Fraunhofer
ITWM

FRAUNHOFER INSTITUTE FOR INDUSTRIAL MATHEMATICS ITWM

ANNUAL REPORT 2017/18

Front page

Not only the view over our institute´s roof top is broad, but also the spectrum of activities in terms of industries and areas of application.

ANNUAL REPORT
2017/18

CONTENT

ITWM continued its successful development both economically and technically in 2017. Revenue once again increased, and at 53 % of the operating budget, represents the best result in the history of the institute. The explanation for this is the innovative power of mathematics for the sectors of the "Old Economy" in the context of modelling, simulation, and optimization. Mathematics is also at the center of many aspects of digitalization and closely associated with the hot topics big data, algorithms, artificial intelligence, digital twins, and machine learning. The demand for expertise and skills in these areas is likely to increase in the future. As a result, our earnings forecasts for 2018 are very optimistic and our employees are highly motivated to face new challenges.

We are currently seeing a renaissance in the context of digitalization and big data in the further development of the neural networks and machine learning concepts that were developed in the 1990s. New deep learning algorithms are experiencing great success in voice, image, and text recognition applications. ITWM is expanding a major research project launched in 2017 to create a HPC-centric, scalable deep learning framework and adding deep learning algorithms to the GPI, GPI-Space, and BeeGFS software tools developed at the institute.

A special highlight for the Kaiserslautern center last year was the successful bid submitted in the federal and state government initiative "Innovative Hochschule." The collaborative project "Offene Digitalisierungsallianz Pfalz" was granted funding from the initiative for a 5-year period (2018 to 2022) as the result of a joint submission by ITWM, the University of Applied Sciences, and TU Kaiserslautern. The joint proposal addresses innovation in the areas of Education – Healthcare – Products – Vehicles. ITWM and the High Performance Center for "Simulation- and Software- based Innovation" contribute significantly to the research in the area of digital commercial vehicle technology, building on previous years of Fraunhofer-Gesellschaft sponsored cooperation with Kaiserslautern's universities. This area is also being further developed through new technologies that simulate the vehicle-environment-human interaction. These technologies are not only important for durability, energy efficiency, and emissions, but are also critical for the development of advanced vehicle assistance (ADAS), which includes autonomous driving.

Our award-winning spin-off fleXstructures received the prestigious ROBOTICS AWARD 2017 for applied robotic solutions at the Hannover Messe for their software product IPS ROBOT OPTIMIZATION. This successful software tool enables automated task and process scheduling for robots, delivering tremendous time savings when programming robotic stations. Among the outstanding moments of the year was the mention of ITWM at BASF's annual press conference where our multi-criteria optimization method for the design of experiments was publicly commended as a disruptive new technology.

In the digitalization of the economy initiative, ITWM is also working on new methods for hybridization modelling and data driven simulation and optimization. In addition to the outstanding success of this innovative method in the chemical industry, the government sponsored ConWearDi (Construction Wearables Digitalization) project was also mentioned. The project is an example of the innovative planning and management services being developed for craftsmen on the building site. The Optimization department is working on the development of a new kind of "construction site scheduler" for planning the various trade disciplines.

ITWM first established the co-leader structure with alternating executive management in 2016. This proved a wise move which positioned us well to manage potential contingencies. For example, in 2017, a department head was able to participate in the parental leave program for several months without any major organizational problem. Cooperation with other Fraunhofer Institutes also continues, as demonstrated by the highly dynamic development of the FPM (Finite Pointset Method) particle code. Subsequent to the integration of the SAMG solvers for linear equation systems developed at Fraunhofer SCAI, the two institutes jointly launched the new MESHFREE software.

PREFACE

Industry cooperation in all departments increased in 2017. Ongoing cooperation in the area of flow and material simulation with three medium sized companies has stabilized in long-term software development projects with a volume of more than a million euros. The topics are, for example, the expansion of the SuFiS software for dynamic filtration simulation and the development of digital compression stocking designs, enabling a direct determination of the optimal machine settings for customized compression stockings.

Our new Center for Materials Characterization and Testing experienced very good growth in the past year. Successful collaborations are underway with other ITWM departments and the Center's technologies are used in a variety of industrial projects. The participation in the Fraunhofer flagship project QUILT enables the center to develop terahertz imaging systems, which operate on the basis of entangled THz/VIS photons and provide access to quantum technologies.

The Data Science working group in the Financial Mathematics department developed a software platform that detects abnormalities in the accounting data and is applicable in various business sectors. The ITWM capabilities in financial mathematics are increasingly demanded by the automobile banks. In the context of vehicle financing, we are pleased to have acquired the BMW Bank as a new and valued customer.

The topic of "machine learning" is of growing importance in the Image Processing department, especially, as traditional image processing products for the industrial sector are being replaced by machine learning approaches. Again in 2017, several inspection systems were installed in production plants serving new sectors, for example, the furniture industry. A special effort was the organization and planning of the "12th European Congress for Stereology and Image Analysis 2017" together with TU Kaiserslautern.

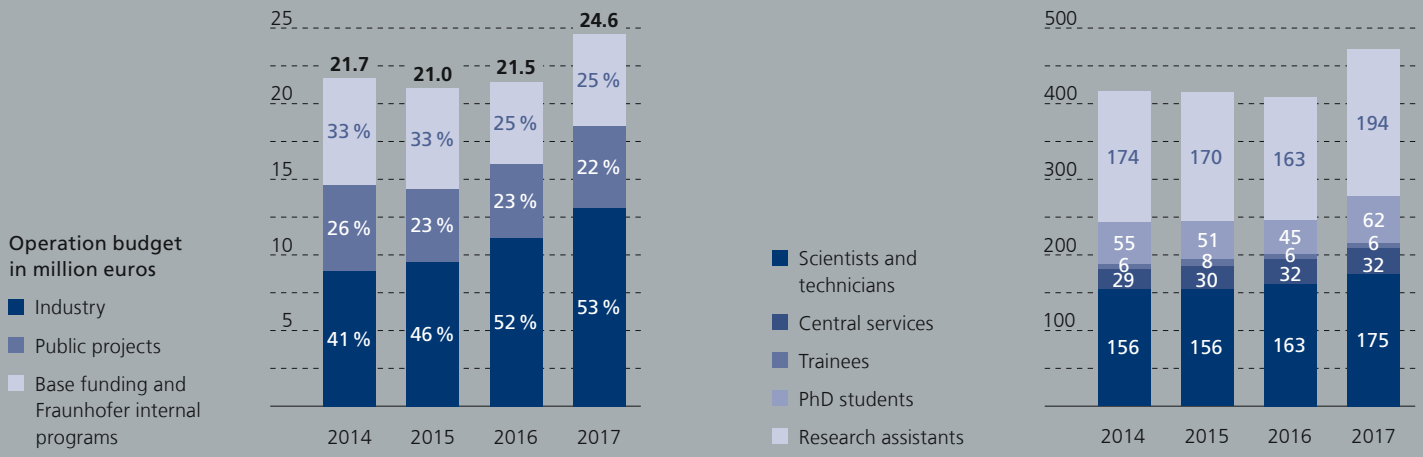
In the context of the energy transition, the feed-in of alternative energies to the power grids is increasingly revealing previously unknown interactions between electrical power grids and conventional power turbine generators. Our TorGrid software is a condition-monitoring-system that allows, for the first time, these interactions to be captured and analyzed by the TorGrid user.

The effort made by our employees is what guarantees the continued scientific and economic success of the Institute. At this point, I take the opportunity to sincerely thank them for their commitment and high level of motivation as well as for their identification with the work and aims of ITWM. Their ideas and expertise are the life force of the institute.

Our website content was updated and given a totally new design, technically and visually, in 2017: At a glance, users learn what is new and, perhaps, their curiosity is awakened about our exciting projects and, if so, more detailed information is provided in the next level. Have a look at it – we appreciate your feedback!

I also express my sincere appreciation to all of ITWM's project partners and thank them for the constructive and pleasant cooperation and I hope you enjoy reading the remainder of our annual report.

Prof. Dr. Dieter Prätzel-Wolters
Director of Fraunhofer ITWM



INSTITUTE PROFILE

Our goal is to further develop mathematics as a key technology, give innovative impetus and implement it in practice together with industry partners.

Not only large companies, but also more and more small and medium-sized enterprises use simulations in the most diverse areas and thus profit in terms of innovation and quality assurance of products and processes. The spectrum of the institute's customers extends across all industries - from automotive and mechanical engineering to the textile industry, microelectronics, computer industry and finance. The basic modules of our projects are consulting, support in the application of high-performance computer technology and the deployment of tailor-made software solutions.

Applied mathematics as an engine for success

Computer simulations are an indispensable tool in the design and optimization of products and production processes, services, communication processes and work processes. Real models are replaced by virtual models. Mathematics plays a fundamental role in the creation of this virtual world. The transverse character of mathematics makes it a "generic technology"; as a basis for bridging into the simulation world, however, it also becomes the key technology for computer simulations which have found their way into nearly all areas of economic life.

Increasingly more small and medium-sized companies utilize simulation for cost reduction. It is specifically these companies that the Fraunhofer ITWM supports with consultation and computing power. They profit in the market through the use of simulation as identification for innovation and quality assurance of their products.

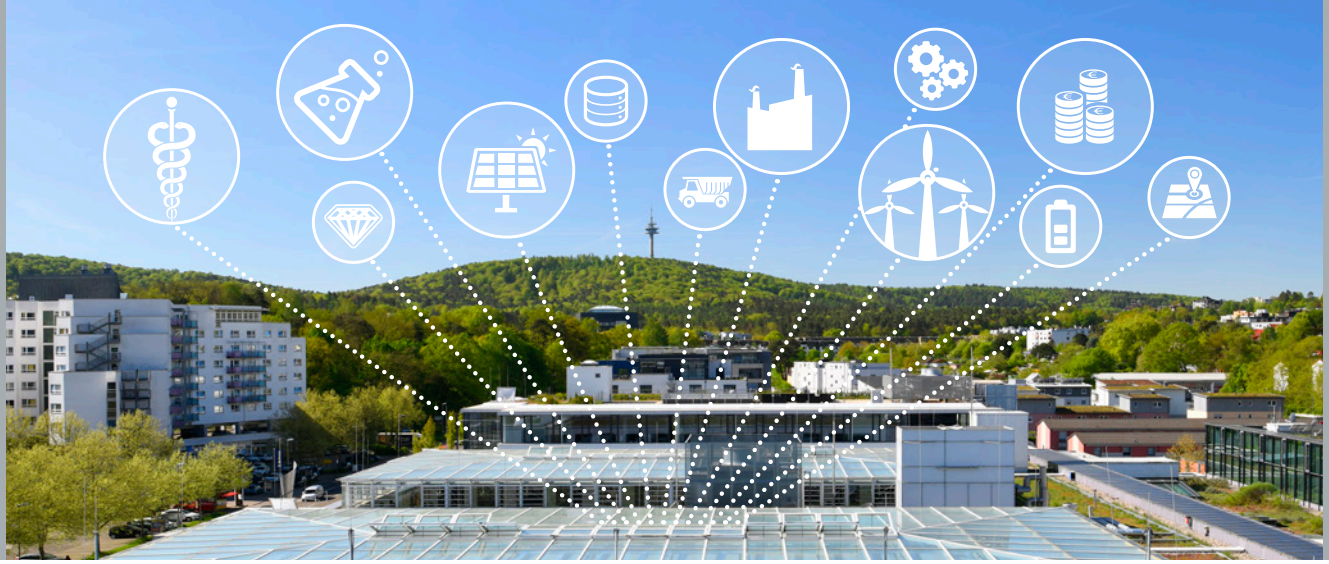
Along with the implementation of this technology in application projects and its further development in research projects, the close collaboration with the Department of Mathematics at the University of Kaiserslautern is also a point of emphasis of the Fraunhofer ITWM.

The classical disciplines of applied mathematics such as numerics, optimization, stochastics and statistics as well as differential equations are cornerstones.

The specific competencies of the ITWM are

- Processing of data acquired from experiments and observations
- Drafting of mathematical models
- Implementation of mathematical problem-solving in numerical algorithms
- Summarization of data, models and algorithms in simulation programs
- Optimization of solutions in interaction with the simulation
- Visualization of simulation runs in images and graphics

The ITWM is member of the Fraunhofer ICT Group as well as associated member in the Fraunhofer Group for Materials and Components – MATERIALS. In addition, the good networking within the Fraunhofer-Gesellschaft documents the participation in numerous Fraunhofer Alliances: Automobile Production, Battery, Big Data, Cloud Computing, Lightweight Design, Simulation, Textile, Traffic and Transportation, and Vision.



INDUSTRIES – WHO DO WE WORK WITH?

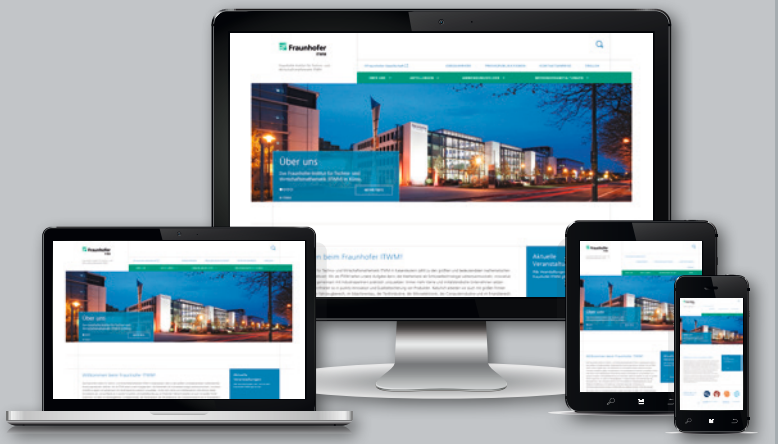
Thanks to the comprehensive methods resident in our departments and the broad spectrum of application areas, our customer base may range across many sectors. Fraunhofer ITWM provides core competencies in the areas:

- Modeling and simulation
- Optimization and decision support
- Data analysis and visualization

and addresses companies and organizations in the sectors:

- Process/Mechanical/Systems engineering
- Automotive and suppliers
- Pharmaceuticals and medical systems
- Power industry
- Technical textiles
- Information technology
- Finance

As a result of the long term cooperation with our regular customers, a considerable domain competence has evolved in some areas of individual sectors; to name a few in particular, the automobile sector, process engineering, and the energy sector. For all sectors: Fraunhofer ITWM's modeling and simulation competence creates a real competitive advantage in the marketplace.



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WEBSITE RELAUNCH – EVERYTHING IS NEW AT WWW.ITWM.FRAUNHOFER.DE

1 The new responsive design uses advanced web technologies and adapts to a variety of output devices.

2 ITWM dissertation series established

The new ITWM website was published in July 2017, which gives our online presence a contemporary look. Like most of the other Fraunhofer Institutes, we are using the AEM Content Management System. We have updated the content and our entire website was completely redesigned, technically and visually, in the responsive design of the Fraunhofer-Gesellschaft. At a glance, users see the latest news and, perhaps, their curiosity is awakened about our exciting projects and, if so, more detailed information is provided in the next level.

MORE AND MORE ITWM PhD CANDIDATES PUBLISHED BY FRAUNHOFER-VERLAG

The institute supports a large number of doctoral students supervised by ITWM scientists, a fact that naturally led to the creation of our own dissertation series. It was slow to take off in 2014, but now the offer is extremely popular: In 2017, seven PhD candidates had their dissertations published by Fraunhofer-Verlag. Not only the topics, but also the universities are broadly diverse: In addition to TU Kaiserslautern, the University of Kassel, Friedrich-Alexander University in Erlangen-Nuremberg, and the Karlsruhe Institute of Technology are among the cooperating educational institutions.

ITWM SUCCESS IN THE INNOVATION FIELD “VEHICLE”

The federal and state government initiative “Innovative Hochschule” has approved one quarter of the 118 applications submitted. Our joint proposal addresses innovation in the areas: Education – Healthcare – Products – Vehicles. In the collaborative project “Open Alliance for Digitalization in the Palatinate,” Fraunhofer ITWM makes a substantial contribution in the field of vehicle research: Project funding flows into commercial vehicle digital technology, mostly into the expansion of the RODOS®/REDAR simulation environment. The collaboration projects between the University of Kaiserslautern and Fraunhofer ITWM will become even more efficient with the use of the expanded digital demonstrator. RODOS® enables the interactions between humans, machines, and environment to be studied on the basis of particularly solid data. The focus is on optimizing reliability and energy efficiency.

1 *Successful karema participants*

KAREMA DAYS – YOUNG SCIENTISTS VISIT FROM ABROAD

The aim of the program "Kaiserslautern Research Matching (karema) – First Class Scientists meet First Class Funding" is to bring young research scientists from abroad together with experienced researchers at TU Kaiserslautern (TUK) and the High Performance Center for Simulation and Software-Based Innovation. Approximately 200 young people submitted an application with their own project idea: 17 of them received an invitation. At the beginning of December, they met in two-person teams with researchers from Kaiserslautern to discuss possible joint projects. The focus of the collaboration involves three major research areas: Optics and Materials Sciences, Mathematical Models in Engineering, and Membrane and Systems Biology. The High Performance Center Simulation- and Software-based Innovation, just like TUK, is a cooperation partner and host of the karema program.

50. ANNIVERSARY OF THE LECTURE SERIES: "BLICK ÜBER DEN TELLERRAND"

The doors to ITWM open once a month to any interested persons to attend the "Blick über den Tellerrand" presentations. This interdisciplinary lecture series of the Felix Klein Center for Mathematics presents very unique perspectives on various topics from research and science. Experts from the most diverse fields give presentations and discuss with guests at ITWM.

In the summer of 2011, the New York science historian Prof. Myles W. Jackson kicked off the series with the topic: "Genome research – between ethics and commerce using the CCR5 gene as an example." The 50th lecture was given last year by sociology professor Rudolf Stichweh from Bonn: "The modern scientific establishment: origins, structures, and social embedding." Through the years, scientists representing the fields of medicine, business, mathematics, philosophy, theology, and art have come to speak and all have found an appreciative audience. Sport journalist Dr. Hajo Schumacher spoke to an absolutely full house: "The time remaining – how to achieve a good, fun and affordable life in old age" was the topic that interested far more guests than the lecture hall could seat. As an example of how far the range of topics may extend, there was also an art history lecture by the director of Kaiserslautern's mpk Museum, Dr. Britta E. Buhlmann: "Physiognomies throughout history."

