## Fab Management Forum

T. Richter
Vice President of the Wafer Fab 150 / 200mm & MEMS
Robert Bosch GmbH, Reutlingen, Germany

**Biography**
Thomas Richter, since July 2015 Vice President of the Wafer Fab 150 / 200mm & MEMS at BOSCH Reutlingen, was born 1974 in Chemnitz.
Working for SIEMENS, INFINEON, QIMONDA and MELEXIS he now has about 23 years of experience in the semiconductor industry.
He holds a Diploma in Micro Technology of the University of Applied Sciences Zwickau (WHZ).

### 2019 Semiconductor Equipment and Materials Market: Where are we headed?

L. Chamness
Senior Market Analyst Manager
SEMI, Industry Research and Statistics, Milpitas, United States

**Abstract**
2018 was truly a remarkable year for the industry, with the semiconductor, equipment, and materials markets all experiencing record levels. However, all good things must come to an end; headwinds in the form of excess inventory, memory pricing and trade tensions are negatively impacting the outlook for this year. This presentation will discuss the 2019 fab and materials markets, with an emphasis on the European semiconductor manufacturing ecosystem, and provide a forecast through 2020 for these markets.

**Biography**
Ms. Lara Chamness is a Senior Manager Market Analysis at SEMI® and is responsible for SEMI's data collection programs for equipment and materials. This includes leading interactions with SEMI's participating companies, partners and subscribers. Ms. Chamness has 19 years of industry experience and earned BA/MS degrees in environmental sciences and a MBA degree from Santa Clara University.

**Self-organization, hype or hope? How to leverage the potential benefits of speeding up in a VUCA world**

C. Ried
Senior Network Partner
Beratergruppe Neuwaldegg GmbH, Wien, Austria

**Abstract**
In this talk we will take a closer look at the agility hype currently hitting organizations.

Why agile ways of working can be extremely meaningful for some and at the same time potentially confusing for others, will be illustrated in three steps:

1. You need to understand better what the organizational challenge is before you go for agility or alternative forms of self-organization.
2. The agile manifesto has originally been written for a technical problem, i.e. software engineering – it therefore needs further thinking before you apply it to the challenge of human beings collaborating more effectively.
3. Agile transformation can easily be misunderstood as leaders letting go of leadership – employees now shall have all the freedom to do what they want! In reality, more people will do leadership work, and in a highly distributed way.

The transformation towards self-organization and agility can offer a highly relevant benefit: It will provide more “processing power” to your organization – not in terms of your server farm, obviously, but when it comes to leadership as a service to the organization.
Much more people distributed across the organization will in some way practice leadership, and they will do it in a more direct and faster way. This has the potential to relief the decision bottleneck in the organization – hierarchical leaders.
Thus, companies gain the capability to deal better with volatile, uncertain and complex situations. They learn what is means to “sense and respond”, when “predict and control” doesn’t work anymore.

Now the change get interesting. Because clearly, for some people in the system there is something to loose. But even for those who might gain something – employees getting more leeway – there are challenges. As you go for distributed power, all those involved need relevant social skills, typically not trained to technical experts. If done carefully, this can be a huge personal development step for your people mobilizing energies blocked before.

**Biography**
**Work experience**
Having a degree in Business Economics with a specialization in marketing communication, Christian acquired his first years of experience as project manager in the CRM software industry. He then went into management consulting, gaining several years of experience in leading projects and providing expert consulting. Here his focus was in customer loyalty management.
In 2008 he changed to the internal consulting unit for organizational development and change of a large German DAX company, taking care of change projects of all dimensions, from simple team workshops up to international integration projects in the M&A context.
For seven years now he is doing process driven counselling and facilitation work in change processes, talent development and coaching together with Consulting Group Neuwaldegg, Vienna.
**Main areas of work**
- Post Merger Integration and corporate development

- Consulting and ongoing support for managers and their business units in large organizational change processes
- Consulting for agile organizational transformation
- Design and delivery of trainings in the field of Change Management and Emotional Intelligence
- Learning and development programs for talents, high potentials and experienced managers with the focus on individual development and leadership
- Support for and development of large project teams during their lifecycle
- Coaching for individual development

