

2nd International Conference on System-Integrated Intelligence: Challenges for Product and Production Engineering

## Editorial: System-integrated Intelligence - New Challenges for Product and Production Engineering in the Context of Industry 4.0

Klaus-Dieter Thoben<sup>a\*</sup>, Matthias Busse<sup>b</sup>, Berend Denkena<sup>c</sup>, Jürgen Gausemeier<sup>d</sup>

<sup>a</sup>Bremen Research Cluster for Dynamics in Logistics (LogDynamics), Bremen, Germany

<sup>b</sup>ISIS Sensorial Materials Scientific Centre, University of Bremen, Bremen, Germany

<sup>c</sup>Institute of Production Engineering and Machine Tools (IFW), Leibniz Universität Hannover, Hannover, Germany

<sup>d</sup>Heinz Nixdorf Institute, University of Paderborn, Paderborn, Germany

---

### Abstract

The editorial introduces the SysInt conference series and the motivation behind it. It describes the structure and content as well as the scientific and technological background to the SysInt 2014 event held in Bremen from July 2<sup>nd</sup>-4<sup>th</sup>, 2014, and provides an outline of the organizing institutions, detailing their individual perspectives on the general topic of system-integrated intelligence.

© 2014 Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/3.0/>).

Peer-review under responsibility of the Organizing Committee of SysInt 2014.

*Keywords:* cyber-physical systems, intelligent systems, logistics, sensor integration, micro systems technology, microelectronics

---

### 1. Introduction

This volume contains the collected research and development activities presented at the 2<sup>nd</sup> International Conference on System-integrated Intelligence (SysInt) held in Bremen, Germany from July 2<sup>nd</sup> to 4<sup>th</sup>, 2014. The SysInt 2014 is the second in a series of events started in 2012 in Hanover, Germany. Just like this first instalment, the current event derives its dynamic and innovative nature from the close cooperation between three major research

---

\* Corresponding author. Tel.: +49-421-218-50005.

E-mail address: [tho@biba.uni-bremen.de](mailto:tho@biba.uni-bremen.de)

centres which focus on similar topics, but maintain slightly different perspectives on it: Their complementarity constitutes the strength of the combined effort. In 2014, this setting has attracted more than 100 contributions from 14 countries worldwide – an increase by more than 50% compared to the first SysInt conference.

## 2. Scope of the conference

The subtitle of the conference series, New Challenges for Product and Production Engineering, is even more important today than in 2012 with trends suggesting a major transformation of the way we make things - a transformation which is entirely based on the capabilities of system-integrated intelligence. On a European level, the respective catchword is Factories of the Future, while in Germany we speak of Industry 4.0, a term that puts a name to what is felt to be yet another industrial revolution: Following the initial one in the 18th century, we have seen the advent of mass production and numerical control, and are now addressing the fundamental issues of autonomy in industrial processes. The promise that parallels this transition is set against a wide range of technological, organizational and societal challenges.

In engineering, however, even a revolution has to be based on sound footings. In many fields, the change we can already foresee has yet to be substantiated by research and development efforts. On a conceptual level, we need to understand and implement the full potential of autonomy and in doing so gain the ability to design this feature into new, complex products. On a software level, we need to develop and implement the algorithms that first help to provide, than to optimally exploit the new capabilities System-integrated Intelligence promises. On a hardware level, we need to master the full chain of technologies behind the so-called Cyber-Physical Systems (CPS) from the individual sensor to the integration of such systems with engineering components forming, individually or as part of interconnected systems, new products. An ever-closer integration of CPS with products to form truly intelligent or Sensorial Materials is not the least step in this sequence. Finally, on an application level, we need to adapt the systems to the requirements of already existent use cases. However, we also need to discuss how these systems will affect the way we live and work in future. The answer to this question may open up a vast ground for new products and business models.

## 3. The organizers behind SysInt 2014

Within this range, all three research centres set their very own specific stress. The University of Bremen as this year's host of the event is represented among the conference chairs by Prof. Thoben as the speaker of the Bremen Research Cluster for Dynamics in Logistics (*LogDynamics*) and by Prof. Busse as the speaker of the board of directors of the ISIS Sensorial Materials Scientific Centre. *LogDynamics* conducts research investigating dynamic processes in logistic systems. It combines fundamental and applied research with transfer and education at the interface between science and industry. Important research areas are: autonomous control in logistic processes and networks, *Cyber-Physical Systems for Industry 4.0*, *Internet of Things and Services* and Supply Chain (Event) Management. Four faculties at the University of Bremen cooperate in *LogDynamics* with the Bremer Institut für Produktion und Logistik GmbH (BIBA), the Institute of Shipping Economics and Logistics (ISL), as well as with the Jacobs University Bremen. ISIS, in contrast, is studying concepts from sensor development [1, 2] to adaptive and reliable data evaluation strategies based on artificial intelligence [3] that address the needs of material-integrated rather than component-applied intelligent systems [4], focussing on application scenarios in areas like robotics and structural health monitoring. The partnership extends over four faculties and integrates external institutes like Fraunhofer IFAM, Bremer Institut für Angewandte Strahltechnik GmbH (BIAS), Faserinstitut Bremen e. V. (FIBRE), Stiftung Institut für Werkstofftechnik (IWT) and the German Research Centre for Artificial Intelligence GmbH (DFKI).