TALENTA – FRAUNHOFER SUPPORTS YOUNG FEMALE RESEARCHERS

1 *TALENTA speed up for Neele Leithäuser; pictured with the Institute director and the administrative director*

2 *Elisabeth Leoff, Ria Grindel, Isabel Michel, and Sarah Staub (l. to r.) also received support.*

The proportion of women in the research departments of our institute could still be greater, but our researchers occupy a top ranking in TALENTA grants: In 2017, five women received support from the TALENTA start and TALENTA speed up programs!

"Fraunhofer TALENTA" is a grant and development program to promote female scientists and focuses on different levels of career development. The grant consists of financial support of the respective organizational unit for the recruitment and sustainable development of female scientists and executives. The major focus is on the individual careers of the women.

TALENTA start is aimed at female MINT graduates who are starting out on a career path in applied research and launch their careers at Fraunhofer. Thanks to this program, we now benefit from having Ria Grindel with us at the institute until the end of 2019.

TALENTA speed up is tailored to Fraunhofer internal and external female scientists with the experience, commitment and potential to assume professional responsibilities or leadership roles. The main focus is on female scientists who are about to assume a leadership position or are planning to do so in the near or medium term. The objective is to systematically assist the candidate to expand their areas of responsibility. The current candidates at ITWM are Neele Leithäuser, Elisabeth Leoff, Isabel Michel, and Sarah Staub; these four women are connected not merely by their TALENTA grants, but also by the bond of managing career and family, as all have small children.

MINT-EC SCHOOL PRINCIPLES CONFERENCE: ITWM INFORMATION STAND AT THE EDUCATION MARKET

The annual meeting of school principals, an initiative of the MINT-EC Association was organized in Kaiserslautern in 2017. The two-day event held at TU Kaiserslautern included workshops and lectures dealing with current issues and challenges in everyday school life. ITWM participated with an information stand at the so-called education market and invited three hundred school principals to the conference dinner at the Institute.

FELIX-KLEIN ACADEMY: A COMPREHENSIVE VIEW OF APPLIED MATHEMATICS

The aim of the Felix-Klein Academy is to mediate a comprehensive view of the role of mathematics in science, business, and society. The organization maintains, coordinates, and supports a network for scientists both at the start and at the zenith of their career – both within and outside the discipline of mathematics. It provides services to students, scientists in training and in a job, and to teachers as well as to the interested public. The Academy facilitates scientific and interdisciplinary exchanges and advanced education. Widely respected experts support advanced and continuing education courses and the most qualified students are given an opportunity to learn from and with the best.

A highlight of the past fall was the international workshop "Networks and Uncertainty." Experts from the USA, England, and Germany gave general lectures on current research about networks with a special focus on coping with uncertainties. In addition, the session last fall included topics from ITWM's day-to-day project work.

1 *Digital human modeling, distillation columns, everyday contact forces and a usage profile in district heating grids were the topics at the fall session.*

READERS VISIT AND THE CONSEQUENCES: ITWM FEATURED IN SPECIAL ISSUE OF "BILD DER WISSENSCHAFT"

In May 2017, readers of the German language magazine "bild der wissenschaft" paid a visit to ITWM; the theme of their trip was "Volcanism, Forests, and Gemstones." They hoped to gain insights into the importance of knowledge and natural resources. Of course, there are no natural resources at ITWM, but the knowledge about them is plentiful, for example in the Optimization department: Karl-Heinz Küfer spoke about "Gemstone Production – Art or Technology" and demonstrated the activities of our gemstone polishing lab. The visit included a tour of the institute, which had a lasting consequence – as the seed was sown for a special issue about "Industrial Mathematics in Kaiserslautern."

Published in mid-June 2018, the issue not only presents the many facets of our work, but also illustrates where and how Industrial Mathematics advances research and creates the basis for many technical innovations.

PERSONNEL RECRUITMENT AT TWO LABS: FROM APPRENTICE TO EMPLOYEE

1 *A useful trade can strike gold at ITWM – as Annika Schwarz and Dominik Gundacker have proven.*

2 *ITWM-Alumni*

Fraunhofer ITWM not only promotes careers in science, it educates and trains apprentices: Dominik Gundacker and Annika Schwarz earned their certification as physics laboratory technicians at IHK Pfalz. They both attended the vocational school for natural sciences in Ludwigshafen.

Annika Schwarz was a trainee for three and a half years in the Image Processing department, under the supervision of Dr. Ronald Rösch, Franz Schreiber, and Kai Taeubner. Now her responsibilities include the predevelopment work and design of surface inspection systems as well as feasibility studies in the image processing laboratory, which provides the basis for successful development of future surface inspection systems.

Dominik Gundacker represents a more complicated case since he attended several different training centers: BASF in Ludwigshafen, where he completed the core vocational training as an external trainee; The Material Characterization and Testing department was responsible for his in-company training. His job now includes the construction of terahertz measurement systems, circuit design, and cable assembly as well as working with drilling and milling equipment.

We are very pleased that both are now ITWM employees!

MEETING OF THE ALUMNI NETWORK: REMEMBERING PEOPLE AND IDEAS

In December, all former colleagues and advisors were invited to the first ITWM Alumni Network Meeting. What awaited them was not merely a friendly reunion, but rather an exciting afternoon program at the institute where alumni spoke about their successful career paths and their ties to ITWM.

At the evening event in the city's "Fruchthalle," the head of the institute, Dieter Prätzel-Wolters, discussed the current situation and future perspectives at the institute. The founder of ITWM, Helmut Neunzert, enhanced the evening gathering with his presentation "Remembering people and ideas."

Front, left to right: Dr. Markus Pfeffer, Michaela Grimberg-Mang, Hülya Zimmer, Brigitte Williard, Sylvia Gerwalin, Prof. Dr. Dieter Prätzel-Wolters, Katharina Parusel, Ilka Blauth, Anja Gordon, Steffen Grützner, Holger Westing, Brigitte Biguet, Elisabeth Wagner-Weig, Elke Münch, Dieter Eubel, Maike Koll, Waltraud Dully, Dominic Schunk, Christian Peter, Eva Schimmele, Martin Braun, Mirko Rahn, Jana Willenbacher, Tino Labudda, Dominic Daneker, Tobias Grau

OUR NETWORK

CUSTOMERS AND COOPERATION PARTNERS SELECTION 2017

- 3D Image Automation Pty Ltd, Perth (AUS)
- AAC Technologies Holdings Inc., Shenzhen (RC)
- AbbVie Deutschland GmbH & Co. KG, Ludwighafen
- ACC Technologies, Turku (FIN), Nanjing(RC)
- AL-KO GmbH, Kötz
- ALTE LEIPZIGER Lebensversicherung a.G., Oberursel
- ante holz GmbH, Bromskirchen
- AUDI AG, Ingolstadt
- AXA Konzern AG, Köln
- BASF SE, Ludwigshafen
- Bayer AG, Leverkusen
- BioNTech AG, Mainz
- BJS Ceramics GmbH, Gersthofen
- BMW, München
- BPW Bergische Achsen Kommanditgesellschaft, Wiehl
- Brückner Group GmbH, Siegsdorf
- BSN Medical, Emmerich
- ContiTech Transportbandsysteme GmbH, Northeim
- Corning GmbH, Kaiserslautern
- Daimler AG, Stuttgart
- das-Nano S.L., Tajonar, Navarra (E)
- delta h Ingenieurgesellschaft mbH, Witten
- Deutsche Institute für Textil- und Faserforschung Denkendorf
- Dilo Machines GmbH, Eberbach
- ebm papst, Mulfingen
- ESI Group, Paris (F)
- Evohaus GmbH, Karlsruhe
- FLSmidth Wadgassen GmbH, Wadgassen, Kopenhagen (DK)
- Ford-Werke GmbH, Köln
- Freudenberg Filtration Technologies, Kaiserslautern
- Gebr. Pfeiffer SE, Kaiserslautern
- GEF Ingenieur AG, Leimen
- GOLDBECK New Technologies GmbH, Hirschberg
- Goodyear S.A., Colmar-Berg, Luxembourg
- Grimme Landmaschinenfabrik GmbH & Co. KG, Damme
- GRS mbH, Köln
- Helmholtz-Institut für elektrochemische Energiespeicherung, Ulm
- Hubert Stüken GmbH & Co. KG, Rinteln
- Hübner Gmbh&Co. KG, Kassel
- IAV Group, Berlin
- IBS FILTRAN GMBH, Morsbach-Lichtenberg
- Imilia Interactive Mobile Applications GmbH, Berlin
- Institut für Textiltechnik (ITA), Aachen
- IPConcept (Luxemburg) S.A., Luxemburg (L)
- Jaguar / LandRover, Whitley (GB)
- John Deere GmbH & Co.KG, Mannheim, Kaiserslautern
- Johns Manville Europe GmbH, Bobingen
- Kliniken Essen Mitte, Essen
- Kreisverwaltung Mainz-Bingen, Ingelheim am Rhein
- KSB Aktiengesellschaft, Frankenthal
- Liebherr, Kirchdorf / Colmar
- Lonza AG, Basel
- MAGMA Gießereitechnologie GmbH, Aachen
- Maja Möbelwerk GmbH, Wittichenau
- MAN Truck & Bus Deutschland GmbH, München

- Marathon Oil, Houston (USA)
- Maserati S.p.A./Alfa Romeo, Modena (I)
- Math2Market, Kaiserslautern
- Meggitt Polymers & Composites, Stevenage (GB)
- Merck KGaA, Darmstadt
- mfd Diagnostics, Wendelsheim
- Miebach Consulting GmbH, Frankfurt am Main
- MVZ Dres. Englmaier GmbH, Waldkraiburg
- Netze BW GmbH, Stuttgart
- Nissan, Kanagawa (J)
- Odenwald Faserplattenwerk GmbH, Amorbach
- Panasonic R&D Center Germany GmbH, Langen
- Paul Wild GmbH, Kirschweiler
- Plastic Omnium, Brüssel (B)
- Porsche AG,Stuttgart, Weissach
- proALPHA Business Solutions GmbH, Weilerbach
- Procter & Gamble, Cincinnati (USA), Schwalbach, Kronberg
- Produktinformationsstelle Altersvorsorge, Kaiserslautern
- Progress Rail Inspection & Information Systems, Bad Dürkheim
- PSA Peugeot Citroen, Velizy-Villacoublay Cedex (F)
- PSI Software AG, Aschaffenburg, Dortmund
- Repsol, Houston (USA)
- RJL Micro & Analytic GmbH, Karlsdorf-Neuthard
- Robert Bosch GmbH, Stuttgart
- RWE Generation SE, Essen
- Santander Consumer Bank AG, Mönchengladbach
- SAP AG, Walldorf
- Scania CV AB, Södertälje (S)
- Schleifring und Apparatebau GmbH, Fürstenfeldbruck
- Schmitz Cargobull AG, Altenberge
- Seismic Imaging Processing SIP, Aberdeen (GB)
- Sharp Reflections, Stavanger (N), Kaiserslautern
- Siemens Technology Accelerator, München
- Stadtentwässerung Kaiserslautern AöR, Kaiserslautern
- Statoil ASA, Stavanger (N), Trondheim (N), Oslo (N)
- Stöhr + Sauer CAD- und Computersysteme GmbH, Würselen
- Stryker GmbH & Co. KG, Freiburg
- SWS Stadtwerke Speyer
- Technische Werke Ludwigshafen
- TGS Nopec, Houston (USA)
- ThinkparQ GmbH, Kaiserslautern
- Toyota Motor Europe NV/SA, Brüssel (B)
- Umicore, Hanau
- Union Investment Privatfonds GmbH, Frankfurt/Main
- uniper Anlagenservice, Gelsenkirchen
- Universities: Aachen, Berlin, Bordeaux (F), Bremen, Dortmund, Dresden, Erlangen, Frankfurt/Main, Freiberg, Freiburg, Heidelberg, Kaiserslautern, Karlsruhe, Kassel, Mainz, München, Münster, Nancy(F), Saarbrücken, Trier, Ulm
- Universities of Applied Sciences: Berlin, Birkenfeld (Trier), Darmstadt, Kaiserslautern, Lübeck, Mainz
- VAN DE WIELE, Kortrijk (B)
- Varian Medical Systems International AG, Cham
- Voith Hydro, Heidenheim
- Volkswagen AG, Wolfsburg
- Volvo, Eskilstuna (S), Göteburg (S)
- Woltz, Wertheim

SPIN-OFFS

Math2Market

Math2Market, our first and largest spin-off, was responsible in the early years for the marketing of the GeoDict software developed by the Flow and Material Simulation department. This software has meanwhile grown into the Digital Material Lab GeoDict®, which Math2Market continues to develop by integrating tools generated at ITWM. Math2Market supports companies with an integrated package for the efficient development of better materials and processes. Customers are located worldwide and represent a range of sectors including filtration, composites, and electrochemistry. However, manufacturers of batteries and fuel cells make up the majority.

fleXstructures

fleXstructures is a spin-off company of the department Mathematical Methods in Dynamics and Durability. It distributes the IPS software jointly developed with Fraunhofer-Chalmers Research Centre for Industrial Mathematics in Göteborg, Sweden. The IPS Cable Simulation is a major tool in this product group; it is used in the automotive and commercial vehicle industries, but also in aerospace and mechanical engineering to ensure the efficient laying of cables and hoses, for example in the vehicle engine compartments.

Sharp Reflections

The Competence Center for High Performance Computing jointly develops the Pre-Stack Pro software with the Norwegian oil and gas company Statoil, for the analysis of seismic reflection data. Sharp Reflections is responsible for the distribution and continuing development. Pre-Stack Pro applies parallel computer technology to derive reliable information about the properties of oil and gas deposits from large data sets. In Norway, Sharp Reflections supports the local customers and manages the worldwide distribution of the products.

ThinkParQ

ThinkParQ, another spin-off from the Competence Center for High Performance Computing, is the company behind the parallel cluster-file system BeeGFS. Large volumes of data are managed in a user-friendly way, both locally and in the cloud using this highly scalable storage product.

Product information office for retirement planning PIA

Since January 2017, on behalf of the Federal Ministry of Finance, this independent office performs the classification of the opportunity and risk profiles of funded pension plan products. It is a wholly owned Fraunhofer subsidiary and works closely with our Financial Mathematics department.

ADVISORY BOARD OF FRAUNHOFER ITWM

August Altherr, JOHN DEERE European Technology Innovation Center

Prof. Dr. Nicole Bäuerle, Karlsruhe Institute of Technology

Dr.-Ing. Erwin Flender, MAGMA Gießereitechnologie GmbH

Dr. Werner Groh, Johns Manville Europe GmbH

Johannes Heger, HegerGuss GmbH

Dr. Anna-Lena Kranz-Stöckle, Federal Ministry of Education and Research

Dr. Wilhelm Krüger, Blue Order AG (Chairmen)

Prof. Dr. Volker Mehrmann, Technische Universität Berlin

Dr. Hannes Möller, Daimler AG

Stefanie Nauel, Ministry of Economic Affairs, Transport, Agriculture and Viniculture of the State of Rhineland-Palatinate (MWVLW)

Barbara Ofstad, Siemens AG

MR Richard Ortseifer, Ministry of Economic Affairs, Transport, Agriculture and Viniculture of the State of Rhineland-Palatinate (MWVLW)

Prof. Dr. Helmut J. Schmidt, President University Kaiserslautern

Dr. Mattias Schmidt, Procter & Gamble Service GmbH

Prof. Dr. Wolfgang Wahlster, DFKI GmbH

Dr. Carola Zimmermann, Ministry of Science, Further Education, and Culture of the State of Rhineland-Palatinate (MWWK)

NETWORKING AND COOPERATIONS OF FRAUNHOFER ITWM

A large network and innovative partners are crucial for the success of projects. That is why we are part of a network of national and international cooperations and a member of several associations within the Fraunhofer-Gesellschaft:

- Fraunhofer ICT Group
- Fraunhofer Group for Materials and Components – MATERIALS (as associated member)
- Fraunhofer Alliances: Automobile Production, Battery, Big Data, Cloud Computing, Lightweight Design, Simulation, Textile, Traffic and Transportation, and Vision
- High Performance Center Simulation and Software-Based Innovation

Further cooperations

- Center for Mathematical and Computational Modeling $(CM)^2$ co-located in the Mathematics department of TU Kaiserslautern, is focused on mathematical applications in the engineering sciences.
- Felix-Klein Center for Mathematics FKZM
  The FKZM is an institutional pooling of resources from the Mathematics department at TU Kaiserslautern and Fraunhofer ITWM, with a focus on the promotion of young researchers, to include modeling weeks for schools, scholarships, and a mentor program for students of mathematics.
- Science and Innovation Alliance Kaiserslautern SIAK
  SIAK is a network for digital transformation, innovation and interdisciplinary research. It is regionally anchored through its members from science – universities and research institutes – and industry – especially from small and medium-sized enterprises.

SUPRA-REGIONAL BRAND THANKS TO A STABLE NETWORK

"High Performance Centers organize the collaboration between university and non-university research units and are characterized by binding, integrated, partner roadmaps for the performance aspects of research and teaching, support to young talent, infrastructure, innovation, and transfer. They serve politicians in prioritizing the promotion of scientific excellence with social benefits." This reflects the Fraunhofer-Gesellschaft strategy to promote the development of local performance centers. The effectiveness of this strategy is evident in Kaiserslautern in the development of the "Simulation and Software-based Innovation" High Performance Center.

