Grace

inteGration of pRocess and quAlity Control using multi-agEnt technology

**Work Package 2**

Self-adaptation and self-optimization

**Deliverable D2.1 Summary**

# Specification for self-adaptation and self-optimization mechanisms in WM production

| | | |
|---|---|---|
| **Document type** | : | Deliverable Summary |
| **Document version** | : | FINAL |
| **Document Preparation Date** | : | Tuesday, February 15th, 2011 |
| **Author(s)** | : | SINTEF, Whirlpool, AEA, IPB |
| **File Name** | : | Deliverable D2.1_summary.pdf |

| | | |
|---|---|---|
| **Project Ref. Number** | : | 246203 |
| **Project Start Date** | : | 01/07/2010 |
| **Project Duration** | : | 36 months |
| **Website** | : | www.grace-project.org |

Project founded by the European Commission under the "Seventh Framework Programme" (2007-2013)

Contract n° NMP2-SL-2010-246203

## Summary

An important objective of the GRACE project is to analyze, develop and implement self-adaptation and self-optimization in manufacturing systems and assembly processes, both at a local and global level. The main motivation for this is to increase process modularity, flexibility and improve the handling of unpredictable changes in the production process.

In this report the focus is on exploring how these functionalities can be implemented at a local level of the factory and by local level is meant the floor and cell levels. Moreover, one or more processes from the Whirlpool production line for washing machines will be used as a case study.

At the local level the project will consider adaptation and optimization of the operation of manufacturing and assembly resources. By resources it is meant machines operating along the production line. Each machine is controlled by local controllers based on simple control functions handled by for instance standard PID controllers. These controllers are often delivered by the system suppliers as part of the total system. More advanced control structures may be implemented on top of the simple controllers by specifying low level references, this in order to achieve more robust systems.

To be able to implement more advanced control structures access to both system measurements and control signals are required. This may in some cases be a challenge as the software and hardware components often are delivered in a closed non-accessible system.

In addition to the process on the shop floor level and cell level, adaptation and optimization of the final product operation will be studied and analyzed.

This report contains the outcome of GRACE WP 2, Task 2.1 ‘Specification for self-adaptation and self-optimization mechanisms in WM production’.

## References

[1] Leitao, P. and Restivo, F. (1999), 'A Layered Approach to Distributed Manufacturing', Proceedings of Advanced Summer Institute International Conference in Life Cycle Approaches to Production Systems: Management, Control and Supervision, Leuven, Belgium

[2] Sastry, S., Bodson, M. (1989), Adaptive Control, Prentice Hall, ISBN 0130043672.

[3] Åström, K. , Murray, R. (2008), Feedback systems: An introduction for Scientists and Engineerers, Princeton University Press, ISBN 0691135762.

[4] Michelsen, F.A., Lund, B.L., Halvorsen, I.J.(), 'Selection of optimal, controlled variables for the TEALARC LNG process', Ind. Eng. Chem. Res., 2010, 49 (18), pp 8624–8632

[5] Lewis, F.L., Syrmos, V.L.,(1995) Optimal Control, John Wiley-Sons, 2 ed.

[6] Panait, L., Luke, S. (2005), 'Cooperative multi-agent learning: The state of the art', Autonomous Agents and Multi-Agent Systems, 11(3):387-434

[7] Shi, Y. & Hou, Y. (2004), 'Distributed optimization for cooperative agents: application to formation flight'.

[8] Kercelli, L.; Sezer, A.; Öztoprak, F.; Yolum, P. & Birbil, S. (2008), 'MANGO: A MultiAgent Environment for Global Optimization''Seventh Joint Coneference on Autonomous and Multi-Agent Systems'.

[9] Holmgren, J.; Persson, J. & Davidsson, P. (2008), 'Agent Based Decomposition of Optimization Problems''Seventh Joint Conference on Autonomous and Multi-Agent Systems'.

[10] Caire, G. (2009), 'JADE Programming for beginners', TILAB.

[11] Bussman, S., Jenning, N.R., Wooldrigde,M. (2004) Multiagent systems for manufacturing control, Springer.

[12] Leitao, P., Restivo, F. (2006),'ADACOR: A holonic architecture for agile and adaptive manufacturing control', Computers in Industry, vol 57, no 2, pp. 121-130, Elsevier.