Self-optimizing machining systems

New Collaborative Working Group
Linked to: STC-M, STC-C, STC-P, STC-G

1st Meeting, 25.08.2016, Guimaraes, Portugal

(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)

CIRP office: 9 rue Mayran, 75009 PARIS – France, E mail: cirp@cirp.net, http://www.cirp.net
An “industry 4.0” scenario …

Source: Die Zeit, 23.01.2014

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
Self-optimizing manual work

[Source: kultur_handwerk]

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
Self-optimizing manual work

Tool clamping and guidance, process monitoring, process control

Experience
Ability to predict future situations
Adaptation

Kinematics
Force sensors
Position / force control

Tool selection, tool inspection, tool modification

Workpiece clamping, process monitoring, process control

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
Enablers to transfer skills to machinery

Tool clamping and guidance, process monitoring, process control

Experience
Ability to predict future situations

Adaptation

Tool selection, tool inspection, tool modification

Workpiece clamping, process monitoring, process control

Kinematics
Force sensors
Position / force control

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
The “Machining system”

CAD/CAM → Simulation → Machine → Geometry → Surface

Controller

Monitoring

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
The “Self-optimizing machining system”

CAD/CAM → Simulation → Process → Machine → Geometry → Surface

Controller → Monitoring → Intelligent components

Wichtigste Fehlerklassen
- Kollision
- Werkzeugbruch
- Rattern
- Spannfehler
- Fehlende oder falsche Werkstücke

Einsatz
- Überlastschutz
- Schwingungsüberwachung
- (Prozessüberwachung)

Losgröße
- Klein- und Großserienfertigung
- Großserienfertigung
- Klein-, teils auch Großserienfertigung

Intelligent components

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
Examples of related literature

CWG “Self-optimizing machining systems”  
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
Examples of related literature

2. P. Kersting, R. Joliet, M. Kansteiner: Modeling and simulative analysis of the micro-finishing process, CIRP Annals 64/1/2015
10. H.-C. Möhring, O. Bertram: Integrated autonomous monitoring of ball screw drives, CIRP Annals 61/1/2012

CWG “Self-optimizing machining systems” (H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
New CWG “Self-optimizing machining systems”

- How to implement „Industry 4.0“ at machine / process level?!
- Exploitation of cyber-physical systems at machine / process level
- Machine control data processing
- Sensor and actuator integrated machines and components:
  - recognition and compensation of error influences
  - machine and process state monitoring
  - process adaptation / optimization and adaptive control
- Sensor integrated materials and structures / smart actuators
- Self-optimizing control strategies
- Integration of process and mechatronic modeling and simulation of process-machine-interactions
- Interdisciplinary scientific and industrial activities

I know, how to self-optimize!

[Keynote paper in 2020]

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
New CWG “Self-optimizing machining systems”

16th CIRP Conference on Modeling of Machining Operations, Cluny, Burgundy, France, 15.-16. June 2017

8th CIRP Conference on High Performance Cutting

2016

2017

2018

2019

Keynote paper in 2020

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
1st draft structure of the Cross-STC keynote paper

1. Introduction
   - Industry 4.0 at machine and process level (cyber-physical systems approach)
   - Aim and overview of the paper
   - Historical perspective (overview of the development of the topic in the past; main steps and achievements)

2. Enabling technologies
   2.1 Machine integrated enabling technologies
      - Machine tool behavior and optimization approaches
      - Sensor and actuator integration (incl. Adaptronics, smart materials, intelligent components, etc.)
      - Exploitation of machine control data
      - Process and machine monitoring systems (incl. qualification and parameterization)
   2.2 Simulation and virtual technologies
      - Mechatronic and thermal simulation of machine tools
      - Simulation of process-machine-interactions
      - Process simulation considering machine control characteristics
      - Prediction of machining results (geometry, surface, etc.)

3. Self-optimization strategies
   - Self-optimization in machining (principles and basic approaches)
   - Simulation-based process layout and optimization
   - Simulation-based machine control optimization
   - Simulation-aided CAM-technologies
   - Simulation-aided monitoring
   - Adaptive and self-optimizing control systems (incl. position / force control)
   - Re-calibration of process- and machine tool simulation

4. Contribution to Industry 4.0
   - Integration of self-optimizing machining systems in Industry 4.0 scenarios
   - Potentials
   - Future requirements

5. Conclusions

Keynote paper in 2020

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)
Cross-STC keynote paper: contributions welcome!

CWG “Self-optimizing machining systems”
(H.-C. Möhring, K. Erkorkmaz, P. Wiederkehr)

K. Erkorkmaz
P. Wiederkehr
H.-C. Möhring
Y. Kakinuma
Statistics

1st meeting:

- 10 contributions proposed
- From 5 countries (Canada: 1, Germany: 6, Hong Kong: 1, Korea: 1, Spain: 1)