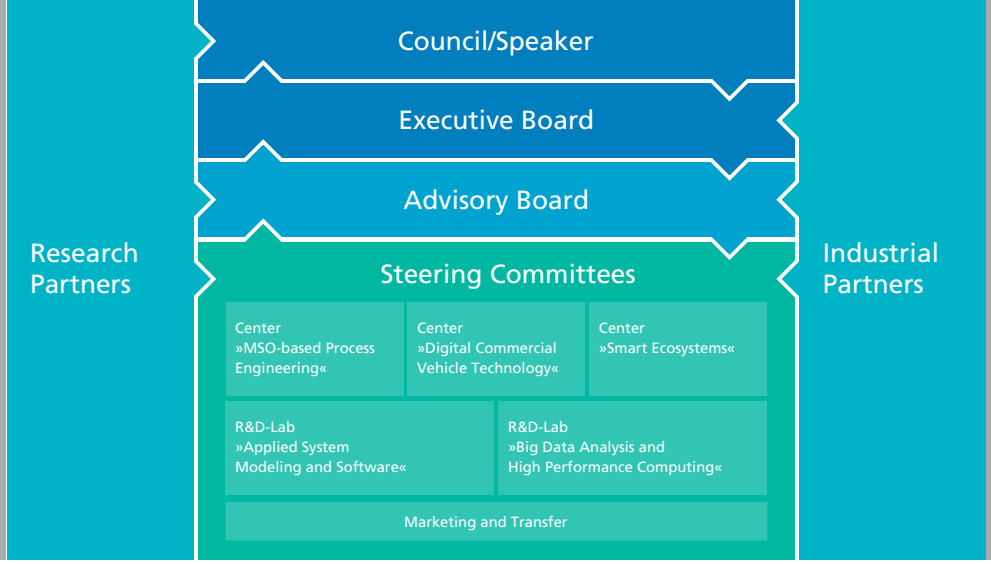
Two years after its establishment, it was subject to an external audit – which it passed with great success: the experts expressly recommended further funding and highlighted the excellent network available to the Kaiserslautern center. This network should experience greater use to increase visibility and build the High Performance Center "Simulation and Software-based Innovation" to a supra-regional brand. In the field of digitalization, it is already the regional contact for R&D and transfer issues. In addition to the simulation and software from which the name derives, the focus is mainly on big data, high performance computing, and machine learning.

Efficient work in centers and labs

The High Performance Center is divided into various components distinguished by their focus and industry orientation. In the R&D Labs "Applied System Modeling and Software" and "Big Data Analysis and High Performance Computing," researchers from TU and the University of Applied Sciences Kaiserslautern as well as the participating institutes are mainly interested in modelling and system technologies. The focus of a performance center is on applications and the work is more closely tied with industry. This structure has proven itself over the past two years as more funding support was raised from industry than originally planned and major projects like the "Open Alliance for Digitalization in the Palatinate" or the collaborative project "EnStadt:Pfaff – Solares Bauen/Energieeffiziente Stadt" were acquired.

Center 1: MSO-based process engineering

Modeling, simulation, and optimization are the mainstays of decision support, for example, in fabrics as well as for filtration processes. ITWM's research partners are: the Math as well as the Mechanical and Process Engineering departments at TUK; Industry partners include BASF, Procter & Gamble, Math2Market, Lonza, KSB, and IBS Filtran.



HIGH PERFORMANCE CENTER
SIMULATION- AND SOFTWARE-BASED INNOVATION

Center 2: Digital commercial vehicle technologies
Interactive vehicle simulation and virtual vehicle testing as well as virtualized test concepts for commercial vehicles are the focus of this center. TU and the University of Applied Sciences Kaiserslautern are active in the research network in addition to the Commercial Vehicle Cluster, Fraunhofer IESE and ITWM. Industry partners include Bosch, Daimler, General Electrics, John Deere, Liebherr, MAN, Schmitz Cargobull, Volvo, and VW.

Center 3: Smart Eco-Systems
Smart Embedded Systems, Digital Villages, and the GreenPowerGrid energy storage platform are all deployed at this center. Besides both Fraunhofer institutes and TUK, the German Research Center for Artificial Intelligence, DFKI is also serving as a research partner. Bosch, E.GO Mobile, Ford Research, John Deere, Panasonic, Toyota, and WVE Kaiserslautern work on the side of industry at the center.

The primary aim of this High Performance Center is the sustainable transfer of results to the business and scientific communities. Besides the transfer to commercial use, the following additional paths are taken:

Transfer through the minds
In association with Felix-Klein Academy for Mathematics, young scientific talent is recognized early on with scholarship grants for students and PhD candidates. Together with the junior talent club of TUK, they are systematically and continuously guided through workshops, lectures, and graduation requirements, so that a new cadre of highly trained and qualified R&D personnel is regularly introduced to business and research.

Transfer path: IP-exploitation and spin-offs
Cooperation with start-ups and spin-offs in selected fields of technology enables rapid provision of needs-based IP to companies. This creates close relationships between the research institutes and the contact office for Information and Technology (KIT) at TUK and its patent office.

Transfer path: Continuing industrial education
The High Performance Center jointly develops requirements-based training programs for business with its cooperation partners and supports companies in the use and further development of methods and technologies in their respective business models.

FRAUNHOFER-CHALMERS RESEARCH CENTRE FOR INDUSTRIAL MATHEMATICS FCC

One of the most important international partners of Fraunhofer ITWM is Fraunhofer-Chalmers Research Center for Industrial Mathematics (FCC), founded by the Fraunhofer-Gesellschaft and Chalmers University in Göteborg in 2001. Its mission is very similar to that of Fraunhofer ITWM and the center works most closely with our Mathematical Methods in Dynamics and Durability department as well as the Optimization and System Analysis, Prognosis and Control department. In 2015, an international committee evaluated the scientific and business development as well as the future strategy of FCC. The successful rating confirms the Institute is an outstanding research facility that has become a center for industrial mathematics in Sweden. Its portfolio covers contract research, service, algorithms and software, all based on modern mathematical methods in the area of modeling, simulation, and optimization (MSO) that flow into industrial innovations for products and production systems. Areas of application include mechanical engineering, life sciences, paper and packing industry, electronics, and information and communication technologies (ICT).

The Fraunhofer-Chalmers Research Center for Industrial Mathematics is structured in three departments:

- "Geometry and Movement Planning" works in close cooperation with Chalmers Wingquist Laboratory to develop simulations for automated path planning, sealants, flexible materials (e. g., cables and hoses) and human movement models. This last area is important for the ergonomic design of assembly processes.

- "Computational Engineering and Design" works on innovative numerical methods, fast algorithms, and engineering support tools for virtual product and process development. Applications include fluid dynamics, structural dynamics, and electromagnetism.

- "System and Data Analysis" supplies expertise in dynamic systems, forecasting and controls, image and video analysis, statistics, and quality engineering, in addition to technical, biological and biomedical applications.

The FCC currently has a staff of 52 employees and a budget of six million euros in 2017.

THE FRAUNHOFER-GESELLSCHAFT AT A GLANCE

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

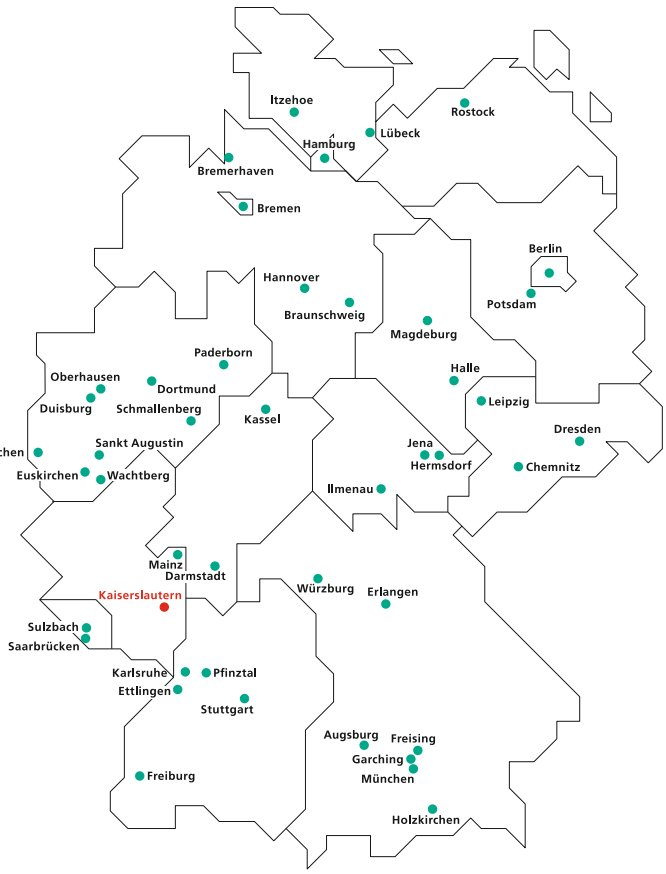
At present, the Fraunhofer-Gesellschaft maintains 72 institutes and research units. The majority of the more than 25 000 staff are qualified scientists and engineers, who work with an annual research budget of 2.3 billion euros. Of this sum, almost 2 billion euros is generated through contract research. Around 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Around 30 percent is contributed by the German federal and state governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.



TRANSPORT PROCESSES

The company Dilo from Eberbach develops and produces innovative plants for the nonwovens industry. The picture shows the formation of the nonwoven in a carding line before it is bonded by needling. Our institute supports Dilo in the development of new needling technologies.

DR. DIETMAR HIETEL
DR. RAIMUND WEGENER
HEADS OF DEPARTMENT

MATHEMATICAL MODELING, SIMULATION, AND OPTIMIZATION OF TRANSPORT PROCESSES

The Transport Processes department models complex industrial problems and develops efficient algorithms for their numerical solution (simulations). The specific tasks are primarily within the context of the technical-natural sciences (fluid dynamics, radiative transport, optics, structural mechanics, etc.). When modeled, these tasks lead to partial differential equations that are mainly characterized as transport equations.

From the perspective of our industrial customers, such problems typically concern product optimization or the design of production processes. The expertise includes collaboration with the engineering-oriented R&D departments of our partner companies, design and optimization studies, as well as software development for individual modules or complete tools.

The year 2017 was a successful one, both scientifically and economically. Our chosen strategy, which also encourages revenue generation from software licensing, is producing first major successes. One notable example is a VW Group license issued for FPM, the mesh-free flow simulator.

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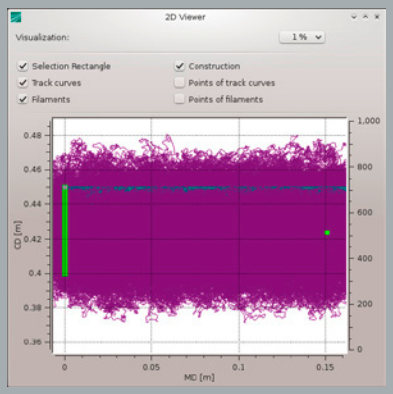
MAIN TOPICS

- Flexible Structures
- Fluid Dynamical Process Design
- Grid-free Methods
- Energy Transport Networks and Model Reduction



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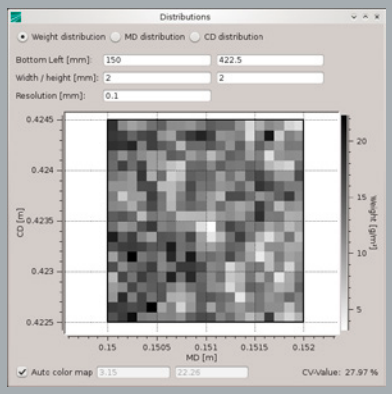

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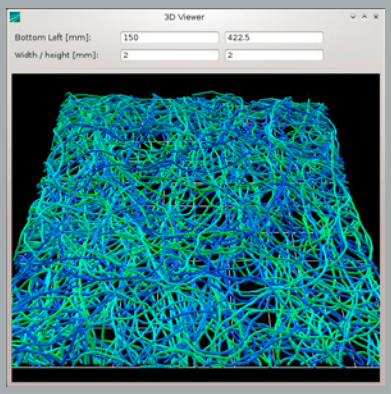


3

VIRTUAL PRODUCTION OF NONWOVEN FABRICS

1 *2D view of the virtual nonwoven in SURRO*

2 *Weight distribution of a sample at 0.1 mm resolution*

3 *3D view of the sample*

The production of nonwoven fabrics involves spinning, entangling, and layering a multitude of thin fibers to form a nonwoven web structure. For many years, our department has been collaborating with a wide range of industry customers to advance the virtualization of this process.

We face many mathematical challenges that cannot be solved with standard simulations because of the complexity and differences in scale. We develop special methods and tools to support the design and control of several key aspects of the technical textile production process with efficient simulations.

SURRO software generates virtual nonwoven structures

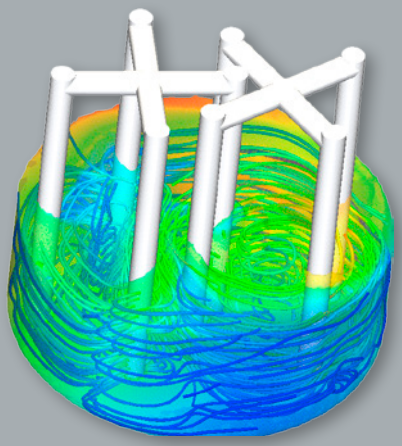
In recent years, we have developed sophisticated methods to generate virtual, large-scale, nonwoven structures. The resulting software SURRO (Surrogate Model) is based on a stochastic surrogate model for the simulation of filaments, which is mathematically described by a stochastic differential equation (SDE).

The input parameters of this process are obtained by first performing physically-based simulations of a few individual filaments using FIDYST (Fiber Dynamics Simulation Tool) software. By means of an identification process, the complex behavior of the filaments is reduced to a few stochastic parameters characterizing the resulting nonwoven structure.

Analyzing nonwovens production processes with SURRO and FIDYST

In comparison to a full physical simulation, fibers can be computed extremely fast with the SURRO surrogate model. It is possible to produce a very detailed resolution of microstructures in the range of several centimeters edge length. The virtual nonwoven structure is then analyzed for weight distribution and homogeneity on different scales. The homogeneity is essential for the quality of the nonwoven fabric and is a criterion for optimizing the manufacturing process.

Furthermore, tensile strength tests can be carried out by means of interfaces to standard software such as Abaqus. We successfully use the microstructure generator SURRO together with the FIDYST simulation software to analyze and optimize the production processes for nonwoven fabrics.



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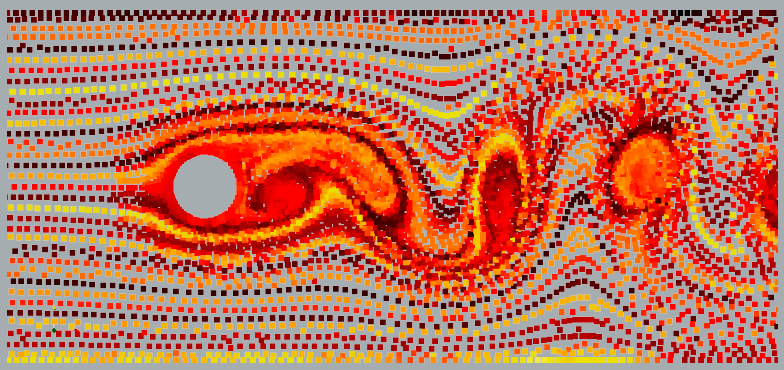


2

SIMULATIONS WITH MESHFREE

MESHFREE is an innovative software tool in fluid and continuum mechanics developed in cooperation with Fraunhofer SCAI and to be released in 2018. It joins the expertise in meshfree simulations and scientific computations of the two institutes.

Goodbye, meshes!

The software MESHFREE combines the Finite Pointset Method (FPM) for solving the conservation equations of mass, momentum, and energy with efficient algorithms for solving linear systems of equations. The underlying method is based on a cloud of numerical points without explicit neighborhood information of a mesh, so the need for costly meshing and re-meshing disappears.

The geometry can be exported directly from CAD tools and used for the simulation. Due to the complete absence of a mesh, MESHFREE is highly flexible regarding the discretization of the computational domain in highly dynamic processes, such as flows with free surfaces or fast moving geometry elements.

The world is neither solid nor fluid

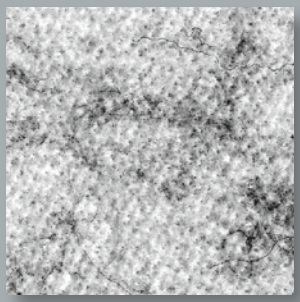
MESHFREE uses a general material model, which allows to simulate complex materials (non-Newtonian fluids, foams or viscoelastic materials) with the same numerical method. The medium does not need to be declared as fluid or solid a priori to choose an appropriate numerical solver. Instead, only material properties such as viscosity or shear modulus are required to predict the material behavior.

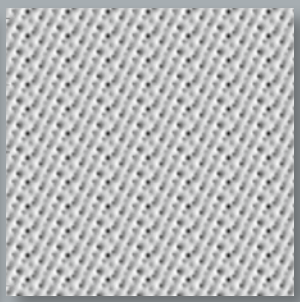
On the shoulders of giants

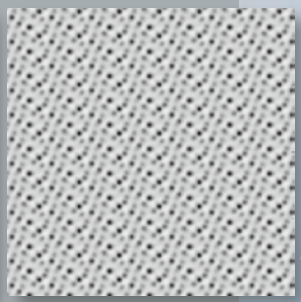
With MESHFREE, the user benefits from extensive experience and expertise of the two Fraunhofer Institutes ITWM and SCAI in simulations of complex physical processes. The product is a synthesis of two software tools (FPM and SAMG) that have been successfully applied in many different industry sectors independently for over 15 years and are both being continuously developed.

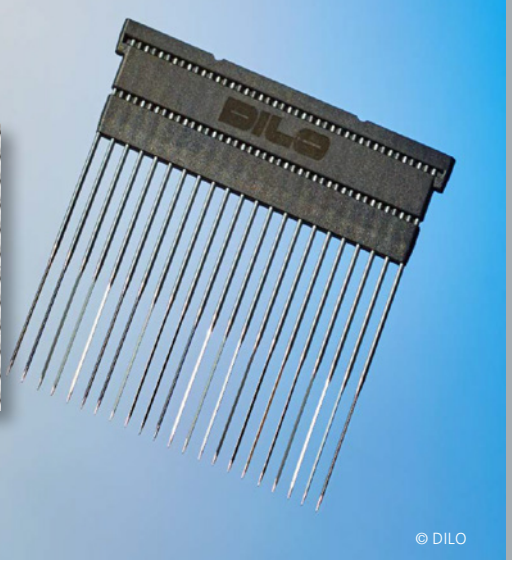
1 *Simulation of a stirring process*

2 *In fluid dynamics, a Kármán vortex street is a repeating pattern of swirling vortices in a flow around an obstacle. The illustration shows a simulation of such a vortex street using adaptive refinement dependent on the gradient of the velocity.*









1 2 3 4

ADAPTIVE NEEDLE LOOMS

1 *Needled nonwoven fabric*

2 *Penetration pattern after image processing*

3 *Simulated penetration pattern*

4 *Needle modules*

The Dilo Group in Eberbach, Germany develops and produces innovative systems for the nonwoven materials industry. Needle punch systems used for mechanical bonding of nonwoven fabrics play a major role in their business. We assist Dilo in the development of Variopunch, a needle punch technology that will contribute to a more uniform penetration pattern. The process is described below.