**Clash of Generations? – Changing Motivations, Requirements and Communication Styles as Seen by Young Professionals**

S. Leopold
MEMS Process Development, Team Leader Acoustics
X-FAB MEMS Foundry GmbH, Erfurt, Germany

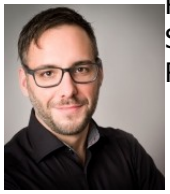
**Abstract**
“The price of doing the same old thing is far higher than the price of change.” (*Bill Clinton*)

Our presentation focuses on three factors of a successful working environment as seen by the “Millennials”. Here, a mutual understanding on the motivation of young professionals, the requirements of today´s semiconductor industry as well as modern ways of communication are key for a successful collaboration across generations. Therefore, we are going to present selected scientific research and add examples of our own working experience. In the first part of this contribution we will emphasise the motivation of young professionals beyond a monthly salary and career-building. Here we critically review if and how buzz-words like work-life-balance, flexible-working, home-office and company child-care are implemented in the semiconductor industry. In the second part we change perspective and try to look from a baby-boomers perspective on requirements, which have to be fulfilled by young professionals in order to make a contribution in their organization. Here we will comment on strategies of filling the gap between academic education and the experience driven specialized knowledge of advanced manufacturing. In addition to that, we will show generation differences in soft-skills and where young professionals may struggle. In the last section we will show what communication can do for bridging the generation gap. Starting with the generation specific habits, we will critically review social media for businesses and explore opportunities enabled by modern communication and contact sharing such as virtual teams. The later one is the key factor of mastering challenges with increasing complexity, while bringing together experts with diverse field of knowledge and creativity.

A change in working environment is needed, not only regarding modern communication, even if we have to pay for it. As Bill Clinton said, the alternative is more expensive.

**Biography**
**Steffen Leopold** is the leader of the Acoustics Group in MEMS process development at XFAB Erfurt. He received his degree in mechatronics at the Ilmenau University of Technology in 2008. In 2009 he joined the chair of Micromechanical Systems at Institute of Micro- and Nanotechnologies IMN MacroNano® in Ilmenau. His research topics were tunable optics based on aluminum nitride thin films and the fabrication of silicon nanostructures. In 2016 he received the PhD degree on his thesis “Aluminum nitride membranes for tunable refractive micro-optics”. In the same year he joined X-FAB MEMS Foundry GmbH in the field of MEMS process integration.

## Full Factory Scheduling



R. Kohn
Senior Manager
Robert Bosch GmbH, MFD2, Reutlingen, Germany

**Abstract**
The semiconductor industry as one of the largest and fastest growing industries in the world needs to continuously reduce production costs to provide affordable products.
Factory operations are likely to be major drivers to realize the necessary cost reductions in wafer fabrication facilities (waferfabs).
For example operational scheduling systems powered by optimization techniques widely replace rule-based dispatching systems as state-of-the-art control systems.
Especially the capability of optimization makes scheduling systems superior to dispatching systems in a manufacturing environment where flexibilty is key to success.
The author describes the transition from rule-based dispatching to state-of-the-art scheduling systems, based on experiences in the Robert Bosch 200mm Waferfab in Reutlingen.
Focus is on strategies to overcome challenges we face on a journey to a fully-automated Waferfab with superior WIP flow optimization capabilities.

**Biography**
ROBERT KOHN is responsible for Fab Simulation, WIP Flow Optimization and ML Solutions of the Robert Bosch Wafer- and Sensorfab in Reutlingen.
Prior to joining Robert Bosch GmbH, he gained experience at Globalfoundries Fab1 Dresden and was involved in research projects with Infineon Technologies Dresden.
He received his M.S. degree in computer science from the University of Applied Sciences Stralsund, Germany and a Ph.D. degree in computer science from the University of the German Federal Armed Forces Munich, Germany.
His interests include Artificial Intelligence and its applications in industry as well as simulation/optimization topics along the supply chain.
His e-mail address is robert.kohn@bosch.com

**Automated Hardware Diagnosis and Qualification**

M. Enzelberger-Heim
Process Engineer
Texas Instruments, Freising Fab, Freising, Germany

**Abstract**
One common challenge for Analog Wafer Fabs is the large variety of technologies, processes and products. Due to the long lifetime of analog products the product-mix and therefore the complexity of manufacturing processes typically increases over the years. This high complexity leads, together with usually mature toolsets, to a growing risk of misprocessing due to equipment weakness or failure.

