# Intermediate report on dissemination activities

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| **Project title** | **A**utonomous **I**ntegrated **S**cheduling in **S**emiconductor **I**ndustry |
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| **Abstract** | This deliverable gives an overview of the dissemination activities that have been done so far and that are planned for the remaining project runtime. |
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# 1 VERSION CONTROL

| Date | Author | Version | Notes |
|---|---|---|---|
| 07.10.2022 | Benedikt Schulz | 0.1 | First version |
| 07.11.2022 | Karlheinz Leonardi, Christophe Senger, Gerhard Luhn, Andrej Gisbrecht | 0.2 | Contributions by Karlheinz Leonardi, Christophe Senger, Gerhard Luhn and Andrej Gisbrecht |
| 07.11.2022 | Benedikt Schulz | 0.3 | Version ready for review |
| 18.11.2022 | Karlheinz Leonardi | 0.5 | Reviewed version |
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| 30.11.2022 | Andrej Gisbrecht | 1.0 | Final version |

# 2 INTRODUCTION

## 2.1 OVERVIEW

In the project AISSI, project partners from industry and from research collaborate to develop models and methods to improve production planning and control in the semiconductor manufacturing industry. With regard to existing models and methods, there are many contributions from other researchers. On the one hand, we intend to base our work on their results. In turn, we also intend to discuss the models and methods we are developing with the scientific community and add them to the body of knowledge. With regard to the application of the developed models and methods in industry – ideally beyond the project consortium as well – it is also important to discuss our approaches with stakeholders from industry. Therefore, dissemination of the work in the project is important regarding both science and industry. In this deliverable, we report on what has already happened in the project AISSI with regard to dissemination and what is planned in the remaining runtime of the project. Here, we address both the perspective on science as well as on industry.

## 2.2 SCOPE OF THE DELIVERABLE

As the project AISSI runs since more than one year now, we distinguish between the dissemination activities that have been performed so far and those that are planned for the future. In chapter 3, we compile the dissemination activities that have been performed so far. Here, we differentiate between the presentation of the project on the internet, participation in public events and documents of the project that are publicly available. In chapter 4, we describe the planned dissemination activities for the remaining runtime of the project. These range from scientific dissemination in terms of contributions for conferences and journals to dissemination focusing on industry in terms of presentations of the project at workshops and the like.

## 2.3 ACHIEVEMENTS COMPARED TO THE PROJECT OBJECTIVES

In the project AISSI, we refer to two kinds of dissemination activities that should ensure maximum visibility and impact of the project. On the one hand, we intend to add to the body of knowledge in science by developing new models and methods to plan and control semiconductor manufacturing systems and by analyzing their performance. On the other hand, we intend to bring theoretical models and methods to practical application in industry. Beside the technical development in the project, this refers to transferring the knowledge generated within the project to interested stakeholders outside the project as well. Thus, the project objective is to disseminate this contribution and the corresponding insights using publications at conferences and journals, workshops at conferences and with other companies and webinars to present the work in the project AISSI. At the moment, all these aspects have been addressed: There is a publication at a conference to appear soon and project members of the project AISSI represented and presented the project at several symposia and workshops. Details of these dissemination activities can be found in this deliverable.

# 3 PERFORMED DISSEMINATION ACTIVITIES

In the runtime of the project so far, several dissemination activities have been performed. These activities range from the public presentation of the project, to participation in public events, to reports written in the course of the project which are publicly available. All of these activities are presented in this section.

## 3.1 PUBLIC PRESENTATION OF THE PROJECT

### 3.1.1 PROJECT WEBSITE

The project's own website that has gone live already in the early phase of the project (milestone 4.1) is the primary output communication platform for the project. The website includes an overview of the project and the current developments and progress. Several sub-pages present the work packages, innovative aspects, public activities and project partners. New content will be continuously added to the website during the project and the activities of the project team will be prepared for the general public.

### 3.1.2 ITEA WEBSITE

Being an ITEA project, AISSI is also presented on the website of ITEA with a description of the project and an overview of the partners involved in the project consortium. Moreover, a project leaflet and two public deliverables of the project (see below for details) are provided on the website of ITEA.

