

MTP Theme: Standards

GOAL: STANDARDISATION OF MACHINE TOOL ERROR FUNCTIONS REPRESENTATION AND COMPENSATION

- Standardisation of machine tool geometric error functions and parameters identification and terminology;
- Standardisation of error functions representation output from different measuring systems and sensors system;
- Definition of standard compensation tables to be interpreted by different Computer Numerical Controls (CNCs) to allow uniform implementation of machine tool geometric error functions and parameters compensation strategies.

Initiative Title: **MATECS – MTP**

Jamal EL CHAAR

jamal.elchaar@icimsi.ch

Renato OTTONE

r.ottone@alesamonti.com



Manufacturing Technology Platform (MTP)

INDEX

1	<u>INITIATIVE TITLE:</u>	3
1.1	R&D OBJECTIVES	3
1.2	OVERVIEW OF THE INITIATIVE	3
1.3	PLANNED WORK, RESOURCES AND TIMING	4
1.3.1	PLANNED RESEARCH ACTIVITIES	4
1.3.2	PLANNED DISSEMINATION ACTIVITIES	5
1.3.3	RESOURCES	6
1.3.4	TIMING.....	7
1.4	PARTICIPATING REGIONS, PROJECTS INVOLVED AND PARTNERS	7
1.5	CONTACT INFORMATION	8



Manufacturing Technology Platform (MTP)

1 Initiative Title:

MATECS – MTP **MA**chine **T**ools **E**rror **C**ompensation **S**tandardisation

1.1 R&D Objectives

The MATECS – MTP initiative focuses on three main objectives:

1. Standardisation of machine tool geometric error functions and parameters identification and terminology;
2. Standardisation of error functions representation output from different measuring systems and sensors system;
3. Definition of standard compensation tables to be interpreted by different Computer Numerical Controls (CNCs) to allow uniform implementation of machine tool geometric error functions and parameters compensation strategies.

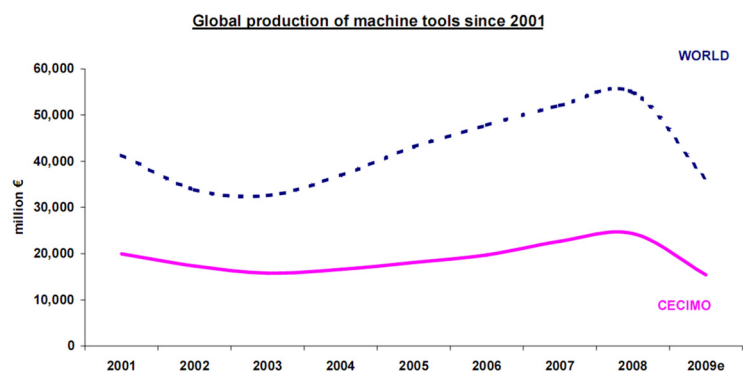
1.2 Overview of the Initiative

World machine tools production in 2008 was worth more than € 50 billion p.a. A very cautious estimate would consider that *machining* performed on machine tools in the world was worth more than € 500 billion.

Year 2009 showed a significant reduction both in machine tool production and in machining operations but a slight improvement is expected for year 2010.

Very many machine tools are currently equipped with Computer Numerical Control (CNC) which, to different extent, are capable of compensating some (or all) their geometric error functions and parameters thus improving the machined part quality.

Such error functions and parameters are determined (measured) by different measuring and sensors systems, each one providing a representation that is specific to the measurement system and sensors system providers.





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Different CNC manufacturers apply different strategies to partially compensate for the effect of the same error function on the machined part quality.

There is a strong need to promote, within the International Standard Organization (ISO), a standard covering identification, terminology and compensation table format for data exchange between different measuring systems, sensors systems and CNCs in order to promote interoperability.

1.3 Planned Work, Resources and Timing

1.3.1 Planned research activities

The standardisation activity shall conform to the ISO/IEC directives within the work program of ISO/TC39 – *Machine tools* and, specifically, within the work programme of ISO/TC39/SC2 – *Test conditions for metal cutting machine tools*.