Based on these challenges and in light of increasing automation of production processes, we have developed a novel automatic hardware qualification scheme for crucial hardware functionalities.

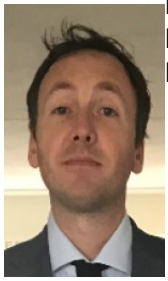
Our method allows to test and qualify vacuum integrity, plasma and gas flow parameters without any human interaction. It can either be run alongside regular process qualifications or while the tool and chambers are idle to assure maximum tool availability. The universal setup allows the implementation on fundamentally different toolsets like dielectric deposition or metal etch without any modification of the underlying routine. The high data density and coverage of this monitoring scheme facilitates root-cause analysis and the vast number of available small signals enables proactive reaction to upcoming failures.

In this presentation, the implementation and data collection as well as the impact on the manufacturing and tool stability will be presented and discussed.

**Biography**
Dr. Michael Enzelberger-Heim is currently working as a process engineer in the Plasma/Thinfilm module of TI's Freising Fab, responsible for PECVD, SACVD and ALD processes.
Starting as a trainee at TI in 2014, Michael held different positions in product and process engineering. In 2018, he has been elected member of the group technical staff.

Michael studied physics in Erlangen and Grenoble and holds a PHD in experimental physics from the FAU Erlangen in the field of Synthetic Carbon Allotropes.

## More than Moore - Edwards EUVL HVM Availability Programme



N. Walsh
Programme Development Manager, Availability.
Edwards Vacuum, Veldhoven, Netherlands

**Abstract**
As EUV Lithography (EUVL) processes enter the high-volume manufacturing (HVM) phase the primacy of system availability has come to the fore. The requirement for manufacturing excellence demands new requirements on critical sub-systems to deliver highest availability. The way of working hitherto in the cleanroom must now become the accepted norm in the sub-fab environment. At the heart of this is the SEMI E10 standard which has been adopted to derive an availability methodology.

Never at any other time in the history of Moore's Law has it been so acute for the sub-fab to understand the critical importance of the EUV Lithography platform. Impact on availability of the supporting EUV vacuum sub-system will automatically lead to a multitude of uptime loss on the tool itself.

With Edwards unique experience in providing EUVL sub-fab solutions the focus on availability projects crosses key areas: people, parts and tools. Derivates of the afore-mentioned include a known issues management system, which actively addresses faults if, and when they arise, continuous optimisation of the sub-system availability performance by defined programmes with in parallel a roadmap for product development in line with changes in the EUV Tool's development as well as a focus for optimization in the design and operation of the sub-system such as with energy savings and overall footprint reduction.

These technology developments are driven by real time system health monitoring of a broad install base. As a result, a continuous improvement programme is delivered to provide the maximum EUVL tool efficiency and uptime possible. Maximum uptime is delivered through minimum downtime which is most effectively enabled by having remote connectivity.

This paper will discuss how, through intelligent product development and service learning Edwards' unique position in providing EUVL sub-fab solutions supports the required EUVL availability and manufacturing and operational excellence.

**Biography**
Niall Walsh has over 15 years of experience in the semiconductor industry. In 2018 Niall joined Edwards as Availability Programme Manager for our fully integrated sub fab solution (EUV Zenith) supporting extreme ultraviolet lithography (EUVL) at customer sites globally.
Prior to joining Edwards, Niall held various engineering and leadership roles supporting semiconductor lithography for Nikon Precision.
Niall is based in Veldhoven, the Netherlands. His education includes a Bachelor of Science in Mechatronic Engineering, Master of Science in Computer Aided Mechanical and Manufacturing Engineering and a Master of Science in Operations Management from Dublin City University in the Republic of Ireland.

M. Kraxenberger
Vice President
ABB Semiconductors, Lenzburg, Switzerland

**Biography**

Manfred Kraxenberger is currently factory manager for ABB's BiMOS wafer fab and assembly line in Lenzburg, Switzerland.

