# SYNTHESIS REPORT

**CONTRACT No : BRE 2- CT92 -0261**

**PROPOSAL No : 5640**

## TITLE : "Development of a system to detect and to remove foreign materials in raw cotton and scoured wool"

**PRIME PROPOSER:** Kortrijkse Katoenspinnerij (B)

**CO-ORDINATOR:** the University of Ghent, Department of Textiles (B)

**PARTNERS :**      Gemona Manifatture (I)

           Greek Spinners (GR)

           Pulsarr (NL)

           Peignage Amédée (F)

**STARTING DATE :01.12.1992**          **DURATION :42 MONTHS**

***Abstract***

*In this pr-eject research was carried out to develop a system to detect and remove foreign materials in raw cotton and scoured wool. For cotton, a system was built and tested that performs at least as well as competing systems, but its price is about 30°A lower. The prototype for wool did not perform so well. In the future, the cotton system will be evaluated for wool.*

# 1.   INTRODUCTION

Cotton is a natural vegetable fibre.  The fibres are picked from the plant, separated from the seeds they grew on (i.e. ginned), pressed into bales and packed, most of the time in polypropylene and jute.  Then, the bales are transported to the spinning mill, where the packages are removed.  Layer per layer, the fibres are taken off of the bales for processing into yarns.

Wool is a natural animal fibre. The fibre mass is shaved from the sheep, pressed into bales and packed in polyethylene or jute. Sometimes, the layers in a bale are separated with polyethylene sheets. The fibre mass can be contaminated with dark fibre tufts. The dark colour is due to burning of the fibres by the urine of the sheep. In contrast to cotton, one whole bale is taken into the process at a time.

All of these operations have been automated to a large extent. The discharge of people has led to the elimination of human inspection of the fibre material. This means that all kinds of foreign materials that may be present in the fibre mass are no longer detected and, hence, not removed.

Part of those "impurities" consisting of large and heavy objects, such as metals, sand and stones etc., can be detected or separated during the normal cleaning processes preceding spinning.  Unfortunately, this is not the case for "fibrelike" materials such as fabrics (pieces from shirts, cloths for cleaning of cotton picking and ginning machines, but most of all rests from packages, i.e. jute, polyethylene and polypropylene) and dark fibre tufts that behave very much like the fibres and may be processed into yarn and fabric. Moreover, because of the quite aggressive mechanical action of the opening and cleaning processes, a piece is torn into a large number of

small pieces spread over a large mass of fibres. As a result, one piece of polypropylene of a few grams for example can cause tonnes of rejected yarn or fabric.

Often the problem is detected not earlier than after dyeing, when they cause differently dyed or undyed spots. At this stage, the economic value of the product is very high, so that financial losses can amount to several 10000 ECU.

So, it is very important to detect those materials as early as possible in the production process. It is a problem that does not occur frequently (except for dark fibre tufts, which occur quite often), but when it occurs, the financial (and. other) implications are enormous.

## 2. OBJECTIVES

The objective of the project is to develop industrial quality control machines for the real-time detection and removal of contaminants and foreign materials in raw cotton and scoured wool. The aim is to detect at least 98°/0 of the harmful materials (coloured, non-coloured and transparent). The system should be fully integrated in the processing line and also contain an information system to provide sufficient statistical process data. The price of the system should preferably not exceed 90,000 ECU.

. quality control of raw material

. higher and constant quality of the" end product

. higher yields and lower costs

The project targets the following general advantages for the textiles industry:

## 3. TECHNICAL DESCRIPTION

### 3.1. Consortium

The consortium consists of a research center (university), a system manufacturer and end users (3 cotton spinners and 1 wool washer).

The **Department of Textiles is** the textile laboratory of the Faculty of Applied Sciences at **the University of Ghent**.

It has a long tradition (since 1929) in testing and processing of natural fibres, in particular flax and cotton. Other research topics are high speed weaving, carpets, composite materials and geotextiles.

A few years ago, the laboratory has started research in the field of applications of vision technology in textiles, e.g. detection of defects in fabrics, automatic assessment of carpet wear, the use of neural networks for various applications. Their tasks were project co-ordination, collection of samples and research on detection methods.

### Kortrijkse Katoenspinnerij (KKS)

The largest independent and non-integrated spinning mill in the BENELUX.

They have been producing yarn from 1928 onwards without interruption. Cotton and cotton blends are processed. Yearly, they produce more than 10.000 tons of yarn for a variety of applications: furniture fabrics, velvet, carpets, tents, conveyor belts, sun shades, table linen, bed sheets, etc.. Their tasks were to provide practical information from the user's side and to test prototypes (cotton).