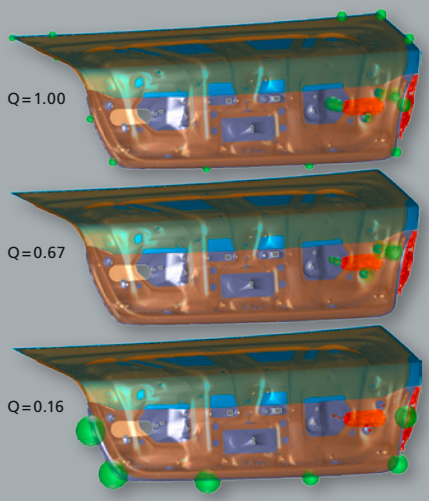
Dilo-Variopunch – adaptive needle punch technology

A large number of needles are arranged in a repeating pattern on a needle board. The needle board continuously moves vertically in and out as the nonwoven material is transported underneath. As a result, the individual fibers are locked together giving the fabric strength. Besides strength, the optical impression also plays a crucial role for many applications because the needle punch inevitably leaves a pattern.

The needles have traditionally been positioned at fixed points on the needle board. The new Variopunch technology being developed at Dilo enables adaptive needle positioning. In a typical line of needle looms, several machines are placed in succession and operate in a sequence of decreasing intensity so as to produce a pattern that is as homogeneous and streak-free as possible. A significant increase in quality is achieved by placing a Variopunch machine with variable positionable needles at the end of such a line, which corrects previously occurring errors through adaptive needling.

Image processing, simulation, and optimization

Our institute supports the development of the Dilo Variopunch, especially in the algorithmic implementation. We use techniques from the fields of image processing, simulation, and optimization. An optical sensor located at the front of the machine scans the incoming fabric. The resulting images are processed algorithmically and the pattern is extracted. By means of simulations we can compute the resulting pattern for any possible positioning of needles in the Variopunch board. Optimization methods are then applied to determine the optimal punch positions and, accordingly, use them to adapt the needle board.



RoMI – ROOT CAUSE ANALYSIS OF MEASUREMENT ISSUES

Systematic studies of deviating measurements in the manufacturing process have yet to provide a way to predict the causal aberrations of components and joints. Although historical trends in the deviations between target and actual dimensions can be detected by statistical process controls, the cause analysis is still missing. While traditional tolerance analysis helps to explain how typical component and joint failure results in measurement deviations, we examine the opposite problem in the Central Innovation Program for SMEs (ZIM).

1 *Tactile measurement*

2 *Cause analysis for measurement deviations at the surface of the rear end of a car (green balls: component and joint faults, RoMI quotient Q: probability of error source)*

The ITWM component of RoMI

In the project RoMI (Root Cause Analysis of Measurement Issues), we have developed an algorithm and implemented the associated software to analyze potential root causes of aberrations in components or joints. Surface measurements, which have been taken during the production process, allow us to automatically detect defective assemblies and error sources in the joining process. In particular, we can reveal an installation error at a spot that is inaccessible and can no longer be measured after final assembly.

The software is able to simulate different assemblies of the parts. Our algorithm selects the most likely assembly from all the potential combinations of component or joint deviations matching the surface measurements. This selection is achieved by solving a non-linear optimization problem. A special effort is made to ensure that the components are not pervasive. Starting with a set of measurements, the appropriate configuration is found.

This is basically an inverse problem, i. e., from an observed effect on the system, we want to identify the underlying cause. Since there are usually many more failure parameters than measurements, identification usually relies on solving a stochastic optimization problem.

Embedding in eMMA

The new RoMI module is embedded in the eMMA software supplied by project partner Q-DAS (formerly Kronion). Many suppliers from the fields of automobile, shipbuilding, and mechanical engineering have chosen to use this product. This integration ensures the responsible managers are informed in a timely manner before any real problems can emerge from the trends identified.

NEWS

NEW AiF PROJECT STARTS – VIRTUAL BOBBIN DYEING AND OPTIMIZATION

Faulty dyeing in the German textile and clothing industry results in costs of 8.8 million euros, which the industry can no longer accept in light of the increasing price competition from East Asia. The aim of a multidisciplinary project called DensiSpul at the German Federation of Industrial Research Associations – AiF (Arbeitsgemeinschaft industrieller Forschungsvereinigungen) is to reduce the rejection rate of poorly colored bobbins by at least 15 percent through the use of simulation. The success of the project could mean annual savings of approximately 1.3 million euros in Germany. Our institute is collaborating on the project with the Institute for Textile Technology (ITA) at RWTH Aachen University and the Society for the Advancement of Applied Computer Science (GFaI).

One of the aims of DensiSpul is to develop a system that generates recommended settings for the winding machines on the basis of a simulation. Together with the other project partners, we are developing an algorithm to simulate a virtual bobbin based on the machine setup parameters. We then calculate an optimized density of the virtually wound bobbin for the subsequent dyeing process. The CT imaging of actual wound bobbins is always a priority focus for the validation of the material models. Ultimately, from the optimized virtual bobbin, the recommended setup parameters for the winder can be determined.

FROM PhD CANDIDATE TO PERMANENT STAFF

Since its establishment, our institute has continually offered scholarships for PhD candidates in cooperation with TU Kaiserslautern and other universities, which can lead to the award of a PhD in just over three years. Because of the close relationships to the supervisors, this program strengthens the research orientation of our department. In addition, the program provides excellent job opportunities for the doctoral candidates while representing a potential source of outstanding qualified employees for the department. The two new staff members for 2017, Jaroslaw Wlazlo and Tobias Seifarth, successfully completed their doctorates in Kaiserslautern and Kassel.

Front, left to right: Dr. Tobias Seifarth, Dr. Walter Arne, Dr. Timo Wächtler, Dr. Simone Gramsch, Dr. Almut Eisenträger, Dr. Raimund Wegener, Dr. Dietmar Hietel, Matthias Eimer, Jens Bender, Dr. Jaroslaw Wlazlo, Dr. Robert Feßler, Dominik Linn, Raphael Hohmann, Manuel Wieland, Dr. Andre Schmeißer, Dr. Jan Mohring, Johannes Schnebele, Dr. Simon Schröder, Markus Rein, Dr. Jörg Kuhnert

FLOW AND MATERIAL SIMULATION

Together with the Institute for Composite Materials (IVW), we are developing simulation methods for virtualizing sheet molding compounding of fiber-plastic composites at the “High Performance Center for Simulation- and Software-based Innovation”. The picture shows the SMC plant with thermoset impregnation and suction system in the IVW pilot plant.

DR. KONRAD STEINER
HEAD OF DEPARTMENT

MULTISCALE AND MULTIPHYSICS METHODS AND SOFTWARE SOLUTIONS FOR INDUSTRIAL APPLICATION

Our department Flow and Material Simulation develops multiscale methods and software tools for the product development and the corresponding process layout. One of the typical challenges for us is to control the mutual influences of manufacturing processes and the multifunctional, local material properties by means of simulations. The unique of the department lies in the development, enabling and specific use of multiscale and multiphysics methods and customer-specific software solutions suitable for industrial application.

Already by name, the department can be divided into two large fields of competence: "Computer-assisted material design and microstructure simulation", enables to simulate and optimize numerically the functional characteristics dealing with porous materials as well as composite materials. There is a strong demand for our highly efficient, micromechanical methods for the material design of fiber reinforced composites and technical textiles. The "simulation-assisted design of complex flow processes" works on the corresponding manufacturing processes such as mixing, dispersing, injection, filtration, coating and segregation. Focusses of the industrial application are processes of filtration and segregation as well as the product design of filter systems or other process equipment.

The projects of application often address material design as well as flow simulation. Thus in the area of electrochemistry, we are engaging in diverse aspects for the appropriate material of battery cells or fuel cells as well as in their production, e. g. the filling of battery cells.

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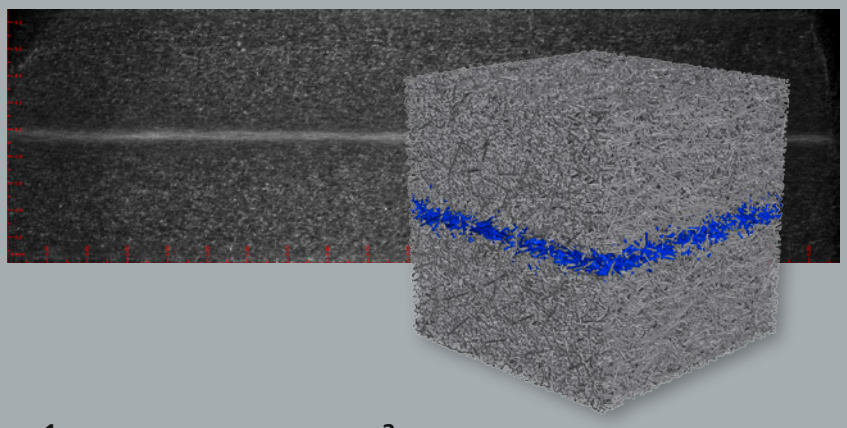
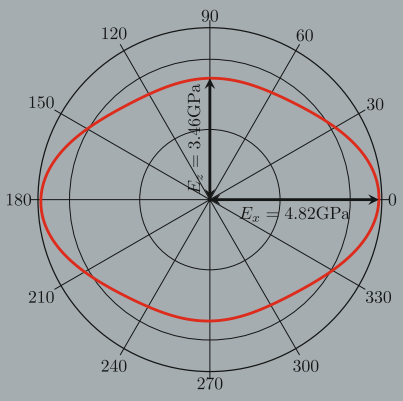
MAIN TOPICS

- Technical Textiles and Nonwovens
- Virtual Material Design and Microstructure Simulation
- Lightweight and Insulation Materials
- Filtration and Separation
- Complex Fluid Dynamics and Multiphase Flows
- Electrochemistry and Batteries





1 2 3

MULTISCALE SIMULATION OF FIBER REINFORCED COMPONENTS

1 *µCT image of short glass fiber reinforced PBT with characteristic middle layer*

2 *Computer model of a short glass fiber reinforced PBT, generated with the software tool GeoDict*

3 *Computed effective stiffness in thickness and longitudinal direction*

Fiber reinforced plastic components are essential in different applications as e.g. in automotive or medical engineering. In the project MuSiko we develop multiscale simulation techniques for reinforced components.

For microstructured materials, the macroscopic deformation and failure behavior significantly depends on the microstructure, which is influenced by the manufacturing process.

For fiber reinforced polymer matrices as for example polybutylen terephthalat (PBT) matrix failure, fiber breakage or delamination may occur. In order to predict these effects often a pure macroscopic analysis is not sufficient. Thus, very complicated phenomenological models are required, which are only valid for certain failure scenarios.

Joint research project MuSiKo

In the BMBF joint research project MuSiKo we develop efficient multiscale simulation techniques in consultation with scientists from the universities of Kaiserslautern and Saarbrücken as well as the Karlsruhe Institute of Technology. The abbreviation MuSiKo stands for "Adaptive Approximation Techniques for the Multiscale Simulation of Nonlinear Composite Behavior". The industry partners Robert Bosch GmbH and Siemens PLM Software are supporting the research project.

The applied multiscale approach is based on a coupled solution of the macroscopic and the microscopic problem. Only the characteristics of the matrix the fibers as well as the local orientation of the fibers have to be determined as input parameters for the simulation. The mechanical behavior at the level of component results in the averaged microscopic values.

Process chain for glass fiber reinforced plastics

In the project MuSiKo which has successfully been finalized in 2017 we carried out the complete process chain for glass fiber reinforced PBT in cooperation with our partners – from the measurement of the plastic properties and the determination of the fiber orientation by means of µCT up to the multiscale simulations. The simulation results are validated via suitable experiments at the component level.

With assistance of these simulation techniques, it is possible to optimize the injection molding process (e. g. the temperature or injection point) with regard to the functionality of the components.

1 2

AUTOMATIC DERIVATION OF MATERIAL LAWS FOR SIMULATING STRUCTURAL COMPONENTS

Fiber reinforced plastics have a high stiffness to weight ratio and can be produced cost efficiently on a mass production scale by injection of compression molding. Therefore, this type of material plays an important role for producing lightweight components. In joint projects with Bosch, we developed an integrative simulation for the dimensioning of short fiber reinforced components, which takes into account the production process as well as the resulting locally varying material properties.

1 *Example of a fiber-reinforced plastic part: the buckle of a lanyard*

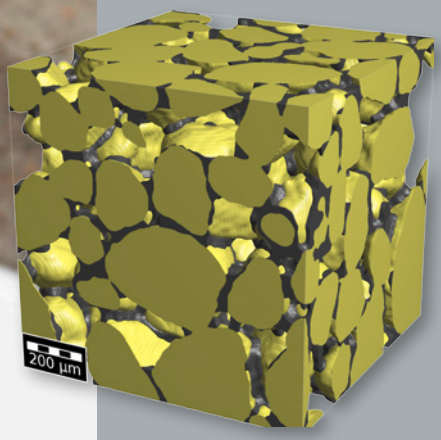
2 *Above: Boundary condition of Abaqus simulation; below: von Mises equivalent stresses obtained from Abaqus simulation*

During the production process the plastic is injected or molded at medium to high pressure into the component shape. The resulting flow processes are influencing the fiber orientation and thus the mechanical properties significantly.

Integrative Simulation

At first, a material database for different fiber orientations is filled during the so-called off-line phase. This stage is relying on a combination of microstructure simulations performed with FeelMath and model order reduction methods. FeelMath is a fast and easy analysis tool for elastic micro-structures given by volume images (e. g. CT-Images) or analytical descriptions. Afterwards, the results of the injection simulation with FLUID, Moldflow or Moldex 3D are transferred onto the Finite Element Mesh (FE-Mesh) of the component simulation.

During the component simulation with Abaqus we interpolate the effective material laws obtained during the off-line phase and take account of the local nonuniform mechanical properties. This allows us to take advantage of the lightweight capabilities of fiber reinforced plastics and to avoid overly large safety factors.



1 2

µ-KERN: MICROSTRUCTURE-BASED CALCULATION METHOD FOR CORE SAND

1 *The sand core was produced by a core shooting process at the UTG. The grains of sand are bound to a mould by a binder.*

2 *Sand grains in beige and binder in grey can be seen in the virtually created microstructure.*

Casting technology uses core sand to map the cooling channels in a cylinder head. Core sand consists of the granular material quartz sand formed to a porous composite by a binder. This is placed in the outer mold before the metal is poured and destroyed after the casting process to produce a sand-free casting. We are developing micromechanical simulation models for core sand in cooperation with the Chair of Metal Forming and Casting (UTG) at Technical University of Munich (TUM).

Calculating the properties of inorganically bound core sands

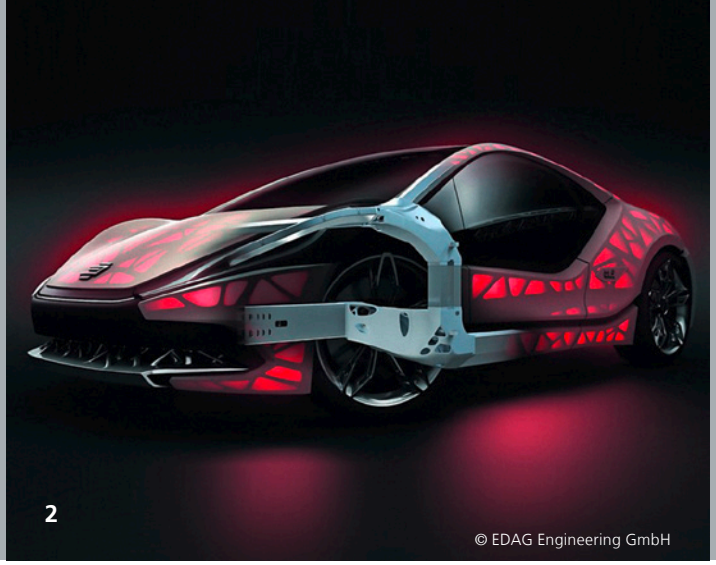
An innovative, inorganic silicate-based binder complies with strict environmental laws and enables sustainable, low-emission production. However, changing the components used changes the physical behavior of the core sand and the result is only visible after passing through the entire process chain. We are able to accelerate development by modeling and simulating the process.

Based on input parameters such as the manufacturing process and the materials used, we effectively calculate physical properties such as strength, gas permeability, and thermal conductivity. In the first phase of the project, we create a representative microstructure for the sand-binder composite and prepare high resolution images of existing composite structures using micro-computer tomography.

Validating the structures produced

The UTG partners measure the elastic properties of the sand and the binder. Then, we create virtual microstructures with stochastic methods and validate them by comparing them with structural images. The properties of the sand (such as grain shape, size, and size distribution) and of the binder (such as volume content and chemical composition) influence the physical properties of the composites. We investigate the dependence of the elastic stresses in the composite on the elastic properties of the materials used i. e., the quartz sand and water glass.

In the second part of the project, we use the Stokes/Navier-Stokes model to calculate the gas permeability and the thermal conductivity. Furthermore, we generalize the elastic model to nonlinear damage effects.



MODELING AND SIMULATING ADDITIVE MANUFACTURING BY SELECTIVE LASER FUSION

Additive manufacturing processes have become an integral part of the production of small-batch size, high-stress components such as blades or fuel nozzles for gas turbines. Besides aerospace, automotive manufacturing is predestined for the use of additive manufacturing methods because of the large variety of products. In the BMBF-sponsored project "CustoMat3D", we develop simulation methods in this area in cooperation with our partners.