Manfred Kraxenberger studied physical engineering and started working as process engineer at Siemens Semiconductor in Munich in 1986. Over the last 30 years, he has held several engineering and management positions in manufacturing as well as R&D at Siemens/Infineon/Qimonda and Globalfoundries.

**Development of an Efficient Software-Backup-Management-System for Semiconductor Equipment Controllers**

M. Liebau
Equipment Engineer
X-FAB Semiconductor Foundries GmbH,
Equipment Engineering, Erfurt, Germany

**Abstract**
All semiconductor production equipment is controlled by different types of controllers, computers and dedicated developed software. An appropriate software backup system is very important to predict unscheduled machine downtimes.

X-FAB developed and implemented a Software-Backup-Management-System (Software-BMS) based on a database which is able to register all different types of unique equipment computer information (hardware & software). The software images of these systems can also be stored in that data base. Additionally there was developed an algorithm to find the best interval at which backups should be created. With this tool, X-FAB was able to reduce unplanned downtime due to unpredicted data loss, which results in significant lower unplanned downtime due to software issues and in a very short payback period.

**Biography**
Matthias Liebau was born on 15th September 1981 and graduated from high school in 2000. Since 2002 Matthias works for X-FAB in Erfurt. From 2002 to 2005 he was in training for a mechatronics technician. After graduating in 2005, he worked as an equipment technician at the local fab maintenance team. From 2007 to 2011 Matthias also studied mechatronics. Since his final exam in 2011 Matthias works as an equipment engineer at the local equipment engineering team.

**Fab cost saving programs with Siconnex Batchspray® Technology**

F. Woerndl
Global Director Sales & Marketing
Siconnex, Global Director Sales & Marketing, Hof bei Salzburg, Austria

**Abstract**
Siconnex BATCHSPRAY technology is used, if a high throughput on a small footprint, as well as a low chemical consumption matters. With this, a fast payback for investments in such equipment is given and cost saving programs are achieved.
In a case study, that was done together with a customers, the benefits of moving from a wetbench to a BATCHSPRAY equipment in terms of money and cost savings are shown.

**Biography**
Fabio Wörndl started as Service Engineer at Siconnex in 2011, maintaining and installing new Batchspray equipment around the globe. After a technical sales support role for the US market, he became Account Manager in 2016, handling several international accounts.
Since July 2017, Fabio is Global Director of Sales & Marketing, managing equipment and spare parts sales as well as marketing activities for Siconnex worldwide.
Fabio has a technical education with a degree in electronics as well as a diploma in industrial engineering and economics.

**Automatic Defect Classification of images of defect or Wafermap using Deep Learning**

L. Bidault
Data Scientist
STMicroelectronics, Defectivity, Rousset, France

**Abstract**
**Overview of the project**

All along the production line, physical defects could be generated by process equipments.

To ensure the highest level of quality of our products, we are inspecting the wafers to detect and address about these defects. In case of detection, an important task is to take **images** of these defects either optical or by an Electronic Microscope (SEM). Based on those images, certified technicians are “manually” classifying them according to the family they belong to.

This task is complex, time-consuming and could be also affected by the human factor.

To overcome these challenges, we developed and integrated an algorithm based on modern **Convolution Neural Network** architecture (**Deep Learning**). This solution is able to analyze available types of images, as well as wafer map, and then to recognize defects type for classifying it.

**Results**

The algorithm is running **in production** for 3 **years** without any interruption, and is providing an accuracy beyond the highest level of certified technicians.

There are already tenths of **inspection layers in production** with a number of **classes** up to **16** for each layer.

In each layer, **all the products** are represented.
Sometimes **it is possible to group several layers** on the same configuration; in this case, it is providing a significant gain of time during the dataset creation used for training the algorithm.

It is worth to notice also that this algorithm is able to reject the classification if the prediction is not guaranteed. This specific behavior is evidenced only for a small number of images so that the level of unclassified images remains low.
Thanks to this, we are able to **detect “novel class”** when it happens.

One important feature of this algorithm is that **it just needs one image per defect**: there is no need to collect a reference image (image with no defect) on the neighboring die.

The result is a **“real-time” classification** (~1 second per image) which is essential to sustain the requirements driven by the production flow

**Biography**
Laurent Bidault is a graduate engineer from the “Hautes Etudes Industrielles” (HEI) school and has been working for more than 20 years in the semi-conductor industry.