### Gemona Manifatture

Founded in 1955, The company runs three spinning plants in North East Italy, producing 20000 tons of single and plied, carded and combed yarns per year for knitting, weaving and sewing. Apart from providing practical information from the user's side and testing prototypes (cotton), they were to compare the prototypes with the Tatsumi system.

### Greek Spinners Association

**Iliotex**   Textile Mills Iliotex S .A. is a manufacturer of 100% combed cotton ring spun yarns for knitting and weaving, ranging from 15 to 40 tex. The average count is 20 tex and annual production reaches about 6000 tonnes.

The company was established in 1974 as a joint venture between the Accas brothers and the Dutch company Royal Nijverdal-Ten Cate. Iliotex is part of a larger group of companies including cotton ginning, spinning and denim production.

They are located in Kilkis (north of Greece).

They have a capacity of 42000 spindles, of which 14000 have been installed . in 1990. The company employs 390 people.

**Naoussa Spinning Mills**    Naoussa Spinning Mills S.A. is a large spinning company producing cotton yarns, both ring and rotor spun as well as blended yarns. The yarns are meant for the weaving and knitting industry. The count ranges from 15 to 60 tex.

The company belongs to the Klonatex I. C.S.T. & T.S.A. group. It was established in 1963. The group includes manufacturing of textiles, weaving, knitting and ready made garments.

There are four spinning mills, located in the area of Naoussa, Macedonia.

They have 81000 spindles, 6048 rotors and employ **760** workers.

They were also to make the link to ginning mills.

### Peignage Amédée

Peignage Amédée was founded in 1851, and is now a leader in wool merchandising and processing. Yearly the mill produces approximately 30.000 tonnes

. provide practical information from the user's side (wool),
- adapt processing line for the integration of prototypes,
. construct prototypes (wool),
- test prototypes (wool),

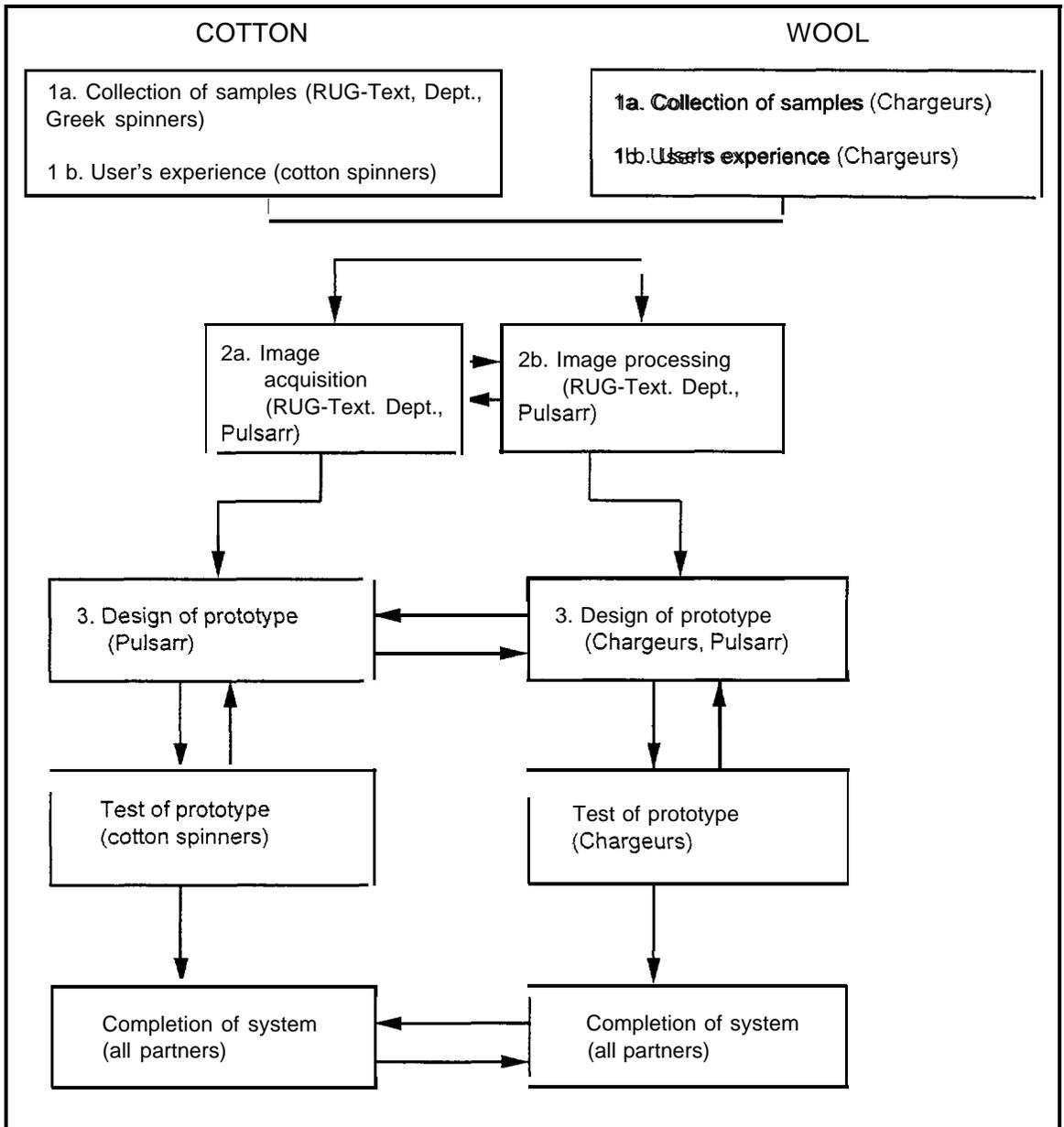of combed wool, with 650 employees. Their tasks were to

