International Academy
Engineering & Technology

SZTAKI

The 5th AET International Symposium of ACSM and Digital Manufacturing

www.sztaki.hu
www.aet-ac.org

2023

WELCOME TO SZTAKI

*Prof. László Monostori, director of SZTAKI, speaks at the international AI & AUT Expo in Budapest, Hungary, at the Hungarian Railway Museum, 2023. 02. 14.

DEAR ATTENDEES

Welcome to the 5th International AET Symposium, held by the Institute for Computer Science and Control, Budapest, Hungary (SZTAKI).

Our mission "Excellence in science and innovation" is articulated in the following statement: "Relying on its strong – and characteristically focused – theoretical research activities, SZTAKI generates new results while utilizing a framework of widespread domestic and international cooperation, and facilitates their applications to the benefit of the sustainable development of the economy and society, and, at the same time, avails in its fields of activity to preserve and, as far as possible, to raise the Hungarian scientific-technical culture to a higher level".

Accordingly, we are most honored to host the 5th International Symposium of the International Academy of Engineering and Technology on Atomic and Close-to-atomic Scale Manufacturing (ACSM) and Digital Manufacturing (AETS2023) which brings world-class representatives of manufacturing science and technology to Budapest.

Some of the topics to be discussed at AETS 2023 are in the forefront of our research agenda, and we also share their strong commitment to transfer the novel results to real-life applications in the service of the society. SZTAKI displays leadership in computer science, informatics, artificial intelligence, systems and control theory, perception and human-machine interaction, production informatics and robotics, as well as new computing services in Hungary, and is widely recognized at an international level. The Institute leads the Artificial Intelligence (MILAB) and the Autonomous Systems (ARNL) National Laboratories.

The pursuit of excellence in science and innovation has guided the Institute throughout its nearly 60 years of existence. In 2001 we were awarded the title of European Centre of Excellence in Information Technology, Computer Science and Control, and in 2017, under the leadership of SZTAKI, the three institutes of the German Fraunhofer Society, Fraunhofer Austria, and two Faculties of the Budapest University of Technology and Economics (BME) established – with the support of the EU and the Hungarian government – the Centre of Excellence in Production informatics and Control (EPIC CoE). Moreover, our technology transfer company, EPIC InnoLabs Ltd., established together with Fraunhofer Society successfully serves the domestic and the international – including overseas – markets.

SZTAKI had a key role in founding and coordinating the Industry 4.0 National Technological Platform of Hungary, in cooperation with companies leading the digital transformation of manufacturing worldwide. I would like to take this opportunity to extend my heartfelt gratitude to our partner company Bosch Rexroth for graciously hosting the closing event of the AETS 2023 symposium.
The Institute's scientific excellence was always highly recognized at the international level. In IFAC and in CIRP researchers of the institute were elected as presidents, and the 9th World Congress of IFAC and the 61st General Assembly of CIRP were organized by SZTAKI in Budapest, in 1984 and 2011, respectively. And now we are honored by the decision of ATE to hold the 5th International AET Symposium in Budapest, Hungary.

Now I wish all the attendees a vibrant gathering, abundant with both scientific and social interactions.

Professor László Monostori

Director of SZTAKI, Professor Emeritus of BME

His key achievements relate to control and monitoring of manufacturing processes, intelligent manufacturing processes and systems, cyber-physical production systems, holonic manufacturing, production networks, cyber-physical production systems and to biological transformation in manufacturing.

He is former President of CIRP; former Chairman of the Coordinating Committee on Manufacturing and Logistics Systems (IFAC), former Chairman of the Technical Committee on Technical Diagnostics (IMEKO).

He is founding Editor-in-Chief of the CIRP Journal of Manufacturing Science and Technology and member of the editorial boards of numerous international scientific periodicals.

He is member of the Hungarian Academy of Sciences, the Hungarian Academy of Engineering, and of the National Academy of Science and Engineering (Deutsche Akademie der Technikwissenschaften, acatech), as well as foreign member of the Royal Flemish Academy of Belgium for Science and the Arts (KVAB), member of the European Academy for Industrial Management (AIM) and of the International Academy of Engineering and Technology (AET).

WELCOME AT AETS 2023!

A new round of industrial digital revolution is currently being nurtured worldwide, thanks to breakthroughs in emerging Industry 4.0 technologies.

With continuous shrinking of feature size for the next-generation products, manufacturing is clearly advancing to a new paradigm, namely Manufacturing III, towards both atomic scale precision and atomic scale functional feature size.
The series AETS Symposia started in 2018 and have provide a platform for fostering collaborations between Academia and Industry and cover a broad spectrum of areas with multi-disciplinary interests, in the field of Atomic and Close-to-atomic Scale Manufacturing (ACSM) and Digital Manufacturing, ranging from fundamental research to real-world applications.
To make the symposium more effective and efficient, keynote speeches andinvited talks are scheduled, while posterpresentations are allocated into a compact program.

On behalf of the organising committee I would like to warmly welcome you to the 5th AET Symposium on ACSM and Digital Manufacturing (AETS2023) which is organised by the International Academy of Engineering and Technology (AET) and the Institute for Computer Science and Control (SZTAKI).

Professor Fengzhou Fang has been working in the fields of freeform optics design and manufacturing, bio-medical manufacturing, ultra-precision machining and metrology, and machine learning when he became a faculty member at university in 1982.

He has spent large amount of his time in understanding the law of manufacturing advancement in recent ten years, and indicated that atomic and close-to-atomic scale manufacturing is the fundamental technology of the new manufacturing paradigm, namely Manufacturing III. He is the President (2023-2024) of the International Academy for Production Engineering (CIRP), the Founding President of t the International Society for Nanomanufacturing (ISNM), and the Editor-in-Chief of the Nanomanufacturing and Metrology.