1 *In selective laser melting, the portion of the powder layer belonging to the component is melted first and then the contour is traced for a better surface quality.*

2 *The car bodies of tomorrow are not only lighter, but above all highly flexible in design. The EDAG Light Cocoon concept car demonstrates the new possibilities of structural optimization opened up by additive manufacturing methods.*

New options and degree of freedom in design

The basic principle of additive manufacturing is the layer-by-layer manufacturing process, which eliminates many design limitations due to traditional production methods, like pre-determined tool paths or draft angles. This allows to make full use of the potential of end-use specific lightweight construction as structural components need no longer be of a generic design covering all possible load cases.

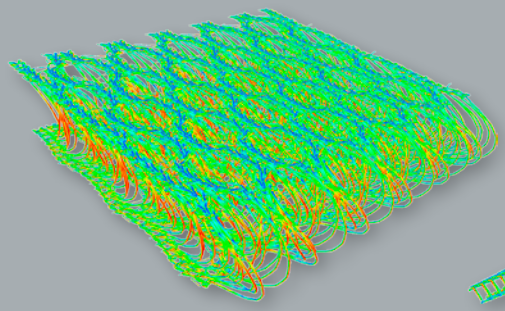
Today's aluminum alloys are generally not customized for a specific application and do not fully exploit cost and weight reduction potentials. Simulations reveal the interplay of material properties, design, and manufacturing processes. However, the optimal simulation approach is still the subject of ongoing research.

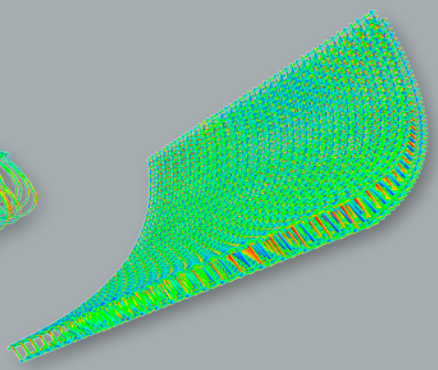
Custom aluminum materials for the automotive industry

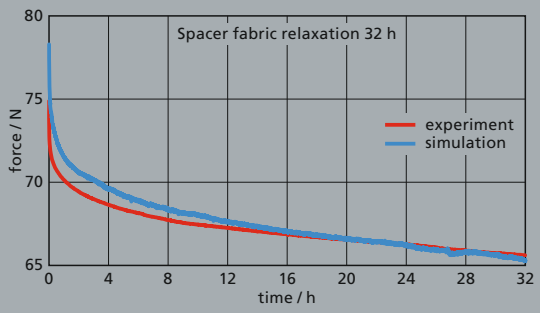
Partners in the CustoMat3D project are: Daimler, Concept Laser, MAGMA, Fraunhofer IAPT, ECKA Granules, FKM Laser Sintering, Institute of Materials Science (IWT), and Altair Engineering. The project is funded within the BMBF project and research scheme "ProMat_3D". The project´s aim is to use simulation-aided development and qualification to create custom-made aluminum alloy materials for use in laser additive manufacturing for the automobile industry.

In cooperation with MAGMA, we are developing new approaches to simulate the extremely fast phase transitions and solidification process as well as the resulting material structures. To predict deformation, we take into account all relevant length and time scales. Specifically, we include:

- The details of the powder and melt pool in the vicinity of the laser.
- The effects of the punctiform influx of heat due to the laser on the residual stress and temperature distribution throughout the component.







1 2 3

SIMULATING THE MECHANICAL PROPERTIES OF KNITTED SPACER FABRICS

1 *Compression calculation of a spacer fabric*

2 *Bending calculation of a spacer fabric*

3 *Comparison of simulated and measured relaxation curve of spacer fabrics under compression*

Spacer fabrics are double knit textiles, in the form of plates or shells that consist of two separate layers of knit fabrics joined by vertical monofil yarn. We simulate spacer fabrics in various projects, for example, the areas of application include the materials used in mattresses and seats.

The properties of spacer fabrics are characterized by diverse parameters, such as the in-plane period, the thickness, and the height of the fibers. We can calculate, for example, the effective stiffness and permeability. To reduce the computing effort, we use algorithms for homogenization and dimension reduction. The spacer fabric is represented by an equivalent, elastic, two-dimensional shell.

The resolved microstructure is stored for use in the flow simulation to calculate the effective permeability. The relationship between the geometric parameters and the load determines how much bending or tension is placed on the fiber at the micro level.

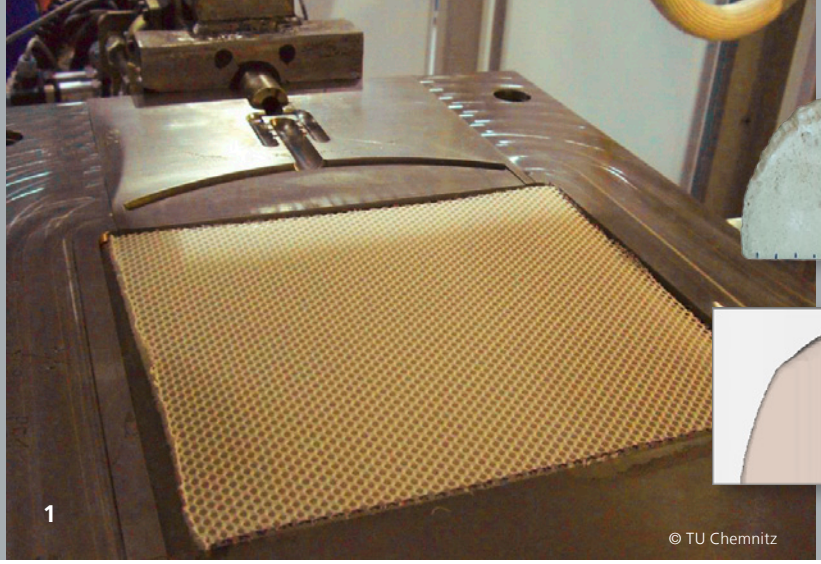
Spacer fabrics are highly resilient, flexible, and strong

One advantage of spacer fabrics is their superior decompression. This means these materials are highly resilient, flexible, and strong when subjected to an external pressure load. In the simulation process, we first build the complex structure of the spacer fabric, resolving all the bonds of the spacer filaments. Subsequently, we simulate the tensile, shear, compression and bending properties using TexMath – software we developed for modeling and analyzing textile fabrics.

DFG Project: Modeling the structural properties of 3D spacer fabrics

The characteristics are generated from the knitting pattern and the yarn's known force elongation curve, cross section, and frictional properties. Using TexMath, we analyze the textile spatial variations of permeability in different directions caused by the outer-plane compression of the structure. This is also a part of a collaborative project with the Technical University of Dresden with the name "Modeling of mechanical and filtration properties of 3D spacer fabrics" and funded by the German Research Foundation (DFG).

Another research question is to what degree the fiber torsion contributes to the overall effective viscoelastic properties. Our investigations show that the relaxation time of the spacer fabrics coincides with the relaxation time of the monofil, as presented in Fig. 3.



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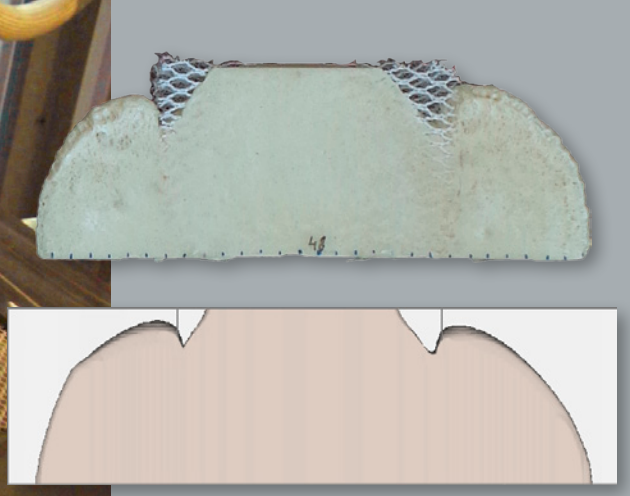


2

RIM PROCESS OF POLYURETHANE FOAMS TO DEVELOP COMPOSITE MATERIALS

Composite structures are considered to be lightweight and stable. Textile reinforced composites materials made from polyurethane (PU) foams are perfect candidates due to their enhanced physico-mechanical characteristics. Using FLUID software module of our CoRheoS simulation platform, we can simulate the form filling process.

1 *RIM process of a PU foam with spacer fabric*

2 *Comparison of the filling fronts in an infiltration study*

PU foams are complex and difficult to study

In the RIM process (RIM - Reaction Injection Molding) of PU foams, a polymer mixture is injected into a mold in which the material develops over a period of time from a low molecular weight emulsion to a complex polymer foam matrix via polymerization.

The expanding foam exhibits complex physical behavior during the production phase, which is initiated by premixing adequate reactants followed by gas and heat creation as well as evolution of material properties resulting in PU foam formation. This makes PU foams extremely difficult to study.

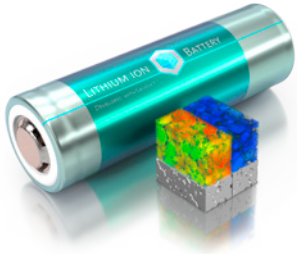
Developing optimal simulation tools for industrial applications

We design mathematical models that describe the dynamics of expanding foams and apply them to study the RIM process of PU foams. Using our FLUID software, we carry out relevant numerical studies to understand and evaluate the foam expansion process. In this way, we are able to predict the required amount of material to completely fill the mold as well as optimize the foam process and mold design.

In order to investigate the expansion process in textile structures, especially, knitted spacer fabrics, we use TexMath to determine the relevant permeability tensors. TexMath is an in-house developed software product for the modeling and analysis of textile materials. The spatial variations of the tensors caused by unequal compression of the structure can be analyzed by TexMath (see left page).

We then use this data in FLUID and extend our numerical studies to predict the foam expansion through knitted textiles. Our findings (see figure) are in strong agreement with the experimental data obtained at the Department of Lightweight Structures and Polymer Technology at Chemnitz University of Technology. In summary, we provide simulation tools for efficient industrial application that help in the optimization, manufacturing, and development of composites.

NEWS



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BEST

BATTERYDICT – BEST MEETS GEODICT

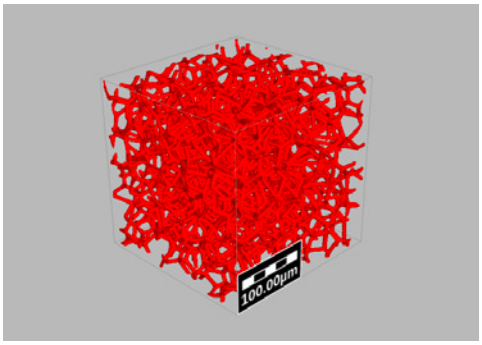
Our cooperation with M2M (Math2Market) was significantly strengthened in 2017 in the area of battery simulations to more closely integrate Fraunhofer ITWM's BEST (Battery and Electrochemistry Simulation Tool) with GeoDict from M2M. This cooperation has produced the new GeoDict module "BatteryDict," which controls the BEST solver algorithms and is completely integrated into GeoDict 2018. Today, in addition to the stand-alone battery simulation software BEST, the software is also completely integrated in GeoDict. We presented BEST and BatteryDict to an interested customer audience and special "short courses" explained the practice in detail at the GeoDict User Meetings in Kaiserslautern, Nagoya, and Tokyo in autumn 2017.

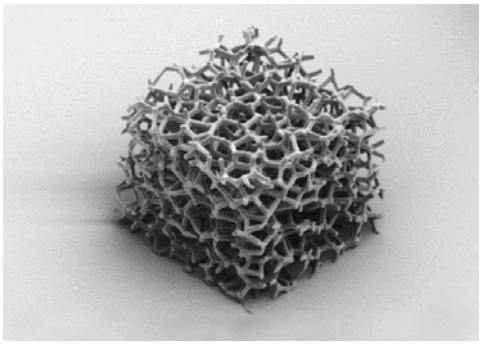
INTEGRATION PROJECT – DIGITALIZATION OF TERAHERTZ TECHNOLOGY

We focus on the experimental qualification of microstructures within the framework of an integration project with the Center for Materials Characterization and Testing. It serves to expand the business areas and promote long term cooperation.

Numerical models and their advanced development are validated on the basis of experimental results to review forecasting reliability. We use the computer to create an optimal microstructure based on the desired material properties, for example, a certain permeability within a specified stiffness.

The 3D printer creates an exact copy of this computer model with (sub-)micrometer resolution, which is then tested for the desired properties. Until now, only indirect verification of microstructure simulations was possible. The success of our explicit validation of additive microstructures creates customer trust and promises new markets.





Front, left to right: Ruturaj Deshpande, Dr. Olena Sivak, Pavel Gavrilenko, Junfan Zhang, Dr. Ehsan Afrasiabian, Dr. Konrad Steiner, Inga Shklyar, Dr.-Ing. Tobias Hofmann, Dr.-Ing. Sarah Staub, Stephan Wackerle, Alexander Leichner, Christine Roth, Dr. Ralf Kirsch, Dr. Julia Orlik, Dr. Ikenna Ebubechukwu Ireka, Dr. Hannes Grimm-Strele, Dominik Gilberg, Dr. Torben Prill, Michael Hauck, Dr. Stefan Rief, Dr. Stephan Kramer, Dr. David Neusius, Dr. Heiko Andrä, Dr. Sebastian Osterroth, Dr. Aivars Zemitis, Jonathan Köbler, Thomas Palmer, Dr. Jochen Zausch, Dr. Dariusz Niedziela

IMAGE PROCESSING

Mortar contains aggregates such as sand or gravel, the sizes and shapes of which determine its processing and material properties. Our 3D grain shape analysis based on volume images helps to optimize these aggregates for high-performance mortars.

MARKUS RAUHUT
HEAD OF DEPARTMENT

CUSTOMIZED IMAGE ANALYSIS FOR PRODUCTION AND THE ANALYSIS OF MICROSTRUCTURES

We develop mathematical models and image analysis algorithms and implement them in efficient, industrial-suited software, mainly for production.

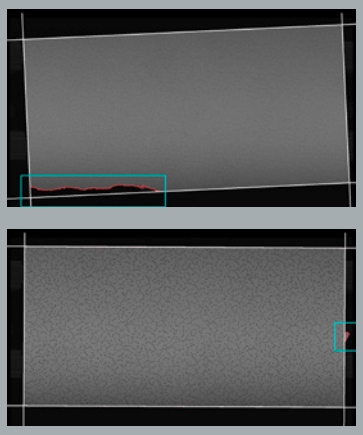
The areas of application include in particular sophisticated surface inspection and the analysis of microstructures. Our large portfolio of algorithms enables the development of image processing solutions that cannot be implemented by the industry. In addition, there are many tasks for which commercially available systems cannot be used or can only be used partially. For these questions we develop tailor-made image processing solutions.

Consulting also plays an important role for us, for example, hardware decisions in the design of image processing systems (IPS) or the integration of additional components into an existing system. We also offer independent consulting in the area of optical quality controls and the development of algorithms.

Contact
markus.rauhut@itwm.fraunhofer.de
www.itwm.fraunhofer.de/en/bv

MAIN TOPICS

- Surface and Material Characterization
- Quality Assurance and Optimization
- Image Understanding and Scene Analysis



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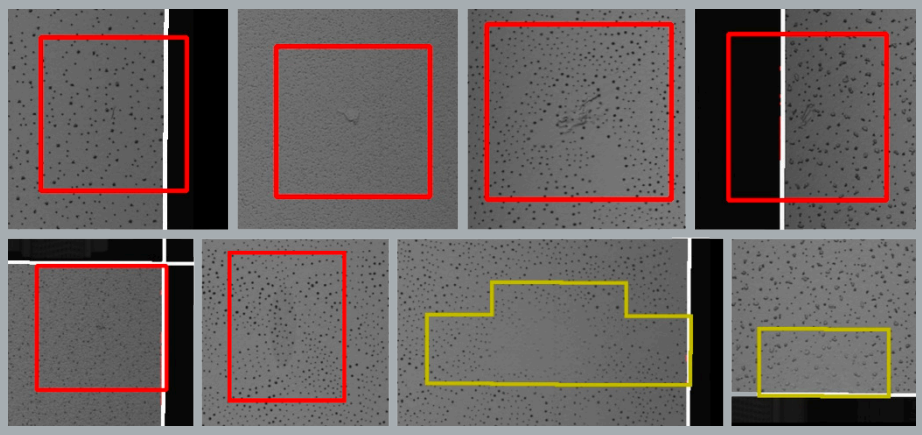


2

MODEL-BASED LEARNING FOR THE INSPECTION OF MINERAL FIBER PANELS

1 *Ceiling panels with detected edges: Typical geometric errors are edge break-offs (top) and overhangs (bottom).*

2 *Examples of surface detail defects and large area design errors in the manufacture of ceiling panels*

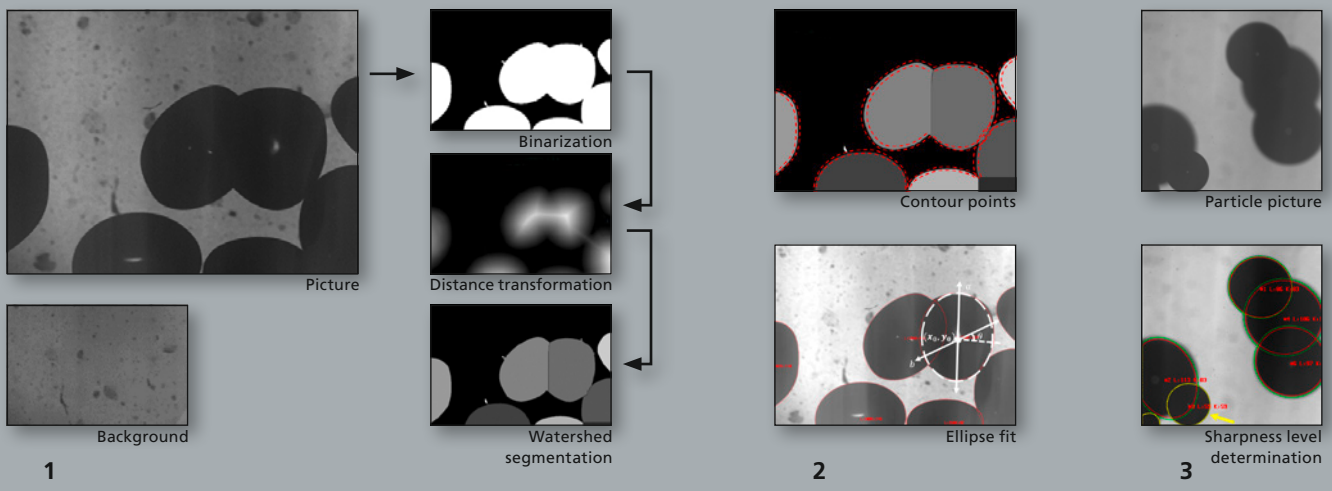
Model-based learning facilitates fast and flexible image processing solutions. We have developed and implemented such a solution for the Odenwald Faserplattenwerk GmbH (OWA) to provide fully automated testing in the manufacture of soundproofing ceiling panels. OWA mineral fiber panels come in a variety of different designs that are continuously extended. The aim of our solution is to ensure a quality inspection that is so flexible that it can be adapted to new designs and defect types with a minimum of effort.