### Pulsarr

Pulsarr Industrial Research BV designs, develops, manufactures and sells quality control machinery for different kinds of industries. The machines are based on computer vision, working at extremely high speed, dealing with strong environmental conditions (e.g. in food processing industry).

Expertise on scanning techniques ranges from the visible spectrum to X-radiation. Research and development result from experience in physics, mathematics, construction, software (image processing) and hardware. Their tasks:

- research on image processing for detection of foreign materials,
- generation of prototypes, including removal of detected objects,
- optimization  of  prototypes,
- set-up of information system.

## 3.2.  Flow  diagram

| COTTON | WOOL |
|---|---|
| 1a. Collection of samples (RUG-Text, Dept., Greek spinners)<br><br>1 b. User's experience (cotton spinners) | 1a. Collection of samples (Chargeurs)<br><br>1b. User's experience (Chargeurs) |

2a. Image acquisition (RUG-Text. Dept., Pulsarr)

2b. Image processing (RUG-Text. Dept., Pulsarr)

3. Design of prototype (Pulsarr)

3. Design of prototype (Chargeurs, Pulsarr)

Test of prototype (cotton spinners)

Test of prototype (Chargeurs)

Completion of system (all partners)

Completion of system (all partners)

### 3.3. Results

#### 3.3.1, Cotton samples

As the really harmful foreign materials only appear after spinning, weaving or even dyeing, little information is available on how they appear in the bales. It is in fact a hidden problem. One can imagine the origin of the materials, but the chance that one see it in the bales at a particular time is negligible.

Since the detector system works only for the range of samples that have been considered from the beginning, it was absolutely necessary to collect a representative set of samples at the start of the project.   Therefore, one person inspected the bale surface continuously until at least 20 samples have been collected. This took **2** months, 1 month at each spinning mill.

| Type | KKS | Gemona |
|---|---|---|
| jute | 50 | 19 |
| co loured fibres | 15 | 42 |
| yarns | **40** | 6 |
| fabrics | 17 | 0 |
| coloured PP | 53 | 2 |
| white/transparent PP | 25 | 0 |
| other | 21 | 14 |
| **pieces per hour** | **1.47** | **3.46** |

. there are many more foreign materials than expected;

. the type and quantity of contamination highly depends upon the origin of the bales.

The conclusions of this task were that

#### 3.3.2. Wool samples

For the best qualities, human inspection is still being done. This is a very efficient way to provide representative samples. However, it will also be necessary to

make this kind of inspection for the other qualities. A set of at least 50 representative 、 samples are collected. The basic pattern of the fibres was also important.

The samples are collected manually.

