



Project no. 508320

DESIRE

Development of Simple and Reliable On-Line Monitoring Equipment for
Thermal Spraying Control

Instrument: **CO-OPERATIVE RESEARCH PROJECT**

Thematic Priority: -----

Final Activity Report

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Project coordinator name : **Ignacio Fagoaga**.

Project coordinator organisation name: **INASMET-TECNALIA**

Revision: vs.00.

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 2 of 11.
	FINAL ACTIVITY REPORT	

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	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 3 of 11.
	FINAL ACTIVITY REPORT	

INDEX

Document Information..... 2

Section 1 – Project Execution 4

Section 2 – Dissemination and Use 10

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 4 of 11.
	FINAL ACTIVITY REPORT	

Section 1 – Project Execution

Project Objectives.

The project consists of the development and manufacturing of simple and reliable on-line monitoring equipment for thermal spraying process control.

The development of the equipment proposed in this project offers the possibility to monitor permanently the characteristics of the thermal spray flame, as direct indicator of the stability of the spray process. Thus the promised quality of the sprayed coating could be guaranteed.

Different sprayshops using the same thermal spraying guns, same powders and same parameters produce coatings with different quality. It means that many changes can occur and are not detectable. As a result different coatings and different properties are obtained. The “in situ” measurement of the flame properties and changes is the only suitable method to guarantee a constant control process, and to assure fulfilment of the most strict demands of the end-users.

The project is focused on the development of a flame properties monitoring device including hardware and software. Using this new equipment the high quality coating will be guaranteed from the beginning till the end of the spray process.

Existing equipments are based on expensive measurements of the in-flight velocities and temperatures of individual particles. These equipments are mainly used in research and development centres to correlate the properties of the particles and the characteristics of the coatings. The data obtained by existing equipments should be processed and an expert is needed to correlate these data with the quality of the coating. The monitoring equipments it will be specially developed for SMEs needs, since it is not focused on the physics of the process but on the process reproducibility, and does not need the presence of an expert to analyze the data.

By using the new monitoring and control systems the SMEs will guarantee a more stable process control assuring a deeper knowledge of the process progress. The utilisation of the device should improve the quality of the sprayed products, it gives information about process instabilities and possible coating defects and the test coupons can be reduced if

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 5 of 11.
	FINAL ACTIVITY REPORT	

monitoring device is used as a process setting procedure. All these advantages should lead to important cost savings but also to important marketing and selling arguments.

The existing equipments are so complex that several days of training are required to understand the “meaning” of the obtained data. Most of SMEs can not afford this “extra time” and finally they refuse to add these equipments to their sprayshops. The new proposed equipment is specially designed for small sprayshops, in order to assure it will be directly introduced into production lines. The developed equipment can be in a short term offered to the market. The equipment is easy to use and can be easily adapted to the existing guns.

List of contractors:

Participant name	Participant short name	Country
MONITOR COATINGS LIMITED	MON	UK
TURBOCOATING	TUR	It
PUTZIER OBERFLACHENTECHNIK GMBH	PUT	Ger
ARTEC	ART	It
INASMET-TECNALIA	INA	Sp
CONSORZIO INTERUNIVERSITARIO DI SCIENZA E TECNOLOGIA DEI MATERIALI	INS	It

Co-ordination Activities.

The Project is co-ordinated by IGNACIO FAGOAGA.

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WORK PERFORMED

The project was divided in 5 technical work packages. In the following paragraphs a brief description of the objectives defined, the work performed and the achievements reached for each work package is included.

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 6 of 11.
	FINAL ACTIVITY REPORT	

Work Package 1. Specifications.

After defining the needs of the sprayshops and focusing on HVOF technology and the usual coating powders, a general document of specifications was agreed by all the partners. This document was the basis for future development of the monitoring equipment.

A characterization of the selected coating powder and technology by each spraying partner was performed on produced set of specimens as coating quality reference values.

Work Package 2. Design and development of the monitoring equipment.

Based on the former work package results the monitoring equipment was designed and manufactured. The monitoring system is composed of a sensor head (camera, filtering set) enclosed in an air cooled structure with a window to face the spraying flame which is protected by an air curtain from the dust and particles inherent to the spraying process. The sensor system is connected to a PC control unit with a specifically developed software.

The monitoring system has a temperature measurement system to monitor operating condition inside and outside the enclosure to assure system safe operation.