### 3.1.3 OTHER PUBLIC PRESENTATIONS

Since AISSI is partially funded by the German Federal Ministry for Economic Affairs and Climate Action, the project is presented on their website. The challenges of the European semiconductor industry and the solution approach in the project AISSI are described there. Organizational elements such as collaboration partners and collaboration coordinator are also presented along with information such as project duration, total volume and funding volume. Finally, information such as details of the contact person and project news can be found on the website:

- Website by the Federal Ministry for Economic Affairs and Climate Action
- Factsheet by the Federal Ministry for Economic Affairs and Climate Action

Beyond the presentation by the ministry, KIT released a news item about the current situation in the semiconductor industry and how the AISSI project can make a positive contribution. It is briefly mentioned how the interaction between the Deep RL agent and the simulation takes place and also by whom this international project is funded.
Moreover, the AISSI project is presented on the website of the institute in both English and German language. There organizational information as the contact persons from the KIT side, who is funding the project, the project participants and the key dates (start and end date) can be found. In general, the page presents the current problems in the European semiconductor industry and describes the goals and approach of the AISSI project.

Furthermore, the project partners posted news about the project AISSI on LinkedIn several times:

- LinkedIn Post by KIT
- LinkedIn Post by KIT IFL
- LinkedIn Post by KIT IFL
- LinkedIn Post by SYSTEMA

## 3.2 PARTICIPATION IN PUBLIC EVENTS

### 3.2.1 EURAXESS SYMPOSIUM

The international symposium EURAXESS took place in Berlin and virtual on September 9, 2021 with more than 100 participants from all over the world representing different projects and partners. To represent the project AISSI, the former project leader Kai Schelthoff (Bosch) participated in this symposium and took an active part in the panel "Application area 3 Digital Industry". During the symposium and the panel discussion, challenges and opportunities arising within the project AISSI have been discussed with the international community from science and industry.

### 3.2.2 GERMANY SINGAPORE BUSINESS FORUM CONNECT

Boon Ping Gan, CEO at D-SIMILAB, and project leader Andrej Gisbrecht from Bosch represented the bi-national project AISSI in the plenary session at the Germany Singapore Business Forum Connect on 11th November 2021. The focus of the event was on facilitating the cooperation between German and Singaporean companies. The participants discussed how a research projects can benefit both partners and presented the different perspectives from the point of view of small and big companies. While big companies are good at scaling up, small companies are agile and can provide innovative solutions. The participants of the event could collect inspirations on how to approach cooperation with international partners.

### 3.2.3 ITEA SMART SYSTEMS ENGINEERING WORKSHOP

The project leader Andrej Gisbrecht (Bosch) presented the AISSI project at the ITEA Smart Systems Engineering workshop on 7th April 2022. The workshop brings together researchers, developers and possible future project participants with different background and expertise to share their experiences and discuss the latest developments and innovations in the area of smart systems development. The workshop participants could learn from different ITEA projects and understand current problems and challenges. They could also gain new insights and collect ideas for new research projects. The project AISSI was presented in the session AI application development, which was recorded and can be viewed under the following link:
ITEA Smart Systems Engineering Workshop

### 3.2.4 TAGE DER DIGITALEN TECHNOLOGIEN

On August 29th and 30th the "Tage der Digitalen Technologien" organized by the Federal Ministry for Economic Affairs and Climate Action took place in the Berlin Congress Center. Dr. Karlheinz Leonardi (Nexperia) visited the event to network with other funded projects, look for potential co-operations and prepare for a potential presentation of the AISSI project in the next event. Details about the event are provided under the following link:
Tage der Digitalen Technologien

### 3.2.5 FACTORY AUTOMATION USER GROUP 2022

On September 22nd and 23rd, project partner SYSTEMA hosted their regular Factory Automation User Group meeting. The current status or the work related to the Nexperia use case and its relation to the other use cases of the project have been presented by Tobias Sprogies (Nexperia) and Martin Krüger (SYSTEMA). The presentation was entitled „Maximizing due date compliance, throughput and other partially conflicting objectives using multifactorial AI-powered optimization". Details about the event are provided under the following link:
Factory Automation User Group 2022