Professor Fang is elected as a member of the Royal Irish Academy (RIA) and fellow of CIRP, ISNM, AET and SME.

There are 5 keynote addresses that will be given by Prof Paul Shore from Loxham Precision Ltd (UK) focusing on ultra precision machining technologies for future quantum devices, by Prof Lihui Wang from KTH Royal Institute of Technology (Sweden) who will address digital twin-driven condition monitoring in predictive maintenance, by Prof Jens Ducrée from Dublin City University (Ireland) highlighting opportunities for micromanufacturing bioanalytical „lab-on-a-chip" systems, by Prof Peter De Wolf from Bruker Nano Surfaces (USA) reviewing atomic force microscopy based metrology & manipulation at the nanoscale and by Gábor Stépán from Budapest University of Technology and Economics (Hungary) presenting the development of hardware-in-the-loop test-rig for high-speed milling.

In addition, the symposium has 5 invited talks that will be given by Prof Nikolaos Michailidis, Aristotle University of Thessaloniki (Greece) who will address digital transition in manufacturing of porous and lattice structures, by Prof Roberto Teti from University of Naples Federico II (Italy) highlighting biological transformation in manufacturing, by Dr Yu Yang, AMETEK Taylor Hobson Ltd (UK) informing the recent advance of 3D optical metrology of freeforms, by Dr Christian Wenzel from Innolite GmbH (Germany) presenting advanced alignment turning of mounted spherical and aspherical optics and by Prof Rong Chen from Huazhong University of Science and Technology (China) who will present surface reaction kinetics for inherent selective atomic layer deposition.

I would like to take this opportunity to thank the organizing committee and all those who have contributed to this symposium, as well as the scientific committee members for their valuable support. My thanks go to the conference sponsor for their suggestions and support. Sincere thanks also go to Prof Jozsef Vancza, the Organizing Committee Chairman and Prof Xichun Luo, the AET Secretary General for their dedication throughout the symposium preparation. Finally, but not least, I want to thank the many volunteers for their diligent work for the symposium.

I wish you all have a great success in participating the symposium and have a pleasant stay in Budapest!

Professor Fengzhou Fang

President, the International Academy of Engineering and Technology

When SZTAKI's Research Laboratory on Engineering & Management Intelligence was established, the Institute had already been involved in the digital transformation of manufacturing for decades.

Dr. József Váncza has been working in the Institute for Computer Science and Automation (SZTAKI), where he is Head of the Research Laboratory for Engineering and Business Intelligence.

His research focuses on the interplay of artificial intelligence, manufacturing science, production engineering and operations management. He contributed to the development of cyber-physical production systems, and his key results relate to advanced planning in production and energy management, and to cooperative and sustainable production.

He has been active in teaching at the Budapest University of Technology and Economics for more than three decades. He is Fellow of CIRP, AET and the Hungarian Academy of Engineering.

FROM THE PAST TO THE FUTURE

SZTAKI's long history with state-of-the-art production technology plays an important role in our institute's identity: our daily motivation stems not only from cherishing the acclaimed pioneering results of the past sixty years but also from the allure of new challenges and opportunities that arise from this ongoing evolution, continuously capturing our research interest.

This year's AET symposium at Budapest gives us a rare opportunity to showcase SZTAKI's rich history, while also exemplifying the importance of our past developments in the perspective of our present.

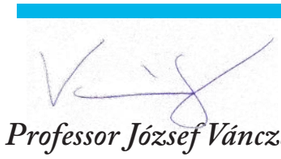
During the first day, our visitors will have the chance to see SZTAKI's original contributions to the development of what is termed now cyber-physical production system in an exhibition titled "From the Past to the Future".

While we will present some digital manufacturing related technologies from the last century, we will also demonstrate some current achievements from several laboratories of the institute investigating autonomous systems, AI and robotics in particular.

The second day will be fully dedicated to the up-to-date scientific issues of atomic and close-to-atomic scale manufacturing (ACSM), as well as of digital manufacturing (DM). Digitalized poster presentations will create a captivating and continuous intellectual backdrop for all our discussions.

Finally, on the last day, we will take a glimpse to the near future by visiting Bosch Rexroth's innovation center to see how research result of engineering are taken up by the industry. For the participants of the 5th AET Symposium – and with their active involvement – we aim to trace the trajectory of production engineering, encompassing the past, present, and future, while also shedding light on the pathways connecting academic research to practical industrial applications.

Three days in three times – I look forward to a profoundly illuminating experience.



Professor József Váncza,

Head of Research Laboratory on Engineering & Management Intelligence,
SZTAKI

WELCOME TO CU.BE!

I cordially invite you to visit our Industrial Innovation Centre, CU.BE Budapest, which is not only an Industry 4.0 showroom where we make the latest digital manufacturing solutions available.

István Ács has been the Managing Director of Bosch Rexroth for more than 20 years. He was born in Budapest in 1960, graduated at the Budapest University of Technology and Economics in 1984 as a Mechanical Engineer, and joined our company's predecessor, Rexroth Danuvia, as a Hydraulic Engineer in 1990, to become the regional head of the company in 1998, keeping his position through Rexroth's merge with the German industrial titan Bosch - he's been Managing Director of Bosch Rexroth Hungary since 2001.