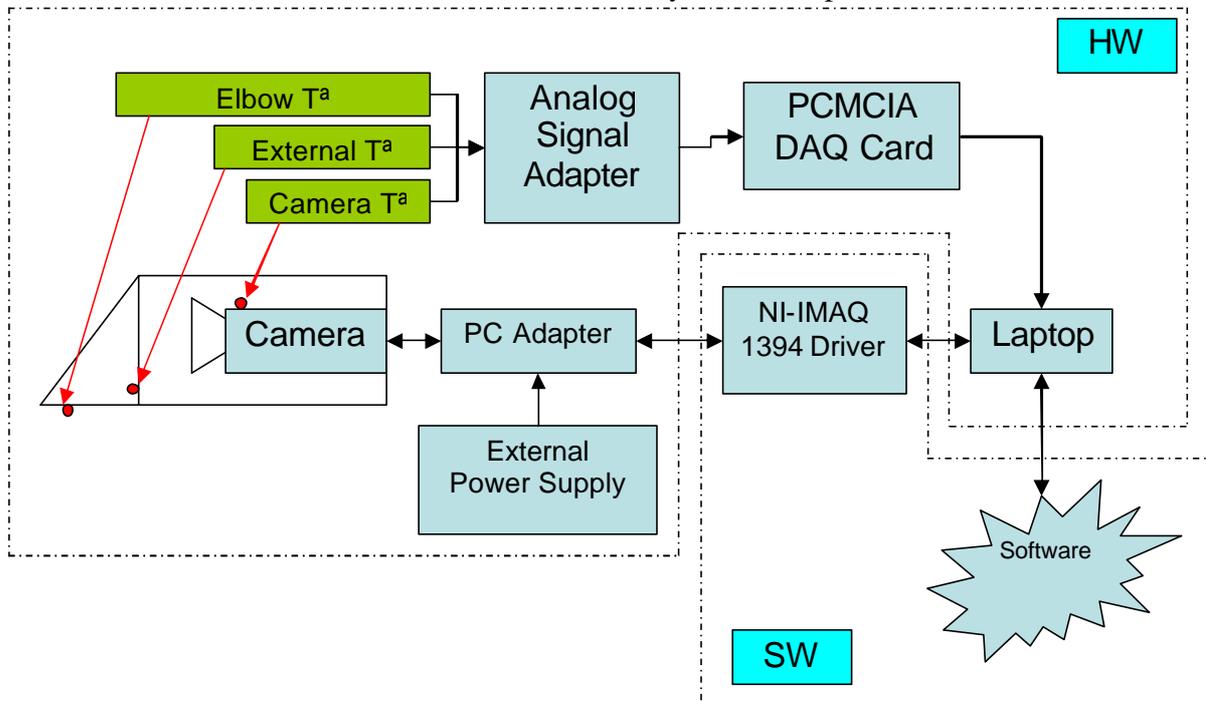


Diagram of the monitoring system components.

	DESIRE	Doc. Ref.: Final Activity Report.
	FINAL ACTIVITY REPORT	Project Ref.: 508320 Date: 5 th October 2006 Sheet 7 of 11.



Monitoring system mounted in HVOF spraying system.

Once the prototype was manufactured laboratory tests were performed to test equipment operability and evolution hardware and software and to adjust sensitivity and operation modes.

Work Package 3. Adaptability to the spraying equipment.

The monitoring equipment was tested at every spraying partner facilities with their specific HVOF gun and coating powder and process parameters.

The equipment worked properly in all the guns where it was installed. It was very easy to be mounted and provided quick useful information about the process variations and control. The equipment was easily adaptable and the monitoring results can be sated as reproducible.

A set of specimens was produced in each sprayshop ranging process parameters from the standard optimal conditions to extreme non usual coating failing conditions with the aim of relating process parameters values with coating quality characteristics by means of monitored flame parameter values. These big amount of specimens were characterised in terms of coating quality evaluation.

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 8 of 11.
	FINAL ACTIVITY REPORT	

Work Package 4. Industrial validation.

Real tests with industrial parts were also produced at each spraying partner facilities. The monitoring prototype behaved adequately and no operating problem arised. Process flow variations were also induced with the aim of, after metallographic characterisation, carrying out an analysis of the monitoring parameters in relation to coating quality values.

The monitoring device was intended to detect changes in the flame that can advice of a possible coating quality variation with values out of specifications. Taking into account the acceptable coating quality values specified for each spraying process the analysis of the measurements obtained from the tests was performed but it was found impossible to relate the process parameters with the coating quality and consequently with the measured flame parameter values registered by the prototype.