### 3.2.6 FOTLOG FORUM TECHNISCHE LOGISTIK 2022

On September 7th, project partner SYSTEMA participated at the "Forum Technische Logistik". This is an annually conference, hosted by the "Institut für Technische Logistik und Arbeitssysteme" of Prof. Thorsten Schmidt at TU Dresden. A more detailed dive-in into SYSTEMA's Holistic Digital Twin and its relationship and embedding into the AISSI project has been presented by Dr. Gerhard Luhn and Johannes Postel (both SYSTEMA). The presentation was entitled „Die innovative Fabrik. Ein holistisch motivierter Modellierungsansatz der Produktionsplanung (The innovative factory. A holistically motivated modeling approach to production planning)". The agenda of the event can be found under the following link:
Programm FoTLog

### 3.2.7 SEMICON EUROPA 2022

On the way to industrial application, Philipp Rossbach (SYSTEMA) presented a contribution at SEMICON EUROPA 2022 that took place in Munich between November 15th and 17th. The contribution is entitled "Interactive Risk-Free Exploration of Production Planning Strategies. How to Simplify Line Engineers' Life in Complex Semiconductor Manufacturing".

## 3.3 PUBLIC DOCUMENTS

During the runtime of the project AISSI, several deliverables are intended to report on different aspects of the work in the project, its progress and the current status. Two of the deliverables that are already completed are publicly available on the ITEA website:

- Deliverable D1.1 provides an update of the state-of-the-art in both scientific literature and industrial practice. Regarding the scientific state-of-the-art, the literature on scheduling in semiconductor manufacturing was reviewed. In particular, scheduling of cluster tools, batch scheduling, scheduling focused on line balancing and WIP balancing, AI-based and adaptive scheduling and dispatching rules, scheduling approaches that are specified for certain areas, maintenance planning as well as approaches for integrated planning of production and maintenance are addressed. To determine the state-of-the-art in industry, a questionnaire with various questions regarding production planning and scheduling in semiconductor manufacturing was set up and sent out to the project partners from industry. Their responses have been aggregated and reported in D1.1 and provide an insight in how production planning and scheduling is currently done in industry. In combination with the scientific state-of-the-art, this allowed to identify opportunities to bring concepts from science to practical application.
- Deliverable D1.2 provides a specification plan for the development phase and the validation phase. All three semiconductor manufacturers / providers in the AISSI consortium defined an independent use case. The use case formulated by Nexperia focuses on optimizing the throughput in the epitaxy area at Nexperia Hamburg (DHAM). This optimization will be achieved through advanced production planning and scheduling methods (APS) and very recent methods such as reinforcement learning (RL). The developed solution will be validated by a set of Key Performance Indicators (KPI). The use case described by Bosch has the purpose to create a full factory scheduling. The goal is to create a RL-agent that improves the WIP flow, achieves an even distribution of material in the factory as well as steady speed of processing across different stages of production for different products. The solution is validated with regard to the following KPIs: An increased fab throughput due to reduced starvation of

bottlenecks, reduced cycle times due to less waiting times, reduced variation of cycle times due to steady speed of production and improved on time delivery due to prioritization of delayed products. The use case of Bosch Sensortec can be described as an AI-controlled product ramp-up. The idea is to analyze the big amount of data gathered along the supply chain and to react accordingly, planning the product ramp-up in the consumer electronics market. The aim is to reduce the time-to-market which will be achieved through automatization of processes.

# 4 PLANNED DISSEMINATION ACTIVITIES

In this section, dissemination activities that are planned for the future are presented. This covers activities intended to transfer the approaches and algorithms that are developed in the course of the project to industrial application and dissemination, activities to increase the visibility of the project and its results as well as activities with regard to scientific dissemination.