He's been also responsible for the Adriatic region since 2015. István has been responsible for all developments for Bosch Rexroth in the Adriatic region as well since 2015; he is the co-president for the Hungarian Industry 4.0 National Technology Platform, and a long-time pioneer of local and worldwide industrial digitalization.

Indeed, it is not merely a place where we work with our partners to select and tailor solutions to their specific needs, so making their processes more efficient and sustainable. CU.BE is an open, inspiring space where we work with industry, our customers, partners, universities, professional organisations to develop innovative solutions and new ways of making our planet a better place.

At Bosch Rexroth, we believe in digitalisation and that technology will positively impact our future.

Industry 4.0 enables us to make our vision of the future come true, where we use our resources optimally and where the entire production cycle is more efficient, machines are predicted in advance if they are going to fail and there are no more unexpected downtimes. Where production processes are flexible and respond quickly to changing needs, reducing overproduction and unnecessary waste.

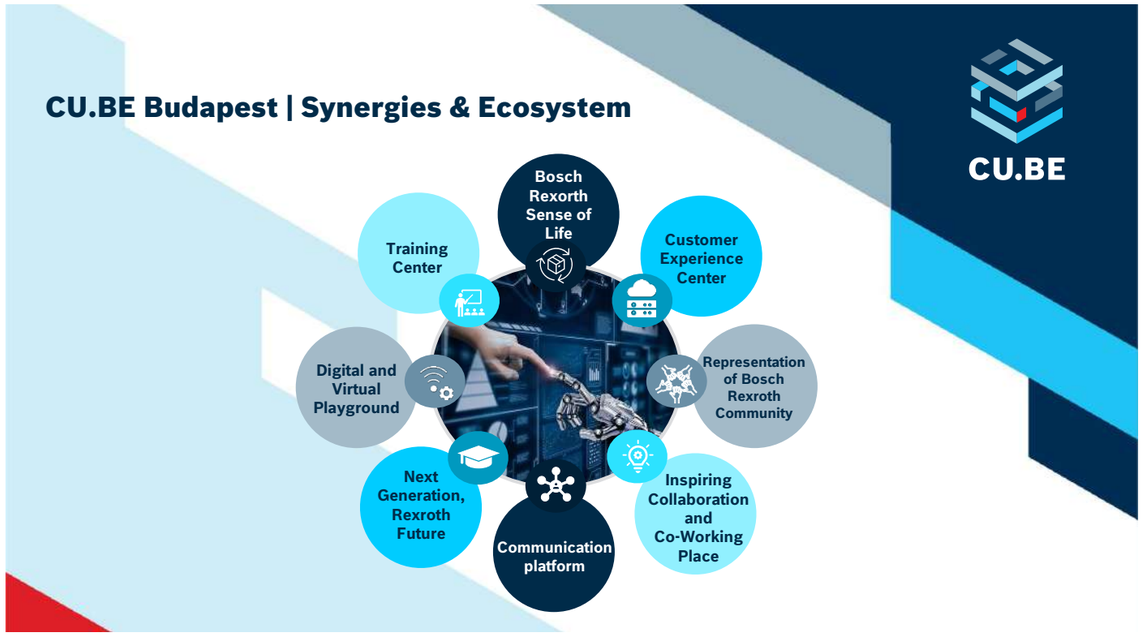
Through connected systems and real-time data analytics, we unlock unprecedented efficiency and productivity potential. We harness the power of information to make informed decisions, reduce our ecological footprint and promote a circular economy. This is why we are at the forefront of industrial digitalisation and why we encourage everyone to

Through connected systems and real-time data analysis, we unlock the potential for unprecedented efficiency and productivity. Using the power of information, we make well-grounded decisions, reduce our ecological footprint and promote a circular economy. That's why we're at the forefront of industrial digitalization, and that's why we encourage everyone to get involved in the development and take a big step forward.

Join the exclusive CU.BE Experience Tour!

István Ács

Managing Director,
Bosch Rexroth Kft.



PROGRAM

WEDNESDAY, 30 AUGUST 2023

SZTAKI Lágymányosi building
1111 Budapest, Lágymányosi u. 11.

15:00 - 19:00
Registration

"From the Past to the Future" hardware history exhibiton

Demos in the Innovation and Demonstration Space of SZTAKI

Viewing Posters

SZTAKI Kende building
1111 Budapest, Kende u. 13.

18:30 - 20:00
Welcome reception

THURSDAY, 31 AUGUST 2023

SZTAKI Kende building
1111 Budapest, Kende u. 13.

8:00 - 9:00
Registration

9:00 - 9:15
Opening Ceremony

Chair: Prof. József Váncza, Institute for Computer Science and Control (SZTAKI), Hungary

Welcome address
Prof. László Monostori, Institute for Computer Science and Control (SZTAKI), Hungary

Opening address
Prof. Fengzhou Fang, University College Dublin, Ireland /Tianjin University, China

Keynote Session I

Co-Chairs: Prof. Kornel F. Ehmann, Northwestern University, USA
Prof. Xichun Luo, University of Strathclyde, UK

9:15 - 9:45
Keynote 1

Ultra Precision - Enabling our Quantum Future
Prof. Paul Shore, Loxham Precision Ltd, UK

9:45 - 10:15
Keynote 2

Digital Twin-Driven Condition Monitoring in Predictive Maintenance
Prof. Lihui Wang, KTH Royal Institute of Technology, Sweden

10:15 - 10:45
Keynote 3

Opportunities for Highest-fidelity Micromanufacture towards Unprecedented Large-scale Integration of Bioanalytical „Lab-on-a-Chip" Systems
Prof. Jens Ducree, Dublin City University, Ireland