He experienced 8 years in Equipment Engineering in Applied Materials before joining STMicroelectronics. During the last 11 years, he worked mainly into the engineering activities linked to Defectivity.

In 2015, he graduated as “**Data Scientist**” of “Telecom ParisTech” school where he learned advanced Machine Learning techniques. Since that time, he specialized in applying modern algorithms based on Convolutional Neural Networks, so called Deep Learning. Among his realizations, he succeeded in implementing a cost affordable solution for an automatic and efficient defects classification.

## Digital Twin / Ion Source Prediction

R. Madani
Sr Staff Project Manager
Globalfoundries, Manufacturing and Operations,
Dresden, Germany

**Abstract**
The ion source is a major concern in utilising implant tools to their full potential. The issue is mostly related to the thermionic filament which either exhibits beam imaging problems or sudden fusing. This work is examining both failure modes by implementing different prediction models. It can be demonstrated that the combination of different prediction models can enhance the overall accuracy of the prediction. The best prediction accuracy is achieved by combining linear regression methods with random survival forest as well as exponentially gradient-boosted trees.
Moreover a fusing event can be predicted within 24 hours before occurrence in more than 75% of breakdowns and uniformity issues are forecast with a minimum accuracy of greater than 50% of the cases. The achieved accuracy has enabled the introduction of the predictive maintenance strategy for implant tools at Globalfoundries which has led to an improved utilisation and a reduction of 12.7% of total maintenance costs. Taking into account additional influences such as cycle time, mean time to failure or time to repair it can be shown that with a balanced approach additional 4.7% of cost saving is achieved.
Based on this outcome the general condition for successfully applying predictive maintenance is discussed. In particular the process of identifying potential opportunities is highlighted. Dependencies in scaling this method effectively are studied with regards to: a) available feature information, b) the opportunity to generate run to fail data and c) easy access to failing components.

**Biography**
Dr. Ramin Madani studied Physics and worked at the Max-Planck-Institute for Plasma Physics in Greifswald until 2004 before joining Infineon/Qimonda at the 300 mm site in Dresden. He joined Odersun AG, a German manufacturer of flexible CIS solar film, in 2009 and was responsible for backend manufacturing. In 2012 he started at Globalfoundries where he initially led projects in the area of process control and successfully reduced tool variability to pave the way for a steady increase in 28nm LPQ prime yield - a major success for Fab1. He later headed a multi-year program to drive manufacturing excellence with sophisticated tool data processing and best in class automation solutions. In line with Globalfoundries' smart manufacturing initiative, he launched in 2016 the equipment and process analytics program which is currently driving data intelligence and ML use cases in Fab1 manufacturing.

**Use of AI based predictive maintenance solutions to predict failures and tovisualize the required preventive maintenance operations within a shopfloor todetermine the optimal maintenance schedule for a production process chain**

C. Kluge
Manager
Ap-s, Aasen, Germany

**Abstract**
In today's approaching industry 4.0 with its highly automated process chaining, any required maintenance and downtime is crucial to a tool's expected performance – especially in the semiconductor world. However, the estimated costs of damages to material or equipment make a preventive maintenance even more valuable – hence the ability to predict potential failures is a key advantage.
But since a tool is just one link in a process chain, the downtime will have effect on the entire chain. This requires the creation of predictive maintenance models that represent all tools within the process chain – or at least its critical path. These models' information shall be used for providing an overview of the tool's state including its healthiness.
In many cases a tool's software does already provide some of the required data in application-specific log files. The combination of this data along with additional external sensor output provide a viable source for learning an AI in order to visualize the results in a shopfloor and to schedule the optimal maintenance windows for minimizing the overall downtime.

**Biography**
Christoph Kluge, CEO of tepcon GmbH, has been developing software solutions for over 20 years. In 2002 he founded the technology and consulting company tepcon GmbH, an AP&S affiliated company. In 2017 he took over the position as Director Software Development at AP&S.

# Innovations to Enable Industry 4.0 for Semiconductor Process Tools

M. Della Pia
IT Installed Base Director
Lam Research Corporation, Milan, Italy

**Abstract**

Increasing costs and increasingly advanced semiconductor manufacturing have created a strong incentive to enable smart manufacturing, where the use of more sensors, more data with machine learning software has the potential to increase productivity and process performance.