After the analysis of the results obtained in the tests the following conclusion were extracted:

- Process parameters variability is high within a sprayshop's coating process (manual control, wear of mechanical parts influencing the flame shape along the time, unstable feeding of gases and powder, etc.)
- At the same time processes seem to be robust, small changes in process flows do not lead to significant changes in coating quality parameters
- Variability in the process parameters utilized by different sprayshops is very high. Depending on the gun, fuel, powder and specifications of the coating the parameters can be four times the value in flow for the same process parameter.
- Coating quality values variability and standard deviations with no nominal variations in flows.
- Due to the variability of the process and the differences between sprayshops' process parameters, setting relations or tendencies between process parameters and coating quality parameters has been impossible. Consequently, setting relations or tendencies between flame parameters and coating quality parameters has resulted impossible.
- No general mathematical model has been able to be developed to correlate flame parameters with coating quality parameters.

As it is formerly explained and due to all the reasons reflected, the prototype, able to detect changes in flame parameters can not be calibrated in a general way for all the different sprayshops' processes in a precise or suitable manner capable of relating failure messages with real coating quality failures. A general calibration would be very sensitive for some processes, shooting failure messages when the coating would support variations within specifications. In any case this general calibration should be a very interesting tool for knowing and controlling each sprayshop's process.

Control parameters set in the prototype in a general way (control parameters to display a failure message if surpassed determined for any spraying process) result in a higher sensitivity of the device to changes in flow. This method of displaying failure or warning messages is more conservative and can be sated as a more secure way of monitoring. Although some of the messages are not related to coating quality failures the operator or process engineer is aware of the variability of the process before having a not acceptable coating.

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320 Date: 5 th October 2006 Sheet 9 of 11.
	FINAL ACTIVITY REPORT	

During the tests performed at the spraying companies' facilities, the aim of the device has been verified in a real manner. Problems with feed flows stability, leaks in the ducts, wear of components, flame shape variations, subsonic flows, feed control instability, etc. have been detected during spraying operations and modified with the operator. The device has shown an ability to diagnose the state or condition of the equipment or process with a glance on the flame screen.

Work Package 6. Cost Analysis.

A cost evaluation of the monitoring prototype was performed. The analysis was focused on the manufacturing and assembly costs. Cost of manufacturing and assembly the developed monitoring equipment is low in comparison with the complex devices in the market devoted to research and development. The objective of reducing costs to the 60% of the prices of the equipments in the market has been totally fulfilled.

Benefits achieved by the SMEs are very difficult to estimate due to the few operating hours employed in the prototype validation. The operation of the prototype has not, in these first utilisations, shifted the usual sprayshops process adjustment procedures, making very difficult the estimation of the reduction in time and material when using and trusting the monitoring prototype.

Work Package 5. Dissemination and exploitation of the knowledge.

Dissemination and exploitation activities have been also designed during the very last period of the year. Due to the late launch of the final results and prototype, there has not been time to develop any exploitation or disseminating activity but meetings and communications have taken place with this objective. A detailed plan has been elaborated and designed for future activities. Further information related with the dissemination and exploitation plans is available in correspondent documents and deliverables.

	DESIRE	Doc. Ref.: Final Activity Report.
	FINAL ACTIVITY REPORT	Project Ref.: 508320 Date: 5 th October 2006 Sheet 10 of 11.

Section 2 – Dissemination and Use

1st result:

Monitoring equipment.

Result description:

Physical device. Hardware and software. Operating demonstrator.

An artificial vision based thermal spray flame monitoring device aimed to detect variations in thermal process parameters.

Market application:

Thermal Spray sector

Stage of development:

Advanced. A fully operative demonstrator (prototype) has been designed and manufactured

The prototype is fully validated but need to work longer in thermal spray shops.

Collaboration sought or offered:

None

Intellectual property rights granted or published:

To be decided before June 2007 by the consortium.

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2nd result:

Correlation and data maps.

Equipment measurements / spraying equipment parameters / coating characterization.

Result description:

Documents covering experimental maps and data, and correlations with coating quality.

Documents include thermal process parameters, monitoring device parameters values and coating quality characterized data from every spraying partner.

Market application:

Thermal Spray sector, industry and research.

Stage of development:

Documents submitted as deliverables.

Collaboration sought or offered:

	DESIRE	Doc. Ref.: Final Activity Report. Project Ref.: 508320
	FINAL ACTIVITY REPORT	Date: 5 th October 2006 Sheet 11 of 11.

None

Intellectual property rights granted or published:

To be decided before June 2007.

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