10:45 - 11:15
Keynote 4

Review of Atomic Force Microscopy Based Metrology & Manipulation at the Nanoscale
Dr. Peter De Wolf, Bruker Nano Surfaces, USA

11:15 - 11:35
Coffee Break & Viewing Posters

Oral Session I

Co- Chairs: Dr. Christian Wenzel, Fraunhofer Institute for Production Technology, Germany
Dr. Nan Yu, University of Edinburgh, UK

11:35 - 11:55
Invited Talk

Digital Transition in Manufacturing of Porous and Lattice Structures
Prof. Nikolaos Michailidis, Aristotle University of Thessaloniki, Greece

11:55 - 12:15
Invited Talk

The Biological Transformation in Manufacturing: Current Trend and Future Development
Prof. Roberto Teti, University of Naples Federico II, Italy

12:15 - 12:35
Invited Talk

Advanced 3D optical metrology of Freeforms
Dr. Yu Yang, AMETEK Taylor Hobson Ltd, UK

12:35 - 12:50
Oral Presentation

A Novel Electrochemical Method to Form Single Layer Graphene Schottky Junction
Prof. Dongping Zhan, Xiamen University, China

12:50 – 13:05
Oral Presentation

High efficiency plasma-assisted polishing of lutetium oxide single crystal
Dr. Peng Lyu, Tianjin University, P. R. China

13:05 - 13:20
Oral Presentation

MD simulation of material removal mechanism of RB-SiC during nano-scratching process
Dr. Changlin Liu, The Hong Kong Polytechnic University, P. R. China

13:20 - 13:35
Oral Presentation

Laser assisted diamond turning of hard and brittle materials
Dr. Kaiyuan You, University of Electronic Science and Technology of China

13:35 - 14:40
Lunch Break & Viewing Posters

Oral Session II

Co- Chairs: Prof. Nikolaos Michailidis, Aristotle University of Thessaloniki, Greece
Prof. Dongping Zhan, Xianmen University, China

14:40 - 15:00
Invited Talk

Advanced alignment turning of mounted spherical and aspherical optics
Dr. Christian Wenzel, Innolite GmbH, Germany

15:00 - 15:20
Invited Talk
Surface Reaction Kinetics for Inherent Selective Atomic Layer Deposition
Prof. Rong Chen, Huazhong University of Science and Technology, China

15:20 - 15:35
Oral Presentation

Kinematic Graphs in Digital Manufacturing: Case Studies from Robotics and Machining
Dr. Gábor Erdős, Institute for Computer Science and Control (SZTAKI), Hungary

15:35 - 15: 50
Oral Presentation

A scale-dependent mathematical definition of manufactured products for standardized geometrical specification and verification
Dr. Yifan Qie, Paris Saclay University, France

15:50- 16:05
Oral Presentation

Mechanochemically-Assisted Manufacturing: From Bulk Monocrystalline Silicon to Two-Dimensional Graphene Materials
Prof. Lei Chen, Southwest Jiaotong University, China

16:05 - 16:20
Oral Presentation

Maskless Fluid Jet Polishing of Functional Structured Surfaces
Dr. Chunjin Wang, The Hong Kong Polytechnic University, China

16:20 - 16:40
Coffee Break & Viewing Posters

Keynote Session II

Chairs: Prof. Han Haitjema, KU Leuven, Belgium

16:40 - 17:10
Keynote 5

Development of hardware-in-the-loop test-rig for high-speed milling
Prof. Gábor Stépán, Budapest University of Technology and Economics, Hungary

17:10 - 18:10
Round Table Discussion

Facilitator: Prof. Paul Shore, Loxham Precision Ltd, UK
Panel: Prof. Nabil Awer, Paris Saclay University, France
Prof. Rong Chen, Huazhong University of Science and Technology, China
Prof. Kornel F. Ehmann, Northwestern University, USA
Prof. József Váncza, Institute for Computer Science and Control (SZTAKI), Hungary
Prof. Xichun Luo, University of Strathclyde, UK

18:10 -18:25
Closing Ceremony

Chair: Prof. József Váncza, Institute for Computer Science and Control (SZTAKI), Hungary

Closing remarks
Prof. László Monostori, Institute for Computer Science and Control (SZTAKI), Hungary

Fellowship conferring
Prof. Fengzhou Fang, University College Dublin, Ireland /Tianjin University, China

AETS 2025 announcement
Prof. Nabil Anwer, Paris Saclay University, France

18:45 - 22:00
Bus transport to conference banquet

Conference banquette on the restaurant boat Primus touring over the Danube, offering the best of Budapest at night. Guests may get onboard at the port at Jászai Mari tér 9., 1137, but bus transfer is also launched from SZTAKI at 18:45.

Return bus is also arranged.

FRIDAY, 1 SEPTEMBER 2023

Bosch Budapest Innovation Campus
1103 Budapest, Felüljáró, Gyömrői út 90.

9:00 - 12:30
Technical Tour to Bosch Rexroth

At the last day of your visit, we take a trip to Bosch's newly opened **Budapest campus** to see the CU.BE innovation center, created by **Bosch Rexroth**.

The name **CU.BE** is coming from "customer benefits", and the center's industrial technologies are to demonstrate the actual, tangible results of industrial digitalization.

Bus ride will be arranged from the recommended hotels, and back. The Bosch Rexroth site (Budapest, Gyömrői út 104) is located conveniently close to the airport, 15 minutes by taxi. The organizer can help with arranging them if requires.

