COST 526

"Automatic Process Optimization in Materials Technology"

(APOMAT)

Half-Yearly Report

To be sent to **V.Tesch@access.rwth-aachen.de** until **August 31, 2003**

1. Reporting Period	**1.1.2003 – 30.6.2003**
Project title	Numerical Calculation of the Process Parameters, which Optimise the Gas Turbine Blade Coating Process by Ther. Spraying, for given Spray Paths
Project leader	F. Lavers
Organization	ALSTOM (Switzerland) Ltd Dept. TMUH, H4/3 1 CH-5242 Birr
Main collaborators involved	Dr. M. Balliel, C. Pedretti, G. Guidati, P. Ryan

2. Funding Situation

Amount of money received specifically for COST – 70 kCHF received from Swiss BBW 2002-10-30, 159 kCHF committed by BBW 2002-06-17 with official project start 2002-07-01.

Other resources partially used for the project kEuros

3. International Collaboration

(mention group and type of work done in collaboration during the reporting period)

Participation in the Working Group Meeting in Brussels + project progress report

✓ YES

❒ NO

Yes, participated in WG Meeting Brussels.
Project progress report is part of this 1st half-year report 2003, section 6.

4. Industry participation

(mention name of companies and work done in collaboration during the whole project)

ALSTOM (Switzerland) Ltd = PL

5. Meetings, visits, exchange of scientists, short-term scientific missions	**Location, date**

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6. Progress within the reporting period (Not exceeding 3 pages, including tables and figures)
See attachment.

7. List of publications a) Published
-
b) Submitted for publications
-
c) In preparation
-

6. Progress within the reporting period

The Swiss ministry for education and research (BBW) has paid CHF 70’000 out of its committed funding of CHF 159’000 with a project start of 2002-07-01.

Objectives

The blading of a gas turbine has to be protected from the hot gas stream. This can be achieved by different techniques, such as cooling air, metallic coating or thermal barrier coating (TBC). The present project is concerned with the process of applying TBC on a turbine blade. Specifically, the project targets the following points:

- The development of criteria and strategies for the optimization of the coating process, which include the coating thickness, porosity distribution and the total coating time as parameters of the objective function.
- The development of methods for the optimization of a spray path for complex 3D shapes by taking into account equipment, process and tooling limitations.

Offline simulation tool

Previously, an offline simulation tool for the coating process has been developed. During thermal spray tests executed in the frame of this project, the prediction of coating thickness turned out to be qualitatively right, but quantitatively not acceptable. This unforeseen issue is addressed by an additional new task in the workplan to baseline the simulator. A series of spray experiments on plates with selected spray parameter variations was initiated. An optimization loop was set up to minimize the discrepancy between measured spray result and simulator prediction, see Fig. 1.

In parallel, the usability of the offline simulation tool is reworked to simplify the definition of a spray path for a given gas turbine blade/vane. Approaches comprise a library of geometrical elements, e.g. robot, gun, table, fixtures, and writing of so-called ‘macros’ to automate repeating tasks. In particular, this reduces the number of input variables, enabling in the current project phase an improved manual operation as well as in the future a more efficient numerical optimization.

Optimization environment

For both, the additional task of baselining the simulator and the offline spray path generation the same optimization software Java Optimization Environment (JOE) developed by ALSTOM (Switzerland) Ltd is applied.

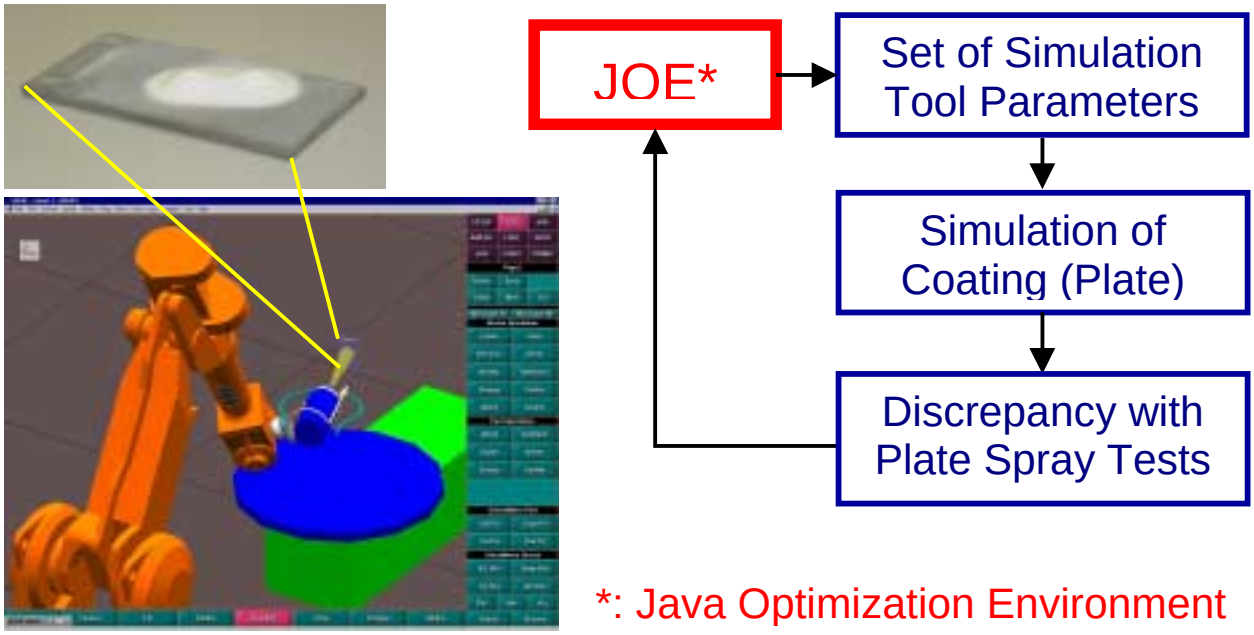

Figure 1: Additional task of baselining the simulator in an optimization loop experimental vs. predicted spray results.

Optimization strategies

To find the best optimization strategy, the following approach is employed (see previous half-year report):

- Coating strategy

This step aims at defining the most appropriate coating strategy. Considering the high number of variables in a spray path definition for a blade/vane, a reduction of variables is needed for both, easier manual input and for numerical optimization.
To achieve this the idea was projected to partition the surface to be coated into subdomains, which can be treated individually. Such subdomains are worked on in sequence with the spray result of all previous subdomains as starting condition for the next subdomain. This ensures that so-called 'overspray', e.g. spraying of surfaces adjacent to a primarily targeted surface, is taken into account at subdomain boundaries.

- Parametrization

This step requires a parametrization of a spray path for each subdomain as defined in the coating strategy. This means that the possible spray paths have to be described in a mathematical form with a limited number of free parameters. An example for the spray path parametrization of a concave side airfoil with 7 parameters is worked out.

Both, coating strategy and parametrization are not finalized yet and need to be reviewed once the simulator baselining is completed and more offline programming experience is accumulated.