Defect detection by combining a series of filter processes with morphological methods in a step by step method is difficult to adapt. We avoid this by exploiting the advantages of model-based learning. In effect, this means that we make model assumptions that generically apply to different types of products and combine them with self-learning techniques. Typical industrial applications mainly produce defect-free parts, so examples of the defects are infrequent. Instead of modeling defects, we use a so-called one-class classification of defect-free parts. Any areas whose properties cannot be assigned to this good class are then identified as defects.

Algorithm finds large-area and small-scale defects

First, we model the rectangular shape of the ceiling panels by detecting the main lines with the aid of the Hough transformation method. In this way, dimensions are determined and the first defect types can be found. To look for defects inside a panel, we model the design or even the needling. We find defects in large areas and also in small details. In the case of large-area defects, we calculate properties across the entire panel width: for small-scale defects, we use just the properties in the vicinity of the needling. For both types of defects, learning is based on a sufficiently large number of sample images classified as defect-free panels. Already a hundred images are sufficient to enable this classification to work productively with little parameterization effort.

By means of this combination of procedures, we quickly provide a good solution for the production of new product variants, which we can also iteratively improve during a running operation with the addition of more sample images.



DETECTING GRAINY AND NON-SPHERICAL PARTICLES IN THERMAL PROCESS ENGINEERING

Particulates play a major role in process engineering, for example, in agitating vessels, bubble columns, extraction columns, and crystallizers. In the AiF-ORBITRO project, we determine the geometries of the particles to enable qualitative and quantitative statements about the real processes. To this end, we have developed a multi-stage, procedurally stable method that quickly detects round and non-round particles.

1 *Step by step procedure for detecting the candidate particles*

2 *Schematic representation of the contour points and ellipse fit after optimization*

3 *Determining grain sharpness by inner (red) and outer (green) circumferences of the ellipses; sharp ellipse in yellow*

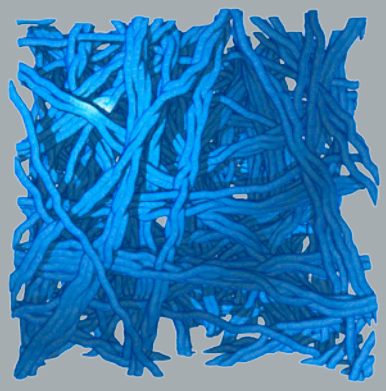
The particle environment is usually not free of dust and dirt, but it is static. First, the particle foreground is separated from the background by averaging over several images. Using adaptive thresholds to binarize both the particle image and the background image, we then recombine both. We use the relative roundness of the particles to divide the resulting particle regions into individual particles. Using the Euclidean distance transformation, these help in the extraction of possible particle centers and then, with the watershed transformation, we separate the candidate particles.

Detection also functions for overlapping particles

Subsequently, the contour points on the candidate particles are used to adjust the ellipses. With these contour points, we use a so-called "general conical model" to estimate six parameters for each ellipse. The fitting step then selects the ellipse that has the smallest absolute distance to all contour points. In this way, we achieve stable detection even for overlapping particles.

In addition to the ellipse parameters, we can set the sharpness level of the particle. This in turn is useful because the degree of sharpness – depending on the recording method – allows inferences about the position of the particle. We use different adaptive thresholds to determine the positions, followed by so-called "skeletonization." The sharpness threshold for particles can be configured by the user simply by selecting a parameter.

The processes developed with our ToolIP software is integrated in the existing LabVIEW environment and used for further statistical analysis particle processes.



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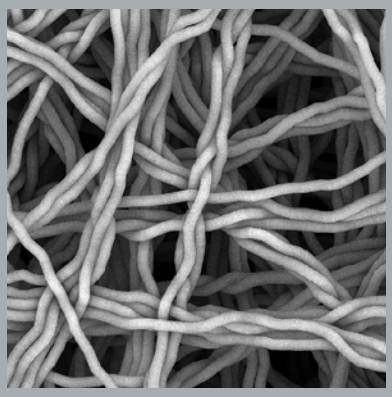

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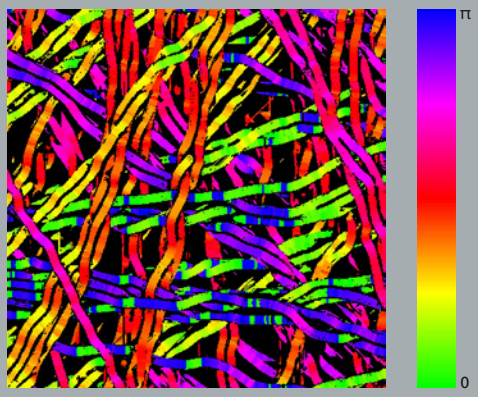


3

MAVIfiber2d – MEASURING FIBER DENSITY, FIBER ORIENTATION, AND CLOUDINESS

1 *Volume rendering of Altendorf-Jeulin model*

2 *Simulated REM image (BSE-Signal) of a random fiber system (Altendorf-Jeulin model)*

3 *Orientation map for the REM image in figure 2*

The quality of nonwoven fabrics depends on the distribution of the fiber thickness, the fiber orientation, and the cloudiness. These properties are evaluated in the laboratory using image data. MAVIfiber2d meets the difficult challenge of automating this evaluation, while also ensuring that it is reproducible.

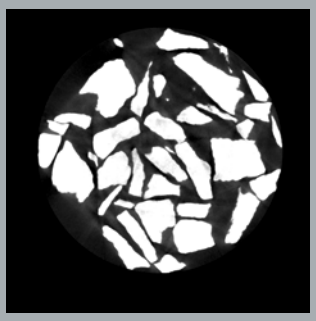
Diffusion filters have been the nucleus of image processing at ITWM and the VQC project, which measured the cloudiness of nonwovens was one of the first industry projects in the image processing department. MAVIfiber2d combines this experience with new tools of mathematical morphology and the typical point concept of stochastic geometry to create software for objective, reproducible evaluations of non-woven samples.

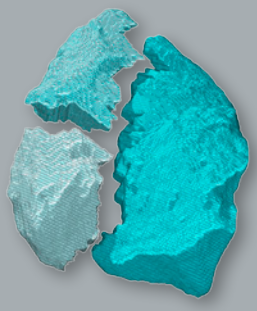
Local analysis without fiber separation

In a random closed set, the typical point concept makes it possible to measure the distributions of fiber thickness and fiber orientation without having to separate the fibers in the image. In ambiguous situations, it is not necessary to decide where each intersecting or looped fiber begins or ends. Rather a simple binarization suffices: for every image pixel, a decision is made as to where it belongs in the fiber system, i. e., the foreground or the background. Local thickness and orientation are defined for every foreground pixel. The result is an area-weighted distribution of thickness and orientation.

Measuring cloudiness from standardized grayscale variances

Cloudiness is mathematically not so easy to describe. MAVIfiber2d builds on the VQC project findings. The input image is smoothed step-by-step with approximated Gauss filters. The grayscale variances of the standardized filtered images reflect the cloudiness for the scale under consideration. The cloudiness index is calculated from the variances as a weighted average. The scales and weights are chosen in a manner that measuring results correspond as well as possible to the technical requirements and the subjective visual impressions.





1 2 3

3D ANALYSIS OF PARTICLE SHAPE FOR HIGH PERFORMANCE MORTAR

Construction mortar contains aggregates like sand or gravel, where size and shape determine the processing parameters and material properties. Standardized test sieves are used to control grain sizes. By using bar sieves instead of perforated sieves, rough statements about grain shapes can be deduced. In the past, to determine the grain shape more accurately, it was necessary to measure manually with sliding calipers.

The shape distribution is also important because, besides the size distribution, it determines the packing density and the mechanical properties of the aggregate. Computed tomography was used for the first time to spatially image the shape of several thousand grains simultaneously in the ZIM project "Developing innovative high performance mortars based on conformity criteria through the use of new 3D measuring and evaluating techniques in computer tomography." In the 3D images generated, however, the individual grains touch each other. The grains must be separated via image analysis before their shapes can be measured.

Standard morphological algorithms for particle separation cannot solve this problem – even with the ideal choice of parameters - because the particles are too flat and too pointed. In particular, grains split in the image if their shape deviates too far from the spherical. In the project, fragments were first interactively assembled and then we tried to distinguish real grains and fragments based on their spatial geometry. However, this method of classification does not work because the grain shapes vary too much.

Correcting the particle separation

Consequently, instead of focusing on the grains or the resulting fragments, we now study the separation areas as spatial geometric objects. Their expansion and rippling are well suited to distinguish real from false separation areas. This approach is currently being tested for subsequent implementation as a separation algorithm.

Successfully separated grains can be measured far more accurately by image analysis today than by the mechanical methods required previously. In addition to volume and surface content, the length, width, thickness, isoperimetric shape factors, elongation, and maximal thickness as well as a number of other parameters can now be determined.

1 *Cross sectional view of the reconstructed tomographic image of a grain packing*

2 *Left: Same slice after automatic particle separation. Clearly, some particles are erroneously separated. Right: Results of interactive post processing*

3 *Volume rendering of a particle that is separated too strongly.*

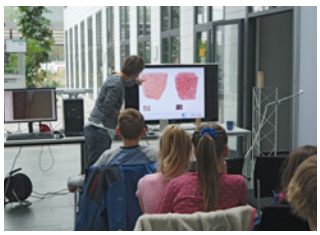
NEWS

12. EUROPEAN CONGRESS FOR STEREOLOGY AND IMAGE ANALYSIS 2017

International research scientists met at the ITWM for the Stereology Symposium on processing, segmentation and analysis of FIB-SEM image data: A special focus was on highly porous structures. The agenda highlighted Annick de Backer for her doctoral thesis "Quantitative Atomic Resolution Electron Microscopy Using Advanced Statistical Techniques."

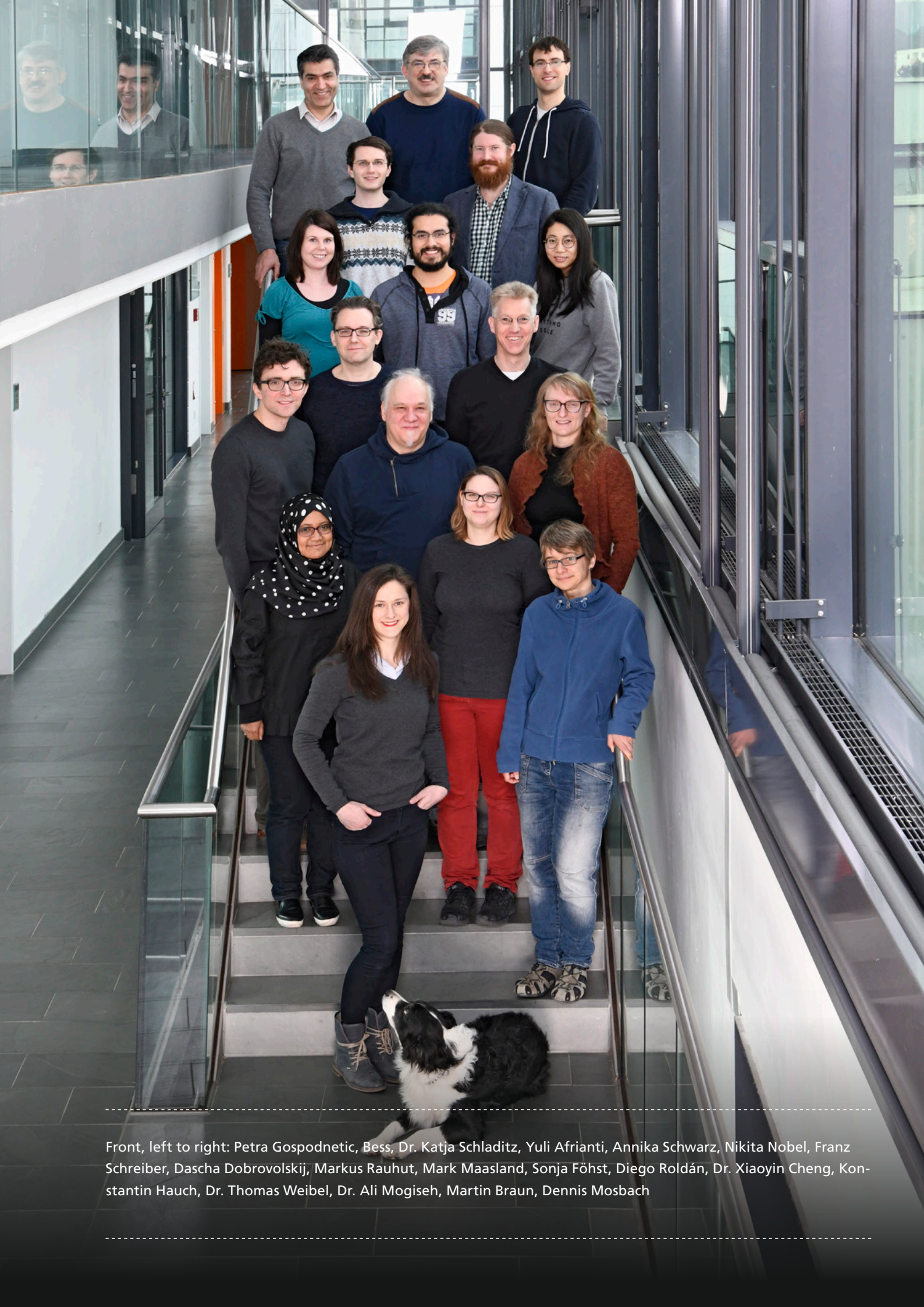
OPEN HOUSE WITH THE MOUSE

The department once again participated in the institute's "Open Doors" program inspired by the German children's TV show "Sendung mit der Maus" and presented its own amusing facts and stories in the atrium. Approximately 30 boys and girls learned about the field of surface inspection and used a computer game to detect and classify various irregularities on a cow hide, for example, insect bites, injury from barbed wire, and stretch marks. The focus topic of microstructure analysis was experienced by the young guests by analyzing different types of lady finger biscuits and blasting dirt particles using compressed air at a greatly enlarged model of a vacuum cleaner filter.



DIGITAL TECHNOLOGIES WORKSHOP FOR FIBERS, NON-WOVENS, AND TECHNICAL TEXTILES

Two-day exchange for experts in industrial development and application-oriented research: The lecture topics were as wide ranging as the application areas of simulation technology and included fiber spinners, technical textiles, fiber processes, nonwoven fabrics, filtration, and textile composites. The workshop participants, for example, worked on the development of new ceramic fibers, a simulation and optimization of needling processes, and the virtual development of filter methods and media. The computer-aided characterization of the microstructure of fiber composites and the virtual design of textile-reinforced composites also played a role.



Front, left to right: Petra Gospodnetic, Bess, Dr. Katja Schladitz, Yuli Afrianti, Annika Schwarz, Nikita Nobel, Franz Schreiber, Dascha Dobrovolskij, Markus Rauhut, Mark Maasland, Sonja Föhst, Diego Roldán, Dr. Xiaoyin Cheng, Konstantin Hauch, Dr. Thomas Weibel, Dr. Ali Mogiseh, Martin Braun, Dennis Mosbach

SYSTEM ANALYSIS, PROGNOSIS AND CONTROL

In the area of electrical power grids, we deal with the modeling, monitoring, and control of energy production units, energy distribution grids and the efficient use of energy by consumers. In particular, an important part of our work is the analysis of up to now unknown interactions between conventional and renewable producers.

DR. ANDREAS WIRSEN
HEAD OF DEPARTMENT

ANALYSIS, PROGNOSIS, AND CONTROL OF COMPLEX SYSTEM AND PROCESS BEHAVIORS

The dynamic systems we consider from the fields of energy management, plant and machine control, as well as medicine and biology are often complex, because they map a network of different sub-systems and structures.

Each of these systems is equipped with specific sensors and actor configurations. In many cases, when we want to obtain information about system behavior from measurements, we have to consider that sensor data is overlaid with interference. Usually, this situation is compounded by incomplete system and structural descriptions.

Typical tasks include the identification of dynamic system parameters (by means of mathematical state estimations), the classification of system behavior (by means of machine learning), the preparation of online-enabled simulation models for system analyses or for the development of controllers, and the validation of the behavior of electronic control units (within a hardware-in-the-loop setting).

The department draws on its core competencies in the field of systems and control theory and machine learning. We have special expertise in the areas of differential-algebraic equations, the use of sequential Monte Carlo approaches (particle filter methods) for the simulation and state estimation of stochastic processes, in statistical learning theory as well as in machine learning with deep architecture (Deep Learning).

