Fab Management Forum

Market Trends

D. Hutcheson
Vice Chair
TechInsights Inc., Greenwood Village, United States of America

Abstract
Coming soon

Biography
Dan is Vice Chair of TechInsights Inc. He is a recognized authority on the semiconductor industry, winning SEMI's Sales and Marketing Excellence Award^[1] in 2012 for "empowering executives with tremendous strategic and tactical marketing value" through his e-letter, *The Chip Insider®;* his book *Maxims of Hi-Tech,* and his many interviews of executives.
As some industry leaders have said, "He is the marketing voice and expert for the industry." "Dan has methodically captured the essence of the industry and produced it in such a way for all to benefit … He has been such an integral part of the industry for so long, it is difficult to imagine the industry without his contributions."
Dan's public work on the industry has often focused on challenging predictions of the demise of Moore's Law that date back decades by demonstrating how doomsayers have been outpaced by emergent behavior through the innate ability of technologists to innovate. This has included invited articles for *Scientific American*, the *SIA*, and the Plenary at the *SPIE Advanced Lithography Conference*.
[1] Formerly SEMI's Bob Graham Award

How to simplify engineers' life in complex Semiconductor Manufacturing. About democratization of information and its usage in production scheduling and root cause analysis.

P. Roßbach
SYSTEMA, Dresden, Germany

Abstract
Digitalization keeps driving increased demand for microchips. Shortening the product lifecycle and the high variety of customer-specific devices lead to a growing need for high-mix low-volume (HMLV) semiconductor production. SYSTEMA drives several activities to achieve a novel quality in production control and explainability of how the fab behaves. The "Autonomous Integrated Scheduling for Semiconductor Industry" (AISSI) project partners with Bosch, Nexperia, Simlab, KIT. Goal is to apply AI-based methods to enable autonomous production scheduling. However, such AI-solutions are "black boxes". They will only be accepted, if users understand the system: "explainability"– see also the EU "General Data Protection Regulation GDPR".

Objective is simplifying engineer's work and hand-over a powerful framework for continuous and rapid learning - and maybe creatig a smile.

SYSTEMA created a semantically inspired holistic information model (HIM). This offers, for the first time, an easily understandable access and method to close the gap between huge amount of data and the need to analyze this data in real-time, while offering at the same time the possibility to create formerly unseen, personalized "insights". The solution concept implements a single point of truth (SPOT) approach, enabling best algorithmic efficiency at the same time. Complex WHAT-IF-Analysis is enabled:
- What are the root causes of those dynamically appearing "WIP bubbles"
- Did the efficiency of the entire production line sustainably improved when the new scheduling method was introduced?
Additionally, counter-factual analysis is enabled – which is critical to enable human learning**.** The aim is to create an informational 'play space' that is fundamental to human imagination.

AI-based methodologies seem to provide important capabilities in order to solve the complex planning task of production or the "job scheduling problem". SYSTEMA has analyzed the requirements together with Nexperia and created a new AI-based scheduling concept utilizing 4M-methodology. Detailed analysis accomplished are, e.g., setup- and occupancy planning of batching machines (furnaces), maintenance and shift activities and many others.

Examples highlighted during poster session and presentation will touch
a "counterfactual" improvement of an entire production area (such as furnace) and showing its influence on the entire fab;
a dive-in into an integrated AI-based scheduling method.

Biography
Philipp Roßbach (Speaker)
holds a M.Sc. in Applied Informatics – Data Science from HTW Dresden, University Applied Science (Germany). He started in 2015 at SYSTEMA for his B.Sc., and later during his M.Sc., and supported his first projects for semiconductor manufacturing. Currently, he is 1) contributing to the R&D program AISSI at SYSTEMA while 2) also researching at HTW for Cell-based analysis in systems medicine.
For AISSI, ("Autonomous Integrated Scheduling for Semiconductor Industry") Philipp helps to develop, integrate and apply novel AI-based approaches in semiconductor manufacturing that builds on European quality-thinking from the automotive sector.

For HTW, his fields of research are data-driven modeling for the analysis of multicellular tissue organization and model-based prediction of an Effective Adhesion Parameter guiding multi-type cell segregation.

Dr. Gerhard Luhn (Mentor)
holds a Ph.D in engineering science from the University of Erlangen-Nuremberg (Germany). He has more than 25 years of experience in semiconductor manufacturing and information science. Currently, he is heading an innovation program at SYSTEMA GmbH together with the Technical University of Dresden and several major renowned industry partners, which aims at the industrial proof, prototypical and scientific validation of a new, mathematically grounded method of causal-holistic information processing. Gerhard previously worked as team leader / program manager and research fellow for Infineon/Dresden, Technical University Dresden and Siemens/Munich. He also held various positions in France with Siemens / IBM joint venture in Essonnes; and ST Microelectronics in Crolles. Gerhard holds a patent application, authors scientific papers, and engages in the science of information.

LineLab, an Analytical Tool for Modeling Semiconductor Manufacturing Systems

L. Nietner
Cofounder
Massachusetts Institute of Technology (MIT),
Cambridge, United States of America

Abstract
Semiconductor production systems have traditionally been difficult to model and optimize. Nonlinear queueing behavior and tools handling dozens of processes introduce great complexity to the dynamics of variation and inventory in a fab. As a result, only Monte-Carlo methods, like discrete-event simulation, could capture the relationships between capacity, queueing, utilization, inventory, and throughput that govern operations and performance. Since any simulation run only offers a single-point solution, optimizing a fab for a new device often requires months of simulation.

We have developed an analytical method that captures these complex system dynamics, and are commercializing it in a new software tool called LineLab. The first true alternative to Monte-Carlo simulation for modeling complex fab systems, it enables a breadth of new analyses and significantly accelerates the development timeline.