Photo by Daniel Olah on Unsplash

AETS 2023 SCIENTIFIC COMMITTEE

Keynotes

ULTRA-PRECISION– ENABLING OUR QUANTUM FUTURE

Prof. Paul Shore
Loxham Precision Ltd, UK

Abstract

Advancement of precision engineering has enabled many of the everyday products and services we enjoy today. From cars to computers to medical devices, precision engineering has been central to their creation and their advancement. This talk will introduce how precision engineering has formed our modern life, and what drove critical innovations to form it.

The role of science advancement as a driver of innovation will be highlighted alongside those of wealth creation and increasingly, humanities quality of life and future sustainability. Paul will illustrate the central role of metrology in making technology advancement. And no doubt as a business owner he will mention the ultra-precision products of the company and suggest why they might have a role to play in our quantum future.

Paul Shore, FRENG is the CEO of Loxham Precision Limited, an ultra-precision machinery company which span out of the Cranfield University Precision engineering Centre. Paul was previously the Head of Engineering at the National Physical Laboratory, Professor of Precision Engineering at Cranfield and the Group Head of Precision Engineering at AB SKF in Gothenburg, Sweden. In the late 90's he introduced new manufacturing technology at SKF that now produces 80% of the Worlds wind turbine bearings. In the early 2000's he developed a new mirror manufacturing method and produced the MIRI spectrometer mirrors for the James Webb Space Telescope.

In 2020, a Loxham μ6 machine which he devised manufactured several of the UKs leading quantum devices. Paul is a Fellow of the Royal Academy of Engineering, a past President of the European Society of Precision Engineering and Nanotechnology (EUSPEN) and a biker. He is the author of > 100 papers and numerous patents.

Keynotes

DIGITAL TWIN-DRIVEN CONDITION MONITORING IN PREDICTIVE MAINTENANCE

Prof. Lihui Wang
KTH Royal Institute of Technology, Sweden

Abstract

Reliable product services depend on the timely acquisition, distribution, monitoring, analytics and utilisation of usage information from the products across spatial boundaries.

These activities can improve accuracy and reliability in utilising the products, and help in maintenance scheduling to bring the products back to normal service conditions. As an emerging tool, digital twin (often combined with big data analytics) provides new opportunities to achieve this objective.

This presentation will first present the current status and the latest advancement of relevant technologies in general, and digital twin in particular. In order to understand such new technologies and their future potential, definitions and characteristics among them will be explained.

This talk will then project their future growth enabled by digital twin. Research and applications will also be outlined to highlight the latest advancement in the field.

While digital twin shows great promise in the future, challenges towards Internet-of-Everything in the areas of future trends remain to be identified in this talk.

Prof. Lihui Wang is a Chair Professor of KTH Royal Institute of Technology. His research interests are presently focused on digital twin, human-robot collaboration, brain robotics, cyber-physical systems, and predictive maintenance. Professor Wang is actively engaged in various professional activities.

He is the Editor-in-Chief of Robotics and Computer-Integrated Manufacturing, Journal of Manufacturing Systems, and International Journal of Manufacturing Research.

He has published 10 books and authored in excess of 650 publications. Professor Wang is a Fellow of Canadian Academy of Engineering, AET, CIRP, SME and ASME, as well as a Professional Engineer in Canada.

He was the President (2020-2021) of North American Manufacturing Research Institution, and the Chairman (2018-2020) of Swedish Production Academy.

Keynotes

OPPORTUNITIES FOR HIGHEST-FIDELITY MICROMANUFACTURE TOWARDS UNPRECEDENTED LARGE-SCALE INTEGRATION OF BIOANALYTICAL „LAB-ON-A-CHIP" SYSTEMS

Prof. Jens Ducree

Dublin City UniversityIreland

Abstract

This presentation shows up the tremendous synergies situated at the exciting crossroads of highest accuracy and precision tooling and replication, digital twin concepts, and an NFT-based research metaverse enabled by blockchain for leveraging order-of-magnitude improvements in the functional integration density of multivariate, high-performance, microfluidic systems. Along the digital twin model for developing exemplary centrifugal microfluidic „Lab-on-a-Disc" systems, it will turn out that the decisive functional integration density is mostly linked to feature miniaturization and manufacturing quality.

Drawing striking parallels to Moore's law and microelectronics, this feasibility study will quantitate the technological requirements for passing challenging technological frontiers, and then sketch next-generation applications, primarily in medical diagnostics and the life sciences. These fields are decisively driven by AI, which needs to be trained by comprehensive, multivariate, population-scale databases. These can be efficiently filled by the proposed technology, for the eventual benefit of patients, economies and societies.

Dr. Jens Ducrée holds a Full Professorship of Microsystems in the School of Physical Sciences at Dublin City University (DCU).

He has been the founding director of FPC@DCU – Ireland's first Fraunhofer Project Centre for Embedded Bioanalytical Systems, a joint initiative of Science Foundation Ireland and Fraunhofer-Gesellschaft.

Dr. Ducrée is also an academic member of the National Centre for Sensor Research (NCSR), the 3U Joint Institute of Global Health (JIGH), a principal investigator at Biodesign Europe (BDE), and the Institute of Ethics.

His main interests primarily reside at the challenging crossroads of microfluidic Lab-on-a-Chip systems for the Life Sciences, polymer replication, digital twin concepts, and blockchain.

Keynotes

REVIEW OF ATOMIC FORCE MICROSCOPY BASED METROLOGY & MANIPULATION AT THE NANOSCALE

Dr. Peter De Wolf

Bruker Nano Surfaces, USA

Abstract

Today, a wide range Atomic Force Microscopy (AFM) based characterisation methods are routinely applied in nanoscale studies of electronic materials and devices. The standard capability of AFM to image the surface topography with nanometre scale spatial resolution is augmented with the capability to measure a variety of physical properties: electrical (for example, surface potential, work function, conductivity, carrier density), magnetic, thermal (temperature distribution, thermal conductivity), mechanical, and more recently also chemical.