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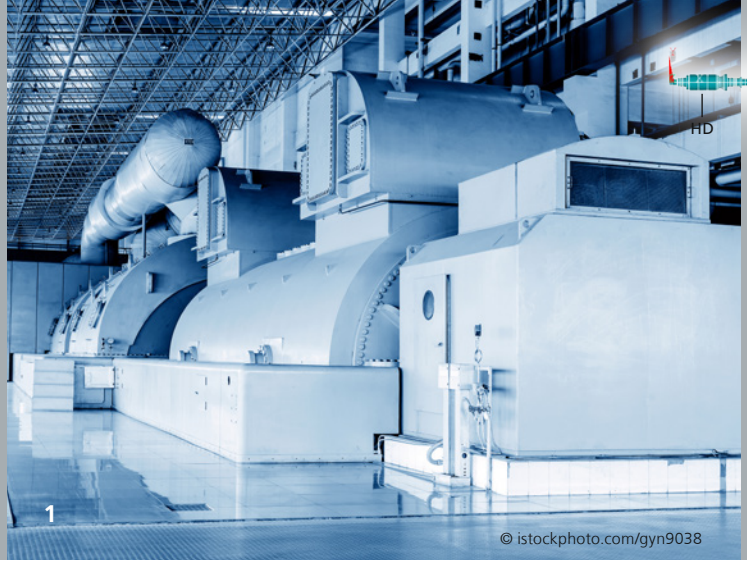
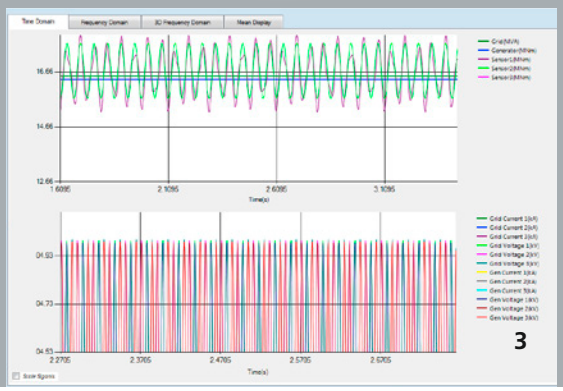
MAIN TOPICS

- Power Generation and Distribution
- Machine Monitoring and Control
- Bio-sensors and Medical Devices
- Machine Learning
- Controller Design for Complex Systems
- Model Identification and State Estimation





TORGRID – MONITORING SYSTEM REACTIONS AT CONVENTIONAL ENERGY PRODUCERS

1 *Power generation unit with generator, and turbine*

2 *A power turbine generator unit scheme with generator (GEN), low pressure turbine (ND), medium pressure turbine (MD) and high pressure turbine (HD)*

3 *Screenshot TorVis – TorGrid*

The significant increase in the power generation of renewable energies and the coupling of high voltage DC transmissions over converters produces novel dynamical effects in the power grid. The management of previously unknown system interactions on conventional power plants, in particular, takes on increasing importance.

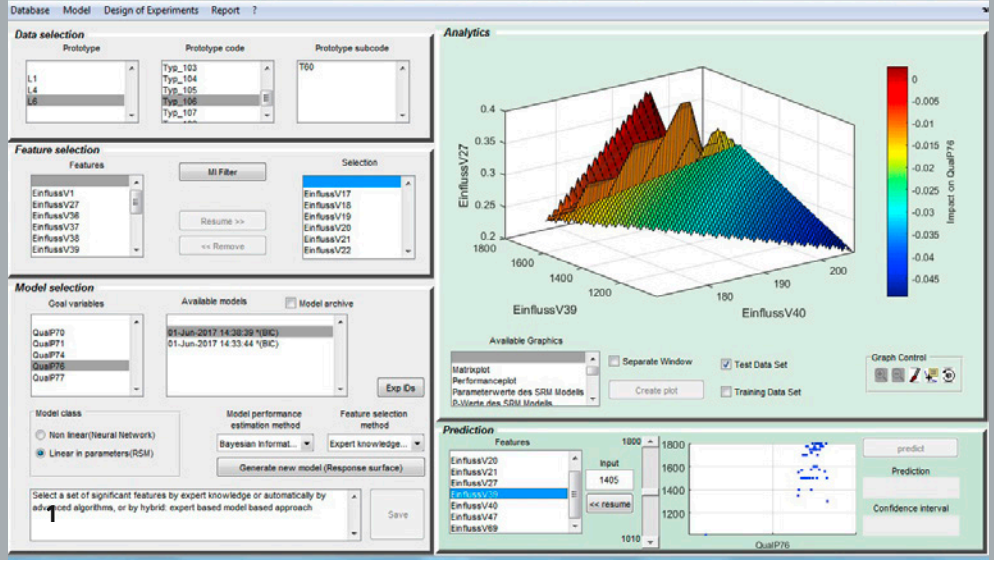
We developed TorGrid, an online monitoring system to detect grid interactions on turbine generator shaft lines. This monitoring system synchronously records the torsional vibrations of the drive shaft and the respective 3-phase electrical voltages and current at the generator as well as at the grid side of the transformer. TorGrid monitors the measurement signals based on intelligent trigger criteria to detect events that have been defined as critical by the operator. In addition to the measured values of up to three non-contact torque sensors and the three instantaneous currents and voltages, in the case of an event, TorGrid also stores the resulting electrical power of the generator and the transformer at the grid side.

Analysis of interaction between grids and turbines with TorVis

TorVis, an integrated visualization software, enables the subsequent analysis of the torques, power, currents, and voltages in time and in frequency domain. TorVis enables the users to determine the cause of the torsional vibration on the drive shaft at the time of a detected event: external reactions/perturbations from the electrical grid, vibrations caused by internal mechanisms at the generation unit, or interactions between turbine generator shaft line and electrical grid as sub-synchronous resonances.

Improved revision planning

Our customers in the conventional power generation sector (i. a. Uniper Anlagen Service) use TorGrid to improve planning of inspections and service activities. The long term goal is to use the signals recorded by TorGrid to compensate for reactions in the grid.



MACHINE LEARNING IN MANUFACTURING

The department has long been involved in finding solutions to a wide range of industrial problems, using machine learning methods. One focus of our research is so-called Deep Learning – machine learning with deep architectures.

1 *Quantification of the dependency of a measured quantity of product quality by means of three significant influence variables of a plastic extrusion process*

Data analytics ensures product quality

Modern production plants face a great challenge in trying to understand the relationship between the various influencing factors in the manufacturing process and the quality of a product. Optimizing the production processes requires quantifying the effects on quality and performance variables when individual process parameters change. Fundamental in this effort is the possibility of using machine learning to predict quality variables from process parameters or features derived from these.

At the department, we develop feature selection/construction algorithms as well as process models based on measurement data from the real manufacturing process, expert knowledge about the process, and related theory.

Optimizing predictive maintenance – through machine learning

Ideally, a technical system is considered reliable and economical, if it is repaired promptly and available when required. This is only possible if the company can reliably predict the maintenance requirements of the systems, taking into account the current production plan and past load history, while guaranteeing the availability of the appropriate resources such as specialists, spare parts, logistics, etc.

Reliable prediction of future events is an integral part of any Predictive Maintenance (PM) system. An important key lies in the analysis of patterns in past events. In a joint modeling approach, we model not only the continuously measured sensor data, but also repetitive discrete event data and failure data. We develop machine learning methods to recognize and visualize complex high dimensional patterns as well as the dynamics and trends of production process states. Furthermore, we use machine learning algorithms to predict and characterize the condition of technical systems.

NEWS

KL-CONTROL SYSTEMS SEMINAR: EXCHANGING EXPERIENCE AND BROADENING HORIZONS

Since autumn 2016, the department has been organizing the KL-Control Technology Seminar once a month, together with research groups from several departments of the TU Kaiserslautern. Discussions focus on ongoing or just completed graduate work as well as current research projects; the spectrum ranges from mathematical methods to technical implementations. The speakers usually present results, but the presentations can also be open-ended in order to provide an opportunity for partner input on open issues.

INTERACTIVE PAPER PRIZE

Six participants reached the final round of the "Interactive Paper Prize" at the 20th IFAC (International Federation of Automatic Control) World Congress 2017 in Toulouse, France. Both the written version of the paper as well as its presentation are evaluated. Among the finalists were Ferdinand Küsters, Stephan Trenn, and Andreas Wirsen with Switch Observability for Homogeneous Switched DAEs.

NEW FUNCTIONALITIES INTEGRATED IN knowCube®

knowCube® provides tools for interactive knowledge management and multi-criteria graphic decision aids and, among other things, also enables any manner of search expressions for freely formulated research in public domain and Fraunhofer-licensed Internet sources. These processes work at two levels: The results list is dynamically displayed on the graphic user interface while, parallel to this, the selected documents are analyzed in the background to provide the details for continued navigation if required.

Front, left to right: Dr. Christian Salzig, Dr. Andreas Wirsen, Hans Trinkaus, Dr. Alex Sarishvili, Dr. Jan Hauth, Jens Göbel, Michael Sendhoff, Dimitri Morgenstern, Ferdindand Küsters

OPTIMIZATION

Multi-criteria optimization and interactive decision support for process planning based on models and data as well as support for Design of Experiments (DoE) to accelerate and improve products are core activities in research and development assignments of BASF under the umbrella of the High Performance Center Simulation- and Software-Based Innovation in cooperation with the University of Kaiserslautern and led by Fraunhofer ITWM.

PROF. DR. KARL-HEINZ KÜFER
HEAD OF DEPARTMENT

MODEL- AND DATA-BASED DECISION SUPPORT

The core competence of the department of Optimization is to develop individual solutions for planning and decision problems in logistics, engineering sciences and life sciences in close co-operation with customers.

Methodologically, our work is characterized by the interrelationship of simulation, optimization and decision support. Simulation in this context refers to the creation of mathematical models while taking into account the design parameters, restrictions and optimization of the quality and cost.

The division´s core competencies include the development and implementation of application and customer-specific optimization methods to calculate the best possible processes and products. Unique selling points are the integration of simulation and optimization algorithms, the special consideration of multi-criteria approaches as well as the development and implementation of interactive decision support tools.

Overall, optimization is viewed not as a mathematical problem to be solved, but rather as a continuous process, which we support by developing suitable tools. We particularly focus on the adequate choice of the model in terms of quantity and quality of the available data. Methods of machine learning are not only used for data processing and calibrating models, but also to represent physically non-explicitly modeled phenomena.

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MAIN TOPICS

- Process Engineering
- Medical Therapy Planning
- Model Learning and Smart Data
- Production Planning and Resource Efficiency
- Arrangement and Cutting Problems
- Supply Chain Networks

USEFUL DATA AND MODELS WITH MACHINE LEARNING

1 *Planar glass plate before the bending process*

2 *Elevated glass plate after the bending process*

Model-based optimization of production processes significantly reduces production costs while maintaining or even improving product quality. However, to get the best possible results, it is crucial that the underlying models are reliable. Oftentimes expertise is already available in practice, either through experience or through well-established scientific equations. From this knowledge one can derive a preliminary expert model. Most of the time though, this model contains too many gaps, so that an overall process optimization is not possible. This is where our optimization department with its proficiency in "machine learning" comes into play.

Supervised and unsupervised learning methods

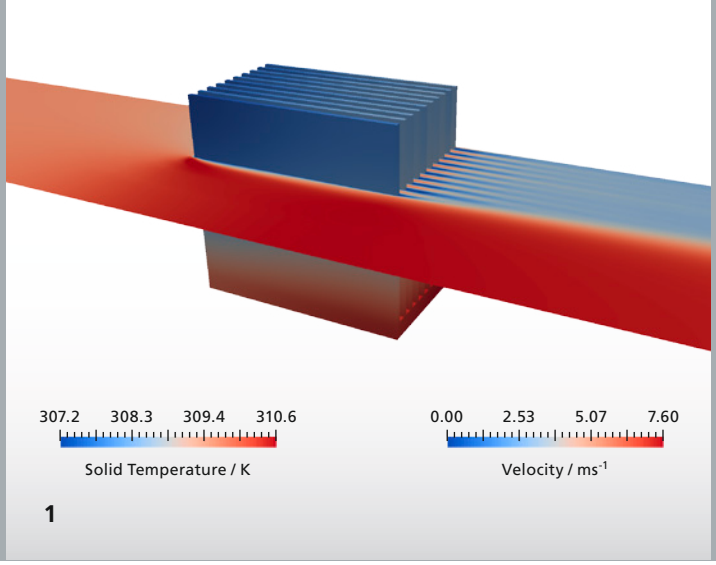
In addition to the expert knowledge, large sets of data are usually available for implemented production processes, where sensors monitor and log the operating state of the production system over time. In chemical production plants, for example, these sensors might monitor pressure, temperature or electrical power consumption. With a sufficient amount of data, statistical learning algorithms can be used to close the gaps left in the expert models.

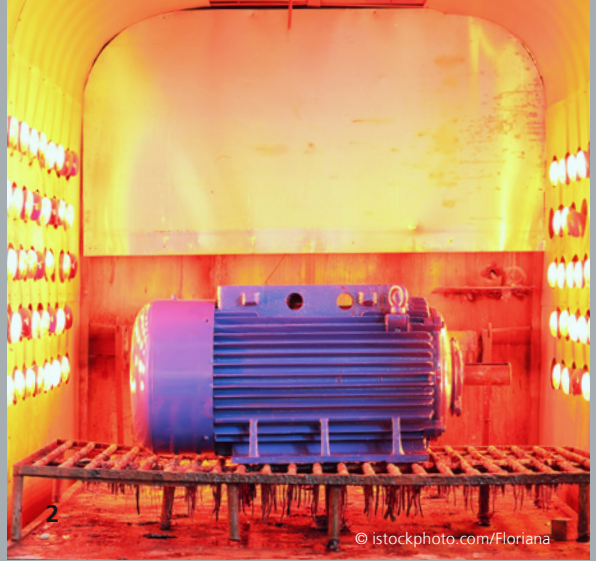
There are many kinds of learning algorithms, broadly divided into unsupervised and supervised learning. Examples of unsupervised learning are pattern recognition and time series clustering. The supervised learning algorithms include, for example, classification methods or approaches via mathematical regression. It is often not trivial to find which algorithm to use in which situation.

Statistical learning algorithms create coherence and reliability

One difficulty with the expert models is that a production process usually consists of many individual, interconnected production units. Gaps in the expert models can result from a lack of data on these individual units or from insufficient knowledge of how they interact.

Through statistical learning algorithms the overarching interactions within the production system can be explored. More detailed models can then be developed and their reliability evaluated with confidence intervals. If physical knowledge is used not only in areas where data exists, but also for extrapolation to areas where no data has been collected. Using strategies for the optimal design of experiments, we can even make suggestions for further data acquisition in order to further reduce uncertainties.





OPTIMIZING HEAT TRANSFER AND COOLING OF ELECTRONIC COMPONENTS

During the operation of electronic components and computer processors, electrical resistance causes heat. Higher computational power increases the temperature. In the worst case, over-heated components malfunction or break. We improve heat-sink designs to provide sufficient cooling for industrial products.

1 *Simulation of air flow and heat transfer*

2 *Oven curing of an electric motor*

Our algorithms outperform the genetic algorithms

Commercial plate-fin heat-sinks transfer heat from the source along multiple fins to the cooling air. The number of fins, their thickness, the height and the distance between them define the heat transfer and fluid dynamics during the cooling process. Our algorithms for the computation of best geometries are efficient and precise. In comparison to commonly used evolutionary algorithms, they outperform by a factor of ten.

Ranging from electronics over paper making to oven curing, we can optimize any problem modeled by a CAD engine. Sandwiching algorithms perform best for convex problems. Hyperboxing algorithms are not as efficient, but, they can process nonconvex information. Sometimes model simplifications help us to reach the optimum faster. If necessary, algorithms are adjusted to adapt to new problems. We are constantly working to improve our algorithms.

Automotive industry, watch out – we optimize cooling processes

Our next goal is the optimization of oven curing processes in the automotive industry. Temperature, air flow and position of painted car parts change the oven curing process. We optimize this process in terms of heat distribution and energy consumption while quality shall not be lost.

Our cooperating partners, the Fraunhofer-Chalmers Research Centre for Industrial Mathematics FCC at Sweden, have developed an innovative simulation method. Due to IPS IBOFlow, we can implement many industrial processes and analyze them automatically. We use it to compute the heat transfer and fluid dynamics during the cooling process.

DIGITAL PRODUCT DEVELOPMENT AT BASF

1 *Laboratory employee tests the wetting properties of a silicon wafer.*

One of the biggest challenges in the chemical industry for product developers is to spend the least possible effort to come up with a low-cost chemical compound that meets certain cost and quality properties.

Problem description, sample project, and software development

An example is the production of surface coatings. Various properties are desirable depending on the area of use of the coating. In addition to surface protection, for example, certain smoothness or optical properties may be required. Frequently, the objectives are competing, so that a suitable compromise must be found.

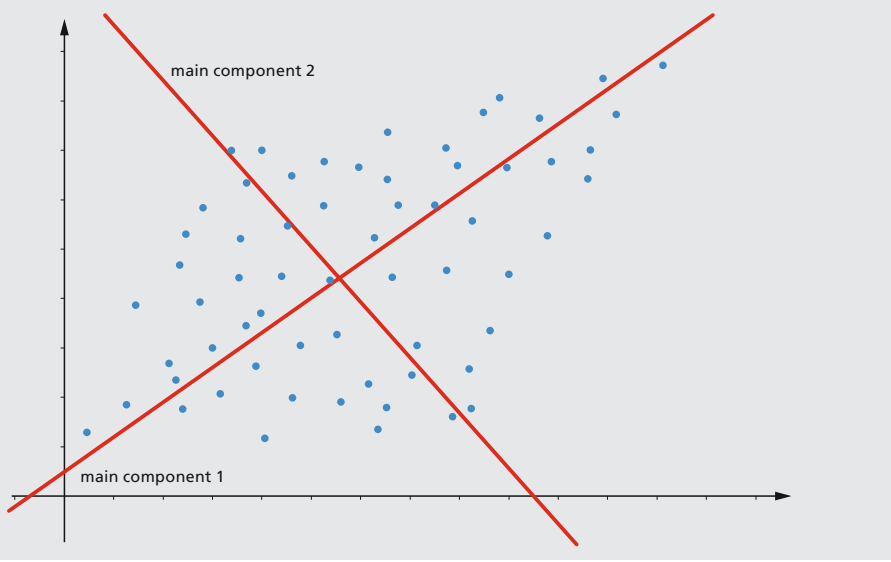
Below, we present a typical workflow for a new research project: First, one defines the objective functions and design variables before starting the first series of experiments. Based on the initial results, one then generates a mathematical model to predict the appropriate design specifications. These are used to start a new series of experiments and this process continues until a satisfactory compound is found.

Our department has developed a software tool to assist the chemists throughout this process. It starts with the analysis and visualization of the data, continues with the modeling of the individual target variables and supports in finding best compromises and in planning of a new experiment.

Machine learning and modeling

The mathematical model chosen to describe the desired functions depending on the design variables is of major significance. The processes in chemical manufacturing are often highly complicated and difficult to model. Together with BASF SE, we are developing a tool to address this issue using machine learning methods. A particularly complex challenge is selecting a suitable model, as this is essential for the quality of the optimized solution.