To create LineLab's powerful solver, we developed prescriptive analytics for queueing systems, and are using an optimization technique that is capable of handling the nonlinear relationships, alongside detailed financial models. For fabs of any complexity, LineLab can optimize capacity, buffers and utilization of each high-value tool, work-in-progress inventory and flow time / cycle time, minimizing total unit cost. LineLab considers the cost of inventory as it optimizes queue sizes, accounting for wafers' value-add with every process. Our approach can capture any level of flow complexity, including re-routing wafers through the same tool many times with intermediate steps, inbound flows and quality, capturing the effects of process time variability. It can also capture the interaction of parallel product flows and determine the effective cost of adding a new product to a shared system in a foundry.

With our analytical approach, the complete sensitivity data for every input are known at all times. Coupled with the ability to specify inputs with uncertainty, LineLab reveals the key performance drivers and risks across the entire system encompassing design, process models, and fab operations. LineLab can determine the marginal cost of variability, design parameters, and any other input.

The approach also allows for parametric models capturing Scope 1 & 2 CO_2, water usage and other sustainability metrics.

An MIT spinout, LineLab is the first tool to optimize complex queueing systems, and it captures their dynamics with a very high degree of accuracy (>99%).

Biography
Dr. Larissa Nietner is cofounder of LineLab, a spin-out from MIT. She received her Masters and Ph.D. in Mechanical Engineering from the Massachusetts Institute of Technology (MIT) after obtaining a B.Eng. in her native Germany. Dr. Nietner has presented at the Flex Conference (now part of SEMI) and given a number of invited talks at universities in the US and Europe. After completing her Ph.D., she held a postdoctoral position at MIT's Sloan School of Management in the Operations Research Group joining Dr. Scott Nill, where she worked on the new modeling framework that makes up LineLab. Together, they spun out LineLab, releasing the launch version of the software in 2021, and continue to co-author peer-reviewed papers about the approach and the far-reaching new analyses it enables.

Machine Learning for Automated Image Classification in Yield Enhancement

V. K. Thomas
Intern
Texas Instruments, Yield Enhancement, Freising, Germany

Abstract
One of the most repetitive and time-consuming tasks for our operation specialists in the Yield Enhancement group is the manual image classification. Moreover, due to stress and environmental conditions the consistency and accuracy of the manual classification varies. Therefore, we have been looking for a fully automated solution to relieve our specialists from the tedious classification tasks. In addition, the implementation of the solution to our production flow and integration to our fab automation has a positive impact on productivity.
We have explored various options available for out pilot automated classification project and found Convolutional Neural Networks (CNN) can produce consistent and accurate results for one specific classification task. We use a generally accepted CNN classification model trained on thousands of images from the scanning electron microscope. Since the input image dataset was highly biased, we used Image augmentation techniques to improve the results. In addition, we have also considered techniques like Transfer Learning to scale our solution to other image classification tasks. Our current model outperforms in terms of consistency and accuracy when compared to the manual classification.
We will achieve more by integrating fab automation to the automated image classification. A successful completion of the classification tasks triggers the fab automation to check whether to logout the lot, to inspect more wafer from the same lot or to put the lot on hold. With a fully automated fab process, we can minimize delays and waiting times of wafers. So far, we have been successful in implementing and integrating automated image classification with fab automation as a pilot project. We have identified a high fan out potential of this automated classification method and will be working to transfer the promising results to other areas as well.

Biography
Vipin holds a bachelor degree in Computer Science and Engineering from Mahatma Gandhi University, India (2013). He has worked for about 4 years in various companies (2014 - 2019) and gained knowledge on diverse technologies and frameworks such as mainframes, angular framework, data analysis with Python, cloud and Data Science/ML frameworks. Since Oct 2020, he is pursuing a MSc. Applied Computer Science at TH Deggendorf with expected graduation in Apr 2023. Currently, he is working at Texas Instruments as an Intern (Mar 2022 - Aug 2022). He is interested in Data Science projects and Edge AI.

Jailhouse: Mixed Criticality Systems for Semicondutor Manufacturing

R. Ramsauer
Head of Research Group
Technical University of Applied Sciences
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Abstract

The advent of multi-core CPUs in nearly all embedded markets has prompted an architectural trend towards combining safety critical and uncritical software on single hardware units. We present an architecture for mixed-criticality systems based on Linux that allows for the consolidation critical and uncritical parts onto a single hardware unit. In the context of the iDev 4.0 project, the use-case of this technological building block is to reduce the overall amount of distributed computational hardware components accross semiconductor assembly lines in fabs. CPU virtualisation extensions enable strict and static partitioning of hardware by direct assignment of resources, which allows us to boot additional operating systems or bare metal applications running aside Linux. The hypervisor Jailhouse is at the core of the architecture and ensures that the resulting domains may serve workloads of different criticality and can not interfere in an unintended way. This retains Linux's feature-richness in uncritical parts, while frugal safety and real-time critical applications execute in isolated domains. Architectural simplicity is a central aspect of our approach and a precondition for reliable implementability and successful certification. In this work, we present our envisioned base system architecture, and elaborate implications on the transition from existing legacy systems to a consolidated environment.

Biography

Ralf Ramsauer is a postdoctoral researcher at the Technical University of Applied Sciences Regensburg where he leads the Systems Architecture Research Group. His academic research interest focuses on mixed- and safety-critical systems, real-time embedded systems and embedded virtualisation on various architectures. This covers the full software stack of embedded systems, from hardware-related low-level virtualisation technologies via kernel-space up to userland. Ralf is a codeveloper of the Linux-based statically partitioning hypervisor Jailhouse, where he currently works on the RISC-V port.