work in very hard environment with high temperature. This new technology uses silicon detectors often combined with scintillators. The long-term stability has been improved in reference to the high-voltage tubes of older generations. The right

choice of detector silicon solution together with the right type of scintillator has solved previous calibration problems.

- ii. **Ash sensor** based on Iron 55 isotope. Since the physical process is independent of temperature and disturbances it provides the customer with an absolute way of measuring - independent of otherwise very cumbersome calibration work.
- iii. **Moisture sensor** with a completely new design of the detector head for four wavelengths allowing "same spot" measurement for all wavelengths in real time. It is based on the principle of infrared (IR) absorption.
- iv. **Caliper sensor** with "zafire" based technology to measure the thickness of the paper in very hard environments with high abrasive forces.
- v. **Gloss sensor** based on Photo Diode arrays exploiting latest opto electronic devices

## 2. Cross directional control

The cross directional control has been combined with the measurement system in the right way. High-frequency electrical induction in has been used in small segments improving control and energy management. The efficiency and the control accuracy have been improved as well.

The results are:

- Adaptive and machine optimized control algorithm software for PC
- Advanced functions for mapping and self tuning
- Grade library stores parameters for control tuning and optimization

## 3. QCS systems

The exploitable results are:

- Design and development of profile management algorithms that permit interfacing to cross directional control subsystems.
- Design and development of SCADA with the aim to control all the measures made.
- Development of simulator
- Development of QCS

In conclusion, the QCS consists of a robust O-Frame or C-frame with A/C motor, frequency converter and cogged belt drive assuring high CD resolution.

## 4. DCS / QCS

The fully integrated system has been concluded and tested. This DCS/QCS system remains as the global solution of previous work and as the main result of the project which integrated the rest of the work

Moreover, in the next table are shown the concrete results achieved in this project together with market application, stage of development, contact details and collaboration:

No	Exploitable products and innovative characteristics	Market applications*	Stage of development	Contact details	Collaboration
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1	Sensors based on silicon and IR moisture: basis weight (This new technology uses silicon detectors often combined with scintillators), ash (provides the customer with an absolute way of measuring - independent of otherwise very cumbersome calibration work), moisture (completely new design of the detector head for four wavelengths allowing "same spot" measurement for all wavelengths in real time), caliper ("zafire" based technology to measure the thickness of the paper in very hard environments with high abrasive forces) and gloss sensor (based on Photo Diode arrays exploiting latest opto electronic devices)	Paper Industry (international)	Developed and tested	Mr. Heikki Hyvärinen Phone: +358 17 3694900 <a href="mailto:heikki.hyvarinen@wالتتlectronics.com">heikki.hyvarinen@wالتتlectronics.com</a> <a href="http://www.wالتتlectronics.com">www.wالتتlectronics.com</a>	Among partners of Consortium
2	3 systems for cross directional control (High-frequency electrical induction has been used in small segments improving control and energy management)	Paper Industry (international)	Developed and tested	Mr. Sören Astrom <a href="mailto:soren@digitalengineering.se">soren@digitalengineering.se</a>	Among partners of Consortium
3	Sensors based on full spectra NIR systems (cover the region from 0.9 micrometer up to 2.2 micrometer. In the near future the region could be increased up to 2.5 microns . The methods used employ full-spectrum analysers without any moving parts by the use of area detectors)	Paper Industry (international)	Laboratory prototype	Mr. Rolf Syding +46855612850 <a href="mailto:Rolf.syding@elsensor.net">Rolf.syding@elsensor.net</a>	Among partners of Consortium
4	Sensors based on cameras and FPGA technology (measurement of the paper surface with a super fast camera allowing a resolution better than 50 microns at full speed or the full spectrum analysis of the paper in the near-infrared (NIR) region)	Paper Industry (international)	Laboratory results	Mr. Rolf Syding +46855612850 <a href="mailto:Rolf.syding@elsensor.net">Rolf.syding@elsensor.net</a>	European industrial partner for a new project
5	Development of QCS systems (QCS consists of a robust O-Frame or C-frame with A/C motor, frequency converter and cogged belt drive assuring high CD resolution.)	Paper Industry (international)	Developed and tested	Mr. Alex Artaza Phone: +34 944 807 170 <a href="mailto:ales.artaza@bapco.es">ales.artaza@bapco.es</a> <a href="http://www.bapco.es">www.bapco.es</a>	Among partners of Consortium
6	Development of DCS systems (simulator of paper production process, from the beginning to the end)	Paper Industry (international)	Developed and tested	Mr. Alex Artaza Phone: +34 944 807 170 <a href="mailto:ales.artaza@bapco.es">ales.artaza@bapco.es</a> <a href="http://www.bapco.es">www.bapco.es</a>	Among partners of Consortium

7	Development of integrated IT solution: DCS/QCS (developing of a complete IT solution integrating all those innovative developments in one)	Paper Industry (international)	Developed (tested in due course once an industrial partner is found)	Mr. Alex Artaza Phone: +34 944 807 170 <a href="mailto:ales.artaza@bapco.es">ales.artaza@bapco.es</a> <a href="http://www.bapco.es">www.bapco.es</a>	Among partners of Consortium
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