SOMMACT Self Optimising Measuring MAChine Tools
Grant Agreement no.: **CP-FP 229112-2**
Start Date: 2009-09-01
Duration: 36 month

SOMMACT

Partners:
ALESAMONTI S.r.l. (IT) - Project Coordinator
API VARESE (IT)
FIDIA S.p.A. (IT)
HAVLAT GmbH (DE)
IBS PE BV (NL)
INRIM (IT)
ISM-3D SL (SP)
KOVOSVIT MAS AS (CZ)
SUPSI (CH)
TTS S.r.l. (IT)
University of Huddersfield (UoH) (UK)
WEISS GmbH (DE)

Deliverable D2.2

Report on the SEM technical solution

Document title:	**D2_2_Rep_on_SEM_Draft.doc**
Reference WP/Task:	**WP2 / T2.2**
Lead Task beneficiary:	**INRIM**
Author:	**Alessandro BALSAMO**
Date:	**2010-06-29**
Revision:	**00**
Status:	**Draft** Final
Nature [1]:	**R**
Dissemination level [2]:	**RE**

1) **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

2) **PU** = Public, **PP** = Restricted to other programme participants, **RE** = Restricted to a group specified by the consortium, **CO** = Confidential, only for members of the consortium

Executive summary

This deliverable is concerned with the description of the SEM solution, at the conceptual level as well as to the mathematical model which implements it. The ultimate purpose is to predict the effects of individual 6 degree of freedom (dof) sensors on the overall position of the tool relative to the machine table, and to set specifications for each of them.

SOMMACT is interested in the kinematical link of the machine table to the spindle along a *metrological sequence*, as opposed to the *actuating sequence*: the latter drives the carriages and supports the machining load, the former may be stress-free and thus much less affected by errors in determining mutual positions. This metrological and actuating sequences can also share some of their portions, when there is no sufficient metrological advantage for a full separation, or when the implementation would be impractical or too expensive.

To help in describing and understanding the metrological sequence and the layout of the 6 dof sensors along it, a general graphical representation of Cartesian machines is presented. This way, virtually all SOMMACT solutions can be represented and evaluated. Based on this, a neat conceptual separation is found between the SEM ad the TiLOR solutions, in terms of sensor layout along the metrological sequence.

To encompass both solutions in a same grand model, the most general situation of presence of all possible sensors along the sequence is analysed, and an analytical expression of the location of the tool tip relative to the machine table is derived. This model allows a uniform treatment of sensors and reference structures (e.g. in the TiLOR solution) along the metrological sequence, the reference structure being regarded as sensors keeping nominally null output signals over time.

When compared with the familiar rigid body model for the compensation of Cartesian machines – supposed to be implemented in CNC's – this model turns out to be identical formally, but with additional terms. However, the parametric errors in the rigid body model have no obvious correspondence with the sensor signals, rather have with suitable combinations of them. This means that most of the compensation model of a SOMMACT machine is already implemented in the CNC, with minor additions.

Based on this model, a sensitivity analysis is performed with the purpose of defining individual specifications of all sensors. Thanks to a tailored spreadsheet programme, simulations of the machine overall performance is carried out, as well as a breakdown of the target MPE (Maximum Permissible Error) to individual sensor. Preliminary simulation results show that the requirements on sensors and reference structures are in the reach of a practical solution, even if not trivial.

The model turned out also to be free of machine specific parameters. This is very advantageous, as relieves from the need of individual machine model tuning: no additional experimental work and calibrated artefacts. The only parameters to input into the model are nominal values with no need of high accuracy, easily derived from the machine blueprints or by direct manual course measurement. Therefore, the simulation activity was diverted to the optimisation of individual sensor specifications, as described in the previous paragraph.

Table of contents