Furthermore, several AFM as well as STM modes exist to manipulate and modify materials at the nanoscale, often based upon specific electrical, mechanical, optical or chemical interactions. We will cover a structured overview of these operating modes presenting their capabilities and limitations with case studies.

Dr. Peter De Wolf is application director at Bruker Nano Surfaces & Metrology. He holds a PhD in Electronics Engineering from the University of Leuven, Belgium and IMEC.

He is author and co-author of over 40 publications related to property characterization using AFM in peer-reviewed scientific journals. He also owns several AFM patents and developed several new AFM modes.

The last 23 years, he has held several R&D and Application positions within Bruker Nano Surfaces.

*Photo: Visitors at SZTAKI's hardware history exhibition on the Long Night of Museums, 2023. 06. 24.

Invited Talk

THE BIOLOGICAL TRANSFORMATION IN MANUFACTURING: CURRENT TREND AND FUTURE DEVELOPMENT

Prof. Roberto Teti

University of Naples, Federico II, Italy

Abstract

This presentation reports on a very ambitious international study carried out in the period 2018 - 2022 on the topic of the convergence between biology (the biosphere) and manufacturing engineering (the technosphere).

Four demonstrators from different sectors of the manufacturing value chain and involving bio-inspiration, bio-integration and bio-intelligence were selected to test the following hypothesis: “Future Manufacturing Systems will incorporate Components, Features, Characteristics and Capabilities that enable the convergence towards Living Systems”.

Each of the four demonstrators have succeeded in supporting this hypothesis and in providing clear evidence to confirm that significant performance benefits may be derived through the “biologicalisation” of advanced manufacturing engineering. The evidence reported provides a robust basis for recommending that a deeper analysis of the implications of biologicalised manufacturing technology and systems be undertaken.

As a result of this initial work, it can be concluded that there is a high likelihood that this new convergence will lead to a major paradigm shift in advanced manufacturing. Existing industries will change and new industries will form and, as a result, outstanding opportunities exist for high levels of innovation in the next stages of development of advanced manufacturing technology and systems from the biological perspective.

Prof. Roberto Teti is Director of the Fraunhofer Joint Laboratory of Excellence on Advanced Production Technology (Fh J_UniNaples) at the University of Naples Federico II, Italy.

His research activity is focused on technological innovation for high-added-value manufacturing; smart sensor monitoring of manufacturing processes; 3D metrology and reverse engineering for additive and direct digital manufacturing; AI/ML for the Smart Factories; Biological Transformation in Manufacturing.

He is among the 100.000 top international scientists for all disciplines in the period 1998-2021, as published by Plos Biology Journal in Oct. 2022, he is author of over 350 publications, chairman of many international conferences, fellow of the main scientific academies for production engineering such as the International Academy for Production Engineering (CIRP).

Invited Talk

DIGITAL TRANSITION IN MANUFACTURING OF POROUS AND LATTICE STRUCTURES

Prof. Nikolaos Michailidis

Aristotle University of Thessaloniki, Greece

Abstract

The digital transition in manufacturing has brought about significant advancements in the production of porous and lattice structures, both and periodic and stochastic ones. This work focuses on exploring the impact of digital technologies on the design and production processes of these complex structures. Digital tools such as computer-aided design (CAD) software and simulation techniques have revolutionized the design phase, enabling engineers to create intricate and customized geometries for porous and lattice structures.

Through simulation tools like finite element analysis (FEA) and computational fluid dynamics (CFD), designers can evaluate structural integrity, fluid flow dynamics, and heat transfer characteristics, leading to optimized designs. Additive manufacturing plays a crucial role in the digital transition of porous and lattice structures. It allows for the precise fabrication of complex geometries, offering design freedom and customization possibilities that were once unattainable with traditional manufacturing methods.

The digital transition also facilitates design optimization, where advanced algorithms and computational models aid in exploring optimal material configurations, pore sizes, and connectivity to achieve desired mechanical, thermal, and fluid transport properties.

While the digital transition presents exciting opportunities, challenges such as design complexity, material selection, and process optimization need to be addressed. Overcoming these challenges will contribute to the efficient production of tailored porous and lattice structures with enhanced performance and functionality. This work highlights the advancements and challenges associated with the digital transition, emphasizing the potential for improved designs, customized structures, and enhanced performance in various industries.

Dr. Nikolaos Michailidis is a Professor and Director of the Physical Metallurgy Laboratory (PML) at Aristotle University of Thessaloniki (AUTH), Greece. He is also a Research Professor at Texas A&M University and Chair of the Centre for Research & Development on Advanced Materials. He is a Fellow of the International Academy for Production Engineering (CIRP) and serves as Editor-in-Chief of the European Journal of Materials.

He is actively involved in various scientific societies, boards, and initiatives, including serving at the Board of the Federation of European Materials Societies (FEMS) and Chairing the Design & Construction Division at AUTH. Furthermore, he is a co-founder of PLiN Nanotechnology S.A., a spin-off of AUTH.

He served as President of the Hellenic Metallurgical Society and Chaired the Scientific Committee of EUROMAT 2019.