Equipment : CCD-camera and storage facilities, light sources

The inspection was made for three qualities of wool : two extreme and a medium one. The defects were classified into five classes, as shown in the table below:

| Trash type | Lower quality | | Medium quality | | Good quality | TOTAL (%) |
|---|---|---|---|---|---|---|
| | output dryer's conveyor | Pit-feeder | Output dryer's conveyor | horizontal apron of card's feeder | output dryer's conveyor | |
| Light Yellow fibres | 120 | 24 | 192 | 24 | 24 | 22.72% |
| Dark coloured or burnt fibres | 96 | 24 | 120 | 72 | 120 | 25.56% |
| Dirty or greasy fibres | 96 | 72 | 120 | 96 | 48 | 25.56% |
| Yarns | 7 | 0 | 0 | 3 | 0 | 0.60% |
| Miscellaneous | 192 | 24 | 0 | 0 | 216 | 25.56% |
| TOTAL | 510 | 144 | 431 | 195 | 407 | 1 6 8 8 |
| Duration of inspection (h) | 130 | 130 | 80 | 80 | 130 | |
| Frequency (minute/default) | 15 | 54 | 11 | 25 | 1 9 | |

Miscellaneous : Skins, Plastics, Papers...


### 3.3.3. Research on detection of foreign materials

This task was split up into two parts, namely image acquisition and image processing.

Image acquisition has focused on the optimal location in the proces for detection and illumination techniques.

Quite soon it became clear that detection at the bales leads to many artefacts becaude of the irregular bale surface.

As for the illumination techniques, special attention had to be payd to detection of transparent and uncolored materials.

### **3.**3.4. Prototyping

Several prototypes were built, for cotton and for wool,

The first ones were static, later on dynamic systems were built that worked at low speed. During the last phase of the project, a fast system was constructed, equipped with a separation system,

All prototypes were tested at the mills in order to evaluate their performance and stability, to trace particular problems and to make comparison with existing systems.

At the end a choice had to be made between a colour matrix and a monochrome linescan camera. The criteria are summarised in the table below:

| "MATRIX" | "LINESCAN" |
|---|---|
| *RGB matrix camera (full colour, 2-dimensional information with possibility of pattern recognition, ECU 6000 per piece, relatively slow: 25 Hz acquisition, illumination difficulties) | *Monochrome linescan camera (shades of intensity, 1-dimensional information with less image processing possibilities, ECU 1500 per piece, very fast: 1500 Hz acquisition, simple illumination) |
| *Very expensive computer (approximately ECU 50000, long development time for software, difficult parametrisation) | *Cheaper computer (approximately ECU 8000, fast development, easy to control) |
| *Synchronization problems (for rejection and image overlap) | *Simple synchronization (for rejection and total product view) |
| *Large and slow machine (with use of a condensor, b i g g e r dimensions, lower capacity, thick cotton layer (also in heaps), more expensive) | *System set-up as extension to pipeline (speed restrictions < 8 m/s, small dimensions, fill production capacity, cotton maximum opened (very small tufts), cheaper) |
| *Detection rates? (also detection of patterns, no detection when inside thick layer, more false rejects because of product inhomogenity, dependent on 'learning file' quality, based on more different options, tested in laboratory environrnent) | *Detection rates? (detection merely on different colours, no hiding of defects, less false rejects and less reject of good cotton with the defects, stabile, in principle based on local tresholding, no figures yet) |
| *Extension (system with special features still gives no satisfying results for polypropylene) | *Extension (extension can create discriminating power for polypropylene) |

The last prototype was installed at the pIant of Naoussa Spinning Mills. The results were good. A comparison with the Optiscan system was made. Both systems show approximately equal performances.

At the plant at Naoussa, a simple rejection system using a flap was installed. A fast flap was selected. After optimisation, about 100g of fibres are rejected each time. The spinner consider this not to be critical, as these fibre mass can be put back in process, after manual cleaning.

Moreover, a fast valve or nozzles cost about equal price.

## 4.    FINAL CONCLUSIONS

Within this Brite Euram project a new machine has been developed, the PULSARR RX-CS, that has the ability to detect and remove contaminants and foreign bodies from a high speed throughput of raw cotton. Real-time in-line detection of packaging materials, pieces of wood and foreign fibers basically is performed on the base of colour differences. Detection starts from contaminant sizes of five by five millimeters.

The machine is easy-to-install as a black box application in existing pipeline designs directly after the bale opener. The price is expected to be 65-75000 ECU, which gives the system an excellent price/performance relation as compared to what is already on the market. Long term tests in production lines with strong environmental conditions are at the moment being completed in two Greek spinning mills. An adjusted set-up of the mentioned machine will be used for final wool tests also. Wool tufts however are less opened (bigger) than cotton tufts, so results will probably be less good.

As for the separation system, it is possible to use a fast flap or air nozzles. Both systems cost about the same price.