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

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Deliverable D2.1

Report on error source analysis

Document title:	**D2 1_Analysis_of_Errors_Draft.doc**
Reference WP/Task:	**WP2 / T2.1**
Lead Task beneficiary:	**THE UNIVERSITY OF HUDDERSFIELD**
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Date:	**2010-03-25**
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 report discusses various measured machine tool errors, considering their significance for SOMMACT in terms of identification and correction. The following list summarises the main categories of errors considered.

- Geometric errors – Static errors that are a function of the machine physical shape.
- Non-rigid errors – Quasi-static errors caused by the finite stiffness in the machine structure and joints and variation in mass distribution.
- Thermal errors – Change in the size and shape of the machine structural elements caused by variation in their temperature, induced by either internally generated heat (endogenous) or by environmental temperature change (exogenous).
- Dynamic errors – High frequency errors caused by vibration or inertia effects or by inaccuracies, update times or incorrect assumptions in the electrical and mechanical control loops.

Various characteristics of the errors are considered to determine their significance for the SOMMACT project. Errors vary in their spatial and temporal propagation as well as their fundamental magnitude. These, in particular, affect the applicability of the proposed TiLOR and SEM solutions for their identification. For an error to be recoverable by the TiLOR approach, the rate of change in the error needs to be negligible for a time period deemed to be the minimum acceptable between sparse measurement on a suitable reference artefact.

Additional errors, potentially insignificant in magnitude or possibly not identified under normal calibration strategies, are also discussed and considered as contributors to uncertainty during self-calibration and on-machine measurement (OMM).

Information about the errors is obtained primarily from measured data obtained from a variety of machines in varying environments during research and commercial activity carried out by the University of Huddersfield. Also included are very applicable non-rigid and Environmental Temperature Variation Error (ETVE) test results obtained by the SOMMACT machine tool builders for Task 1.2.

An interactive tool in the form of an Excel spreadsheet '*Spatial and Temporal overview.xlsx*' is described. This tool enables adjustment of the significance of different potential error sources for machine or application specific spatial and temporal sensitivity analysis.

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