## 4.1 PLANNED TRANSFER OF DEVELOPED ALGORITHMS TO INDUSTRIAL APPLICATION AND DISSEMINATION

Next year Bosch will develop a plan on dissemination of the AISSI platform, which is being developed to facilitate the application of AI in the semiconductor industry.

## 4.2 PLANNED DISSEMINATION ACTIVITIES TO INCREASE VISIBILITY OF PROJECT RESULTS

To increase the visibility of the work in and the results of the project AISSI, we intend to visit different events in the future. Details will depend on which events will take place in the future, but events like the EURAXESS Symposium, the “Tage der Digitalen Technologien”, the Factory Automation User Group meeting or similar events are suitable to present the project AISSI and to discuss challenges that are addressed and approaches applied to handle them. On the one hand, we intend to participate in events to get into contact with other projects and colleagues. On the other hand, taking an active role in events in terms of presenting the project AISSI to the community and interested stakeholders, participating in panel discussions etc. is also an interesting opportunity for the remaining runtime of the project. To find appropriate events, the different partners in the project consortium can bring in their experience and network. Additionally, the “Programmbegleitung” of the DLR may provide support and contacts to find appropriate events and the projects partners can search for such events independently as well.

## 4.3 PLANNED SCIENTIFIC DISSEMINATION ACTIVITIES

During the first months of the project AISSI, the project partners developed an approach to formalize and model the state of a semiconductor manufacturing system based on a graph. Using an approach from the literature called *graph2vec*, graphs that represent the state of a semiconductor manufacturing system can be embedded into an embedding space with a certain dimensionality. This approach constitutes the starting point to develop approaches to control production systems based on the embeddings that can be generated. To report the approach for graph representation and embedding to the community and other researchers and practitioners, a paper was written in which the approach is described and a numerical example for a small system (the so-called MiniFab) is given. The paper was submitted for the Winter Simulation Conference 2022 in April 2022 and has been accepted for publication and presentation. Thus, the paper will be published in December 2022 and the approach will be presented at the Winter Simulation Conference in December 2022.
In a second contribution at the Winter Simulation Conference 2022, Holger Brandl, Hajo Terbrack, Philipp Roßbach and Tobias Sprogies present insights on “Maximizing Throughput, Due Date Compliance and other Partially Conflicting Objectives in Semiconductor Production”. Beyond these two contributions, visiting the Winter Simulation Conference also allows the project partners to discuss the current ideas and approaches with the community and to get insights into the work of others.

Beyond these approaches that will be published and presented at the Winter Simulation Conference 2022, we plan to publish about approaches that will be developed within the remaining runtime of the project AISSI and the performance that is achieved using these

approaches as well. There are various options for such publications ranging from scientific journals and conferences addressing questions of production systems in general to such that are focusing on the semiconductor manufacturing industry in particular. Below, some examples of scientific journals and conferences that seem appropriate are listed:

- Winter Simulation Conference (in particular the International Conference on Modeling and Analysis of Semiconductor Manufacturing (MASM) as part of the WSC)
- CIRP Conference on Manufacturing Systems
- International Symposium on Semiconductor Manufacturing (ISSM)
- International Conference on Automation Science and Engineering
- International Journal of Production Research
- IEEE Transactions on Semiconductor Manufacturing

# 5 REFERENCED DOCUMENTS

The listing below provides an overview of the documents and other sources of information which have been referenced in this document.

| Short name | Full name |
|---|---|
| - | - |

# 6 NOTES

## 6.1 ABBREVIATIONS

A list of used abbreviations.

| Abbreviation | Meaning |
|---|---|
| AI | Artificial intelligence |
| AISSI | Autonomous Integrated Scheduling in Semiconductor Industry |
| APS | Advanced Production Planning and Scheduling |
| DLR | Deutsches Zentrum für Luft- und Raumfahrt |
| KIT | Karlsruhe Institute of Technology |
| KPI | Key performance indicator |
| RL | Reinforcement learning |
| WIP | Work in Progress |

## 6.2 TERMINOLOGY

A list of used terminology.

| Term | Explanation |
|---|---|
| - | - |