Participants shall attend to all ISO/TC39/SC2 meetings in order to establish/maintain the required credibility within the subcommittee, which will be indispensable for the successful outcome of the planned standardisation work.

Research activities will consist in:

1.3.1.1. State-of-the-art analysis and appraisal of the existing ISO 230 series of standards (11 existing standards) with specific indispensable attention and deep understanding of the following documents:

- ISO 230-1:2012 *Machine tools – Test conditions for machine tools – Part 1: Geometric accuracy of machines operating under no-load or quasi static conditions*. The current version of this International Standard includes significant contributions from MATECS partners.
- ISO 230-2:2006 *Machine tools – Test conditions for machine tools – Part 2: Determination of accuracy and repeatability of positioning numerically controlled machine tool axes*. This document is now being revised; the project leader within ISO is Mr. Renato OTTONE (technical coordinator of the EC Funded SOMMACT – **Self Optimising Measuring MACHine Tools**). The current status of this document is ISO/DIS 230-2:2012 and it is undergoing public enquiry. Publication is expected by 2014.
- ISO 230-3:2007 *Machine tools – Test conditions for machine tools – Part 3: Determination of thermal effects*. This document is currently undergoing periodic revision.
- ISO 230-6:2002 *Machine tools – Test conditions for machine tools – Part 6: Determination of positioning accuracy on body and face diagonals (Diagonal displacement test)*.

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- ISO/TR 230-9:2005 *Machine tools – Test conditions for machine tools – Part 9: Estimation of measurement uncertainty for machine tool tests according to series 230, basic equations.*
- ISO/DIS 230-10 *Machine tools – Test conditions for machine tools – Part 10: Determination of the measuring performance of probing systems of a numerically controlled machine tool.* The project leader within ISO is Mr. Renato OTTONE. The document has been published on 2011-05-15
- ISO/CD/TR 230-11: *Machine tools – Test conditions for machine tools – Part 11: Measuring instruments and their application to the machine tool geometry tests.* This document is under preparation; its actual stage is Committee Draft (CD) and will still need a lot of work that is being performed with the active participation of MATECS partners.

1.3.1.2. Research on the existing machine tool error functions measurement file format of state-of-the-art instrumentation, specifically including:

- Laser interferometers for linear displacement and angular accuracy measurements;
- Laser interferometers for straightness measurements;
- Multi-axes sweeping alignment lasers;
- Laser tracers for multilateration measurements,
- Inclination measuring systems.

All above mentioned instrumentation is made available within the EC Funded SOMMACT project and some of it is also made available by DOOSAN INFRACORE, Korea.

1.3.1.3. Significant research activity related to (i) data collection and validation, (ii) development and (iii) follow-up and drafting of the ISO/NP TR 16907 — *Machine tools — Numerical compensation of geometric errors of machine tools.* This document has been generated by the impulse of MATECS initiative. The project leader within ISO is Mr. Renato OTTONE. The development of the document is conforming to schedule and it will be discussed during next ISO/TC39/SC2 meeting to be held in Hangzhou, China, on 2012-05-14/18.

1.3.2 Dissemination activities

1.3.2.1. The IMS – MATECS – MTP initiative (at its “seeking partners” stage) has been promoted at the IMS meeting held in June 2010 in Lugano, CH.

1.3.2.2. Standardisation activities within the SOMMACT project and within the IMS – MATECS – MTP initiative have been promoted at the Standardisation in Innovation and Research activities, held in Brussels on 2011-11-10.

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1.3.2.3. *Dissemination of the outcomes of the ISO NWIP to be proposed*

This dissemination will be the direct result of the (expected) publication of the resulting ISO TR 16907 with paramount benefit for the world machine tool industry (manufacturer and users);

1.3.2.4. *Dissemination within the EC Funded SOMMACT project.*

The IMS – MATECS – MTP initiative progresses and outcomes has been and will be publicised in conjunction with the different dissemination activities that are on-going within the EC funded SOMMACT Project.