The Leibniz Universität Hannover, represented among the chairs by Prof. Denkena, stresses the concept of intelligent materials and components [5, 6]. According to this vision, products are to be equipped with a memory of their past experiences that covers their full life cycle from beginning to end. The idea is that development of new products should incorporate knowledge from the past in an analogy to the way genes and their expression control who we are in relation to the experiences of our ancestors. Realization of this concept is supported by the German

Research Foundation (DFG) via the Collaborative Research Centre 653 - *Gentelligent Components in their Life Cycle*.

The Leading-Edge Cluster *Intelligent Technical Systems OstWestfalenLippe* (it's OWL) is funded by the German Federal Ministry of Education and Research (BMBF) via the Project Management Agency Karlsruhe (PTKA) and a pioneer in *Industry 4.0*. It pools the resources of global market leaders in mechanical engineering and the electrical, electronics and automotive supply industries, as well as internationally renowned, cutting-edge research institutes. The objective they share is to secure the OWL region a leading position among global competitors in the field of intelligent technical systems [7]. At the University of Paderborn, for which Prof. Gausemeier joins the chairs, the Collaborative Research Centre 614 - *Self-optimizing Concepts and Structures* has built the basis for Intelligent Technical Systems [8, 9].

#### 4. Structure of the event

The SysInt 2014 conference covers the full range of these topics. The conference programme, which is reflected in the proceedings volume, is divided into five different symposia, namely

- Intelligent Systems: Enabling Technologies
- The Future of Manufacturing: Cyber-Physical Production Systems
- Perceptive Robotics
- Structural Health Monitoring
- The German-Malaysian Workshop

The first of these covers fundamental technologies that facilitate the broader introduction of system-intelligence on conceptual, software and hardware level. The following three symposia address different application scenarios. The final one presents results of a long-standing German-Malaysian cooperation in the field of the conference and on broader engineering topics, thus continuing a co-operation initially established within the SysInt 2012 conference. All authors are required to complete the Procedia exclusive license transfer agreement before the article can be published, which they can do online. This transfer agreement enables Elsevier to protect the copyrighted material for the authors, but does not relinquish the authors' proprietary rights. The copyright transfer covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions, microfilm or any other reproductions of similar nature and translations. Authors are responsible for obtaining from the copyright holder, the permission to reproduce any figures for which copyright exists.

#### 5. Conclusion and Outlook

To organize this event, to bring together all contributors, to fairly judge their work and to provide them with the lively, motivated and open-minded environment that alone allows exchange across the disciplines can never be a single person's work. We would therefore like to take the opportunity to thank all those many people who contributed to the success of the SysInt 2014 conference. This includes the members of the Organizing Committee, the International Programme Committee and the Editorial Committee as well as all those who assisted on site to make the SysInt 2014 conference a smooth and memorable event. We would also like to thank our sponsors, the German Research Foundation (DFG) and the International Academy for Production Engineering (CIRP).

Last but not least, we would like to bring to your mind that the SysInt 2014 will not be the last instalment of the series. Instead, we are already now looking forward to the SysInt 2016. In two years, Paderborn will be the host, setting their own special focus within the broader topic of System-integrated Intelligence. Needless to say, we welcome all the SysInt 2014 contributors to be our guests again in Paderborn, in the summer of 2016.

#### References

- [1] Lang W, Jakobs F, Tolstosheeva E, Sturm H, Ibragimov A, Kesel A, Lehmkus D, Dicke U. From embedded sensors to sensorial materials – The road to function scale integration. *Sensors and Actuators A* 2011;171:3-11.

- [2] Dumstorff G, Paul S, Lang W. Integration without disruption: The Basic Challenge of Sensor Integration. *IEEE Sensors Journal* 2014;14(7):2102-2111.
- [3] Bosse S. Distributed Agent-based Computing in Material-Embedded Sensor Network Systems with the Agent-on-Chip Architecture. *IEEE Sensors Journal* 2014;14(7):2159-2170, DOI:10.1109/JSEN.2014.2301938.
- [4] Lehmhus D, Brugger J, Murali P, Pane S, Ergenemann O, Dubois MA, Gupta N, Busse M. When nothing is constant but change: Adaptive and sensorial materials and their impact on product design. *Journal of Intelligent Material Systems and Structures* 2013;24:2172-2182.
- [5] Denkena B, Henning H, Lorenzen LE. Genetics and intelligence: new approaches in production engineering. *Production Engineering - Research and Development* 2010;4:65-73.
- [6] Denkena B, Mörke T, Krüger M, Schmidt J, Boujnah H, Meyer J, Gottwald P, Spitschan B, Winkens M. Development and First Applications of Intelligent Components over Their Lifecycle. *CIRP Journal of Manufacturing Science and Technology* 2014;7: 139-150.
- [7] Gausemeier J, Dumitrescu R, Jasperneite J, Kühn A, Trsek H. Auf dem Weg zu Industrie 4.0: Lösungen aus dem Spitzencluster it's OWL. Paderborn: it's OWL Clustermanagement GmbH; 2014.
- [8] Gausemeier J, Schäfer W, Rammig FJ. *Design Methodology for Intelligent Technical Systems*. Heidelberg: Springer Verlag; 2014.
- [9] Gausemeier J, Schäfer W, Rammig FJ, Sextro W. *Dependability of Self-Optimizing Systems*. Heidelberg: Springer Verlag; 2014.