Invited Talk

SURFACE REACTION KINETICS FOR INHERENT SELECTIVE ATOMIC LAYER DEPOSITION

Prof. Rong Chen

Huazhong University of Science & Technology, China

Abstract

With the development of Atomic and Close-to-atomic Scale Manufacturing(ACSM), the chemical principal and mechanisms that enable selective atomic layer deposition (ASD) is gaining rapid growing interests to unlock attractive avenues for the development of novel nanostructures by depositing atoms at desired surface locations. It has found versatile applications in emerging fields beyond semiconductor industry. Yet with the continuing downscaling, it is important to expand approaches for selective ALD with atomic scale precision on nanoscale features.

In this talk, the inherently selective atomic layer deposition processes will be discussed. Previously, we have demonstrated facet-selective ALD processes, which based on intrinsic differences of precursors chemisorption on terraces or step edges of nanoparticles. To expand the inherently ASD, the acidity and alkaline, surface electronegativity, lattice strains could be exploited to achieve this inhibitor-free selective deposition process.

It is demonstrated that the electronegativity differences altering the chemisorption energy barrier, which affects the initial nucleation rate. Oxides ALD was studied on a series of oxide substrates. Although the oxides have -OH groups on the surface and proposed to have similar nucleation sites, there are long nucleation delays on basic oxides. The H-transfer reaction is a key factor to influence the reaction barrier.

It is hard to nucleate on basic substrates because the H-transfer reaction is blocked. In addition, an anisotropic growth model with the dynamical competition of expansion and dissociation of the nucleus is proposed to nucleation delay are quantitively predicted and the model provides a practical method to evaluate the selectivity of ALD theoretically. It provides a new strategy for inherently selective ALD, which will expand the selective toolbox of nanofabrication for next-generation nanoelectronic applications.

Professor Chen is a full professor at Huazhong University of Science and Technology with the School of Mechanical Science and Engineering, by courtesy of School of integrated circuits, optical and electronic information, China-EU Institute for clean and renewable energy of HUST, and college of future technologies. She received her M.Sc. and Ph.D. degrees from Stanford, B.S. from University of Science and Technology of China.

She was a senior research scientist at Intel Labs before she joined HUST. Her research focuses on atomic layer deposition in ACSM, by understanding surface science, and applying this knowledge to a range of problems in sustainable energy, semiconductor processing, and nanotechnology.

Invited Talk

ADVANCED 3D OPTICAL METROLOGY OF FREEFORMS

Dr. Yang Yu

AMETEK Taylor Hobson Ltd., UK

Abstract

Characterisation of Freeforms are increasingly demanded by optical manufacturers and users and are always challenging topic for metrologists.

The metrologist now has both advanced contact and non-contact measurement solutions available and a combination of these techniques to provide more detailed understanding of opical components.

Form errors of the freeform surfaces resulting from the manufacturing process are critical, in terms of the functionality and reliability of the freeform optics. This presentation will introduce two advanced Freeform measurement techniques, a 3D contact profilometry and a 3D non-contact scanning point interferometry.

The contact method is accomplished by use of an ultra-low noise measurement platform, combined with a patented phase grating interferometry (PGI) technology and specially developed algorithms for calibration and analysis.

The high slope measurement capability of PGI Freeform, together with its large gauge range, enables 3D form measurements for most freeform surfaces. Non-contact scanning metrology is based on a patented multi-wavelength interferometry (MWLI) technology.

It provides high density 3D data in short measurement times at a highly reproducible form measurement accuracy.

The long-range absolute measurement capability of the MWLI sensor, together with its ultra-precision metrology platform and improved calibration routine through which the sensor accurately follows the designed shape of optical surfaces, enables precise 3D freeform surface measurements within its tangential slope measurement range.

Dr. Yang Yu received her BSC degree in Precision Engineering at Tianjin University, China, and completed her MSc and her PhD in Material Physics at Loughborough University, UK. She is currently working at the headquarter of Taylor Hobson Ltd. in UK, operating globally as a Senior Applications Scientist/Manager in the field of Optic metrology, including contact and non-contact metrologies.

Invited Talk

ADVANCED ALIGNMENT TURNING OF MOUNTED SPHERICAL AND ASPHERICAL OPTICS

Dr. Christian Wenzel

Innolite GmbH, Germany

Abstract

The performance of modern optical systems is dominantly determined by the precision of the alignment of single lens elements in the optical path of the system. The highest alignment precision as well as leading productivity in fabrication can be achieved by alignment turning. A lens to be assembled is glued into a metal mount not considering precision orientation yet.

The lens and mount are introduced to an alignment turning machine to measure the optical axis and to correct the metal mount by slow tool turning in a way that the optical and mechanical axis have the same orientation after machining. Remaining shifts of down to 1 micron and tilts < 10 arcsec can be achieved within minutes. As the glue has been solidified prior to machining, there are no more subsequent displacements.

The new machine system to be presented is the world leading platform for flexible alignment turning of various types of optics. With its latest sensors, it is capable of measuring IR optics with a 4.05 µm laser system. In addition, aspherical lenses can be characterized in their orientation by a full aperture confocal scan.

Full automation applies to the measuring steps, the slow tool machine program calculation as well as subsequent quality assurance steps. Current tests on objectives with aspheric lenses have led to an overall optical system improvement of > 30% at significantly reduced assembly times. The presentation covers an introduction to the technology and the machines as well as sample machining results.

Dr. Christian Wenzel studied mechanical engineering at the Aachen University of Technology (RWTH) with a focus on production technology. Subsequently he joined the Fraunhofer Institute of Production Technology IPT to achieve a PHD degree in the field of corrective polishing of precision optical elements. He continued as head of department for ultra precision machine tools, micro-assembly and machine characterization at the institute. In 2009 he founded the Innolite GmbH with a focus on the commercialization of diamond machining and the development of advanced multi axes ultra precision machine tools. With over 50 employees and a subsidiary in Shanghai China the company is developing in mechanics, control systems, in line metrology and software.