1.3.3 Resources

ALESAMONTI (IT) and IBS-PE (NL) researchers are already active as nominated national experts within ISO/TC39/SC2.

SUPSI – ICIMSI is planning to have a researcher nominated by SNV, the Swiss ISO member body, to focus specifically on the applicability of the new standard for the compensation strategies that will be developed within the EC Funded SOMMACT project (GA N. CP-SP 229112-2; estimated total cost: € 5.210.340,00).

DOOSAN INFRACORE researchers are already nominated Korean experts within ISO/TC39/SC2.

Financial resources are budgeted as follows:

1.3.3.1. *Availability of equipment*

EC Funded SOMMACT project partners will make the measuring instruments described in 1.3.1.1 above (worth approximately € 350.000,00) available to the IMS – MATECS – MTP initiative; sought partners from other IMS regions are expected to make available some equivalent measuring systems;

1.3.3.2. *Coordination between the EC Funded SOMMACT project and IMS – MATECS – MTP initiative*

Estimated financial coverage for approximately € 12.000,00 are budgeted within task T0.4 of the EC Funded SOMMACT project; sought partners from other IMS regions are expected to foresee financial coverage for their activities associated to this topic;

1.3.3.3. *Standardisation activities within ISO/TC39/SC2 framework.*

Task T6.4 of the EC Funded SOMMACT project provides budgeted coverage for approximately € 70.000,00 including research activities and travel expenses for active participation to relevant ISO/TC39/SC2 meetings (typically two meetings per year); sought partners from other IMS regions are expected to foresee financial coverage for their activities associated to this topic.



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1.3.3.4. Dissemination of IMS – MATECS – MTP Initiative outcomes.

Promotion expenses will be included in item 1.3.3.2 above. Dissemination expenses will be included in the EC Funded SOMMACT project WP6.

1.3.4 Timing

Preliminary activities started during the ISO/TC39/SC2 meeting that was held in Milan, Italy on 2009-10-11/13.

A New Work Item Proposal (NWIP) was submitted during the ISO/TC39/SC2 meeting that was held in Switzerland on 2010-09-13/17.

The NWIP was favorably accepted and was registered as ISO/NP TR 16907 – Machine tools – Numerical compensation of geometric errors of machine tools.

The IMS – MATECS – MTP initiative activities will be spread throughout the EC Funded SOMMACT project that will terminate by 2012-08-31 and will carry on after that date in order to pursue:

- The publication of ISO TR 16907;
- The needed revision of existing machine-specific ISO International Standards to ensure relevant specifications are not conflicting with SOMMACT project and IMS – MATECS – MTP initiative outcomes.

1.4 Participating Regions, Projects involved and Partners

The MATECS – MTP initiative is promoted by the SOMMACT consortium that is actively pursuing the objectives of the EC Funded SOMMACT project (GA N. CP-FP-229112-2) that aims at obtaining high quality small and even single batch production by developing: (i) new metrological concepts, (ii) innovative sensors, (iii) stable reference artefacts and (iv) *ad hoc* self-learning systems to minimise the effects of process disturbances like variable workpiece mass and variable ambient temperature.

Currently, the participating regions and partners are:

EUROPE

With the major involvement of the following SOMMACT consortium partners:

- ALESAMONTI (IT) – Project Coordinator – SME
- IBS-PE (NL) – SME

SWITZERLAND

- SUPSI – Academia

KOREA

- DOOSAN INFRACORE – LE



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1.5 Contact Information

Renato OTTONE
ALESAMONTI / Italy
r.ottone@alesamonti.com

Jamal EL CHAAR
SUPSI – ICIMSI / Switzerland
jamal.elchaar@icimsi.ch

Guido FLORUSSEN
IBS PE / The Netherlands
Florussen@ibspe.com

Taeweon GIM
DOOSAN INFRACORE / Korea
taeweon.gim@doosan.com