There are significant challenges to be able to achieve this goal such as infrastructure, specialized machine learning and organizational challenges to connect data science with process and tool knowledge.

Historically semiconductor manufacturing solutions around tool data and tool control have been implemented as fab-wide solutions. To achieve the level of performance demanded, by the objectives of smart manufacturing, will require a secular change where tool type specific solutions will supplement the fab-wide systems, as the level of specialization required means a 'one-size-fits-all' approach is inadequate.

Existing solutions for advanced tool data analytics face a critical challenge as the data science and computer science approaches lack the critical element of applied tool knowledge. What is needed is a way to enable richer tool data and machine learning that adapts to new complex process flows and a common platform that brings together the data teams, the process teams and the tool experts.

This paper will illustrate these challenges and a solution, with use case examples that show how smart manufacturing is being enabled for process tools from Lam Research.

**Biography**

Mr Della Pia is a semiconductor professional with 24 years experience in the high-tech industry. He started his career working for Texas Instruments and when the DRAM division was acquired by Micron Technology he continued his career with them.

In 2000 he moved to China and being amongst the first to join the foundation of the first cutting-edge IC foundry in China (SMIC), played an active role in the construction of the semiconductor industry on the mainland. Whilst at SMIC, Mr Della Pia progressed to various leadership roles across multiple fabs.

In 2013, he joined Lam Research and is currently Director in Lam's Customer Support Business Group, responsible for EMEA Installed Base Operations and for the Big Data project in the EMEA region. Mr Della Pia holds an M.Sc. in Chemical Engineering.

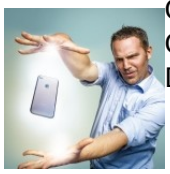
**Real time compounds monitoring in clean room environment**

M. Didierjean
Product and Business Development Manager of Contamination Systems
Pfeiffer Vacuum SAS, Product Management Contamination Systems, Annecy, France

**Abstract**
Due to chip node size shrinking down, contamination is known to be one of the biggest contributors of yield loss in semiconductor fabs.
Contamination such as particles or molecules can impact on devices with or without packaging during the manufacturing, therefore AMC and particles needs to be under control to avoid crisis.
With more than 10 years experience, Pfeiffer Vacuum is recognized as a key actor in Semiconductor contamination control for providing innovative monitoring and containment solutions that are used notably in the following fields of application: Microelectronics and the pharmaceutical industry.
Our collaborative customer-oriented solutions have been qualified by technology leaders and have demonstrated quantified results such as yield enhancement, quality improvement and manufacturing flexibility.
Real time compounds monitoring in clean room environment are now key solutions in most advanced semiconductor fabs.

**Biography**
**Manuel Didierjean** is the Product and Business Development Manager of Contamination Systems for Semiconductor Fabs within the Pfeiffer Vacuum Group since 2018.
Prior to the semiconductor sector, his position was Head of Marketing in a French company called ALDES dedicated to indoor air quality as well as energy efficient solutions in the buildings industry.
Manuel was in charge of the market launch of different product solutions to protect people from inside and outside pollution in their living areas.
He was particularly involved in Chinese projects where PM 2.5 particles due to atmospheric pollution is a national concern.
His education background is a Master of Science in Engineering Design from the University of Edinburgh in Scotland.

**From now on everybody is #Agile, or what?**



C. Bredlow
CEO
Digital Mindset GmbH, Laatzen, Germany

**Abstract**
Under the title "From now on everybody is #Agile, or what?" Christian Bredlow deals with the question why the whole world is currently dealing with buzzwords like agility and new work. Why does everyone write on their windows with chalk pens and why do these posties stick everywhere now?

Bredlow explains the importance of the topic for businesses and their managers. Because changed ways of working and leading function only then successfully, if they are understood and lived by high-level personnel.

**Biography**
Inspire, develop, manage –Christian is an assertive guide with a focus on digital media, collaboration and modern, team-oriented leadership and employee motivation.
He loves helping customers with issues that allow them to compete, attain and retain new challenges. Persuading audiences in and out of a company has been an attribute that Christian strives to develop. Change happens when a group of people move in the direction of the goal.