AUGMENTED REALITY IN COLLABORATIVE ROBOTICS

A DEMONSTRATION AT THE INNOVATION & DEMONSTRATION SPACE, SZTAKI

POSTER PRESENTATIONS

Atomic and close-to-atomic scale manufacturing and measurement

1 **Proposition of atomic and close-to-atomic scale manufacturing**
Jufan Zhang

2 **Local anodic oxidation of single-crystal silicon: AFM probes for precise oxidation feature size modeling**
Ning Huang, Fengzhou Fang

3 **A combined electrochemistry and mechanical engineering methods to fabricate atomic-sized metallic structures**
Yang Yang

4 **Atomic rearrangement induced by a pulsed magnetic field within cemented carbides tools for enhanced cutting performance**
Zhe Chen, Lin Zhang, Leng Song, Jian Liu

5 **Fabrication of nanostructures on diamond by local oxidation on an atomic force microscope**
Jinyan Tang

6 **Error compensation for near optical coaxial phase measuring deflectometry with refraction error model**
Yanling Li

7 **A miniaturised aspheric camera design with large depth-of-field**
Chenghao Chen, Fengzhou Fang

Ultra-precision machining and material removal

8 **Laser assisted diamond turning of hard and brittle materials**
Kaiyuan You, Guangyu Liu, Wei Wang, Fengzhou Fang

9 **Research on ultra-precision machining of complex surface microstructures based on single point diamond turning assisted by slow tool servo**
Ji Zhao

10 **Machinability of RB-SiC by applying in-situ laser-vibration hybrid assisted diamond cutting**
Xinhuan Li, Yufan Fu, Yongjing Yu, Shanyi Ma, Shaojin Shen, Jianguo Zhang, Jianfeng Xu

11 **Investigation into the anisotropy of C- and R-planes of sapphire in material removal**
Wei Gao, Qi Sun, Han Fang ,Wu-Le Zhu, Bing-Feng Ju

Femtosecond laser processing

12 **Optical far field-induced nearfield breakdown for sub-20-nm ultrafast laser processing**
Lei Wang, Zhen-Ze Li, Xin-Jing Zhao, Yi-Shi Xu, Qi-Dai Chen

13 **Ab initio study of femtosecond laser-induced atomic layer etching of Si**
Peizhi Wang, Fengzhou Fang

14 **Study on the manufacturing method for fiber-end lenses based on femtosecond laser**
Le Song

Injection molding, printing

15 **Precision manufacturing of polymer-based therapeutic functional microstructures**
Wangqing Wu, Bingyan Jiang

16 **Tuning the 3D printing parameters and strategy to control the shape memory effect**
Apostolos Argyros, Andreas K. Lianos, Alnto Koualiarella, Apostolos Arvanitidis, Anargyros Karakalas, Dimitris C. Lagoudas, Satish Bukkapatnam, Nikolaos Michailidis

Material removal modelling -- grinding

17 **Calibration of material removal model based on mechanism and small sample data-driven method in compliant grinding**
Hongwei Sun

18 **Ultrasonic vibration assisted end grinding SiCp/Al composite: Surface formation mechanism, surface characterization, and multi-objective process optimization**
Da Qu, Xingqi Tang, Yang Song, Wei Zheng, Hongji Pu

Fast tool servo, freeform optics, dynamic continuous friction model

19 **Manufacture of near-rotational freeform optics for infrared imaging system**
Zexiao Li

20 **A novel machining approach of freeform multi-mirror mold via normal swing cutting**
Peng Yao, Shimeng Yu , Yifan Wang ,Haijun Wang

21 **Study on manufacture approach of optical freeform surfaces by performance constraint**
Le Song

22 **A dynamic friction model with continuous transition for force control systems**
Tianzhu Xun

Electroforming, plasma processing

23 **Pushing the boundary of ultra-precision electroforming at the atomic scale**
Honggang Zhang

Polishing at atomic and close-to-atomic scale

WHAT TO SEE AT SZTAKI?

"From the past to the future" hardware exhibition

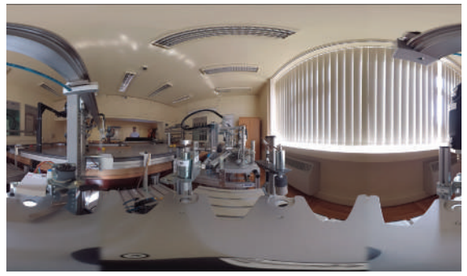
An open exhibition showcasing some of the most important hardware developments of our institute, from the early 60s to the early 2000s, before our focus mainly turned to software development.

Innovation and Demonstration Space

An entire floor of robotics, autonomous systems, AI demonstrations and more; this recently opened co-working office focuses on the current scientific research areas of SZTAKI.

SmartFactory

The SmartFactory is a compact, high-level but functional research and demonstration facility of SZTAKI which compresses a production site to the size of a single room.



PUBLIC TRANSPORT

Public transport just works great in Budapest (and across all Hungary).

If you plan to visit the city, then the best way to do it reliably and affordably is by public means of transport (buses, trams, **4 metro lines,** suburban trains and boats).

Tickets and passes can be bought at any of the numerous **automated selling points,** too. One of the best solutions might be to buy a 1- or 3-day pass.

Also, you can easily use their mobile devices to buy tickets or plan complex routs by downloading and using the **Budapest GO application**.

More information can be found on the **BKK company web-site**.

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