Various methods are used to measure the suitability of the model, such as cross-validation. This method uses part of the data for training and the remaining part for the validation of the model. For example, it is used in selecting the components for linear regression models in order to avoid over-adaptation of the data.



2

Specifically, it is about improving model quality by filtering out the low-impact components that are random in nature. However, in very few cases do purely data-driven models lead to the goal. That is why we include the user's expert knowledge in the modeling process.

Optimization and experimental design

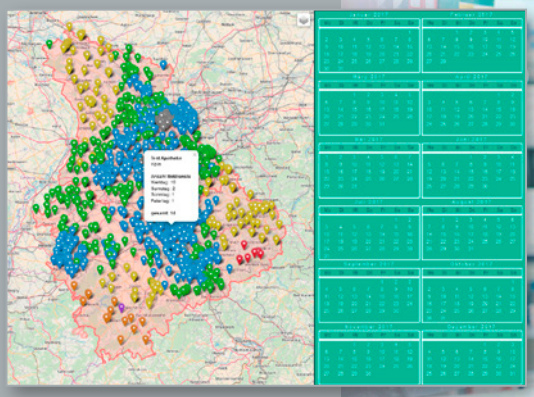
As mentioned above, a key element is the planning of new experiments. This activity is often time consuming and costly, which makes efficient design of experiments even more important. Our tool helps to reduce the number of attempts required and saves valuable resources for the user.

The problem is solved as follows: The user navigates within a range towards the most attractive target functions. This requires a multi-criteria optimization to be performed in advance. The new experiments are planned within the boundaries of this range. The tool also supports forward planning based on the model, which means the user can directly test particularly promising individual recipes. The user also receives information about the uncertainty of the prediction in the form of confidence intervals.

Web architecture in a big data system

The software is implemented as a web solution with a modern database, which is able to manage a large amount of data. By doing so, a simple and computer-independent use of the tool on mobile devices such as tablets is ensured. At the same time, team productivity is increased because all data are stored centrally and all users always have access to the latest version.

2 *The figure shows a data set with two principal components in a two-dimensional space. Principal component analysis finds the directions which best explain the variance of the data.*



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HealthFaCT – OPTIMIZING OUTPATIENT MEDICAL CARE IN RURAL AREAS

1 *Interactive evaluation and exploration of optimised pharmacy emergency service plans*

2 *Pharmacies are an essential component of outpatient medical care.*

Our healthcare system faces major challenges in outpatient medical care. Despite the decline in population and rising costs, medical care must still be guaranteed in rural areas. The aim of HealthFaCT (Facility Location, Covering and Transport) is to find the optimal distribution of the scarce health care resources in rural areas.

The collaborative project HealthFaCT is developing an innovative software-based optimization and decision-making system to improve outpatient medical care. The software quickly identifies and evaluates the best possible option for strategic, tactical, and operational decisions. In addition, the user can interactively visualize, explore, analyze, and verify the results. We are developing a web-based simulation platform that integrates the optimization methods designed by our project partners.

Research alliance with focus on three pillars

The project is funded by the German Federal Ministry of Education and Research (BMBF) and focuses on three major pillars of outpatient care: Pharmacies, emergency doctors, and ambulance and rescue services. Together with our project partners RWTH Aachen University, Technical University of Kaiserslautern, and University of Erlangen-Nuremberg, we are optimizing the following three areas based on future requirements forecasting:

- Location structure and emergency service plan for pharmacies
- Location structure and resource distribution for emergency doctors
- Waiting times in the ambulance and rescue services

Software-based implementation of mathematical algorithms

The project primarily studies location, coverage, and route planning problems from a mathematical perspective. The main challenges are real time optimization and robustness against uncertainties. Moreover, in a complex use case with divergent target functions, it is not possible to determine a single optimal solution by means of a purely algorithmic approach.

Therefore, we develop a data-driven tool that focuses on the decision maker. The software objectively shows the user different options and provides opportunities to interactively evaluate the solutions. Discussions with the application partners prove the need and the enormous potential of such a software-based optimization and decision-making system.

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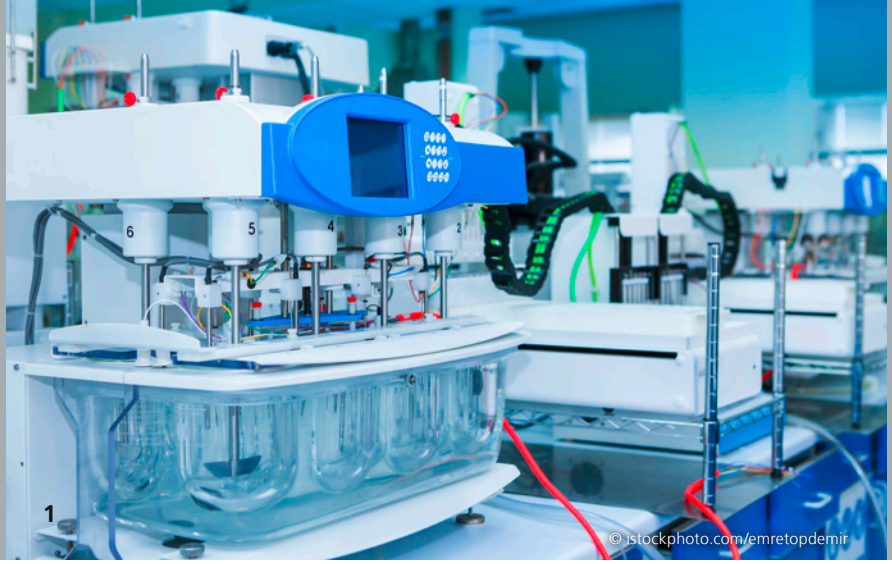

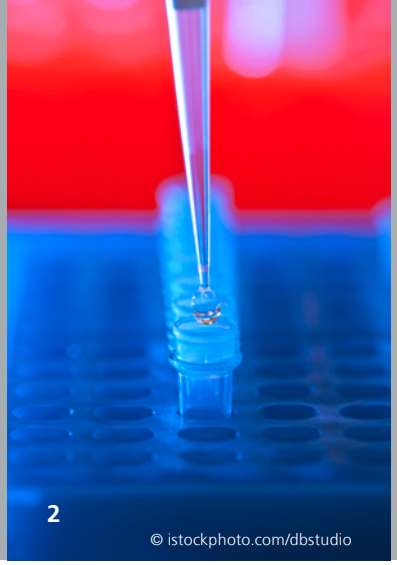

PERSONALIZED MEDICINE – METHODS FOR PRODUCTION PLANNING

Personalized therapies are new and promising trends for the treatment of many diseases. They have been proven exceptionally effective in low scale tests. However, in order to succeed economically, the production processes need to be scaled to an industrial level. They need to be secure, cost efficient and last, but not least, fast. After all, long waits will be unacceptable for patients – especially in life and death situations. Therefore, it is of the essence that the production is planned and executed optimally.

1 *Laboratory equipment*

2 *Pipetting a DNA solution*

Challenges of bio-processes

Bio-processes show characteristics that complicate the optimal design and efficient management of industrialized processes.

- High quality standards often call for re-executing process phases for individual patients.
- Heterogeneous processing times complicate the development of a periodic production flow.
- The probabilistic nature of processing times and error occurrence prevent a structured, predictable workflow.

Approaches for process optimization

First, we can get a better understanding of the processes by carefully studying the capacities of different process phases, especially those with high failure rates. For example: In which period should a patient ideally arrive so there are no long waiting times? Knowing this, we can align process phases and determine where to keep additional production capacities ready to compensate for workload spikes. Furthermore, the purchase of more or better devices can be evaluated.

In order to avoid frequent changes to the production plan, we can add puffer times between production steps. Thereby, we can limit the impact of delays to a small part of the process and it is possible to set up a periodic production schedules: For every process section, we determine when best to start and how many patients should roughly be processed at the same time. The resulting schedule is more stable, although errors and probabilistic processing times still cause some variance.

These are just two examples of how we analyze the individual challenges of bioprocesses and develop new methods to manage and optimize workflows. Using digital twins of the processes, we assess our strategies and simulate the interactions of different ideas.

NEWS

SOFTWARE-PLATFORM FOR COLLABORATIVE WORK-SHIFT SCHEDULING IN HEALTHCARE PROFESSIONS

In 2017, our department started the GamOR (GameOfRoster) research project with the aim of developing models and algorithms to assist nurses and others in the planning of their work schedules. The special focus is on the identification of incompatible planning requests and their resolution using methods from game theory. In cooperation with ergonomists, designers and application partners, we implement the models and algorithms in a prototype software to test and evaluate the services in daily operations.

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung
ESF Europäischer Sozialfonds für Deutschland
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DIGITALIZATION OF CONSTRUCTION SERVICES AND PROCESSES WITH INDUSTRIE 4.0 TECHNOLOGIES

How can digitalization be used to improve and redesign services and processes in construction engineering? Answering this question is the aim of the collaborative project ConWearDi (Construction – Wearables – Digitization) launched in 2017. The main effort of the Optimization department, besides implementing a prototype of integrating software-platform, is the study of stochastic scheduling models that can be used for scheduling and control on construction sites.

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

FLAGSHIP PROJECT – QUANTUM METHODS FOR ADVANCED IMAGING SOLUTIONS (QUILT)

In recent years, a second generation of quantum technologies has emerged. The flagship project QUILT bundles the expertise of six Fraunhofer Institutes and other quantum technology centers, such as the Institute for Quantum Optics and Quantum Information at the Austrian Academy of Sciences, and the Max Planck Institute for the Science of Light. We make contributions in the field of quantum imaging and play a key role in the modeling, simulation, and optimization of quantum-based non-contact methods. Launched in 2017, the project aim is to make rendering processes for material surfaces more reliable, faster, and less expensive.

Front, left to right: -Dr. Alexander Scherrer , Jasmin Kirchner, Pascal Wortel, Prof. Dr. Karl-Heinz Küfer, Dr. Christian Weiß, Dr. Michael Helmling, Dr. Tobias Fischer, Dr. Gregor Foltin, Dr. Michal Walczak, Dr. Sebastian Velten, Dr. Martin von Kurnatowski, Dr. Volker Maag, Dr.-Ing. Tino Fleuren, Dr. Heiner Ackermann, Dr. Patricia Bickert, Dr. Neil Jami, Julie Damay, Diana Ackermann, Andreas Dinges, Dr. Neele Leithäuser, Dr. Elisabeth Finhold, Felix Riexinger, Dr. Dimitri Nowak, Dr. Michael Bortz, Till Heller, Esther Bonacker, Dr. Johannes Höller, Melanie Heidgen, Johanna Schneider, Patrick Schwartz , Dr. Raoul Heese, Tobias Seidel, Dr. Jens Babutzka, Dr. Philipp Süss, Dr. Kai Plociennik, Dr. Jan Schwientek, Rasmus Schroeder

FINANCIAL MATHEMATICS

Financial mathematics issues arise in the sales and risk management of vehicle financing and leasing offers, which we deal with in our department for various industrial customers, such as BMW AG Munich. For example, we develop models for the probability of closing a financing application and forecasts for the residual values of used cars.

DR. ANDREAS WAGNER
HEAD OF DEPARTMENT

EXPERTISE IN CLASSICAL FINANCIAL MATHEMATICS, DATA SCIENCE, AND THE ENERGY INDUSTRY

Our applied research provides solutions for problems in development, analysis, and implementation of mathematical models. We rely on the latest findings of financial mathematics and statistical research. At the same time, we draw on a portfolio of successfully completed projects with banks, insurance companies, and energy suppliers.

We cover all relevant areas of practical financial mathematics – from modeling to the development of valuation algorithms and their implementation – and maintain our own software libraries. Frequently, projects result in software systems for operational deployment in companies.

We assist our customers to validate their data using mathematical modeling and to discover insights from the data using classical and modern statistical methods. The applications include the most diverse areas of controlling – from the valuation of company-specific assets such as leasing vehicles, to the detection of anomalies. Our work involves a combination of classic statistical methods such as regression models and cluster analysis and current machine learning methods.

Financial mathematical methods play an increasingly important role in the energy sector. We have experience in various models; we use current research results to implement algorithms for the efficient solution of valuation problems; and, we know the specific problems and characteristics of the energy markets. In addition, we also provide finished software packages for the management of portfolio risk.

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MAIN TOPICS

- Financial Economy
- Data Science for Controlling
- Energy Industry

1

CREDIT RISK MANAGEMENT FOR GOVERNMENT AND CORPORATE BONDS BASED ON NEWS RELEASES

1 *Machine learning methods are used to index news from different media and divide it into specific categories.*

The aim of the SenRisk project is to develop a credit risk management system in cooperation with one domestic and two foreign industry partners. Project funding is provided through Eurostars, a program for SME driven research of EUREKA and the European Commission. In addition to market data and macroeconomic information, current news reports (press, tickers, blogs, etc.) are also assessed to improve forecasting quality.

Machine learning classifies messages

Data providers specializing in data processing provide preprocessed, enriched, and machine-processed messages. Specifically, this means messages are given a classification using the techniques of machine learning, for example, auto-encoding methods. These classifications

- by reference (e. g., country, industry, company, etc.)
- by topic (e. g., management decisions, product market launch, profit warnings, etc.)
- by the assessed severity or relevance
- allow the user to filter out or limit the relevant news about a particular bond.

We use non-linear regressions and time series approaches as well as neural networks to combine these recently provided explanatory variables to forecast future price changes (spread changes) or, at a minimum, to develop better risk indicators. These are integrated into an information system to assist traders and portfolio managers.

The methods are applicable to government and corporate bonds. Due to different maturities, there is a maturity structure, which is not the case with equities. In addition, large parts of the market are less liquid than the equities or derivatives markets and price movements are driven by a complex combination of currency, interest rate and economic momentum.

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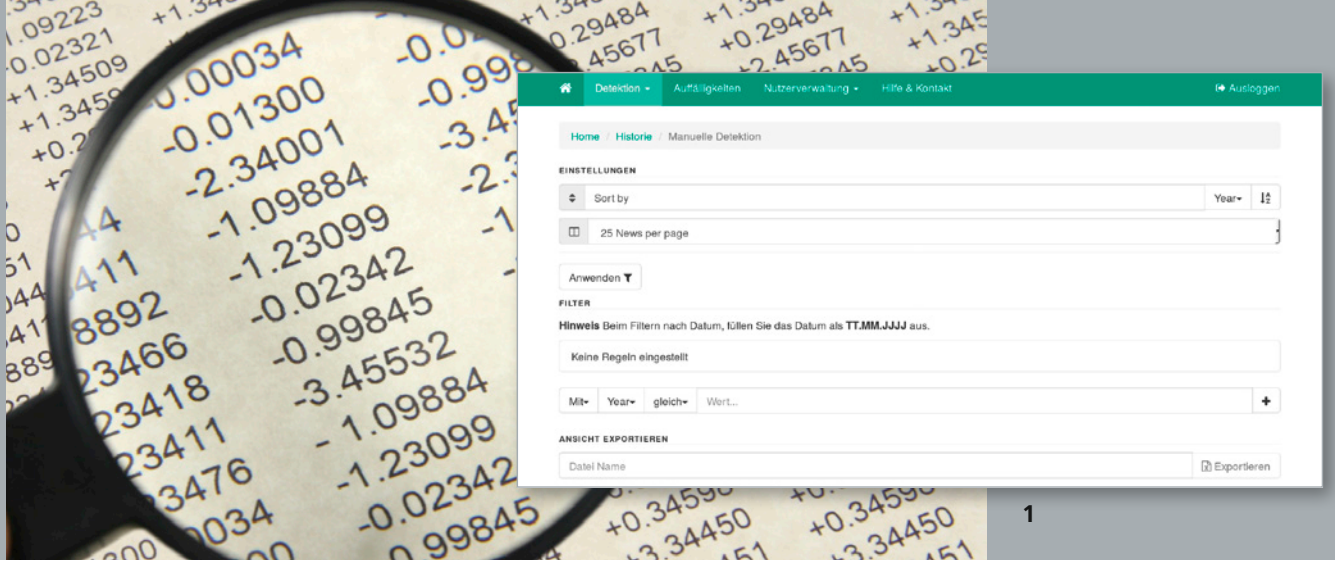
The "SenRisk" project is part of the European "Eurostars" funding programme and the German partners are funded by the Federal Ministry of Education and Research.



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ANOMALY DETECTION FOR CONTROLLING

Researchers in the Financial Mathematics department, together with industry partners, have developed an anomaly detection software. The product enables users to find and assess various types of anomalies (outliers) in very large data sets – usually, in accounting data.

1 *Example of detection of suspicious messages*

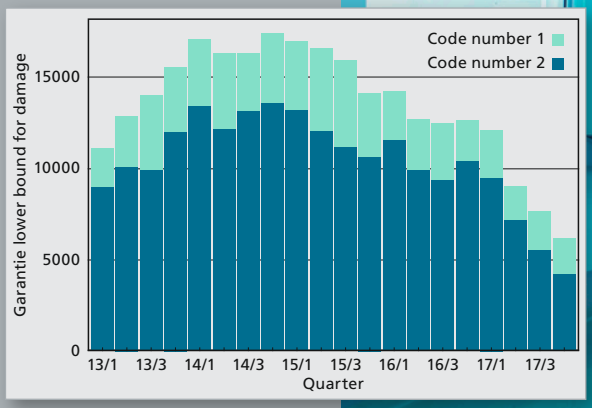
Identifying anomaly types – developing efficient algorithms

Our software lets us define various anomaly types tailored for the actual use case. In almost all projects, we detect mathematically simple anomalies, such as duplicate statements. However, deviations from the Benford distribution are also found and examined. Furthermore, we implemented a number of clustering methods that find, for example, highly deviating invoices in a large set. We also apply machine learning methods to define detection algorithms. In all cases, the development of efficient algorithms is an essential research task in the associated projects.

Software provides optimal support of workflows

The software we develop is optimally adapted for workflows encountered in controlling. Multiple users such as administrators, employees, and team leaders can work at the same time. The anomalies detected by the software can be viewed by all users who, if required, can check the underlying files or procedures to classify the anomaly according to severity or amount of damage. The users comment on or classify each stage of an anomaly, while a revision proof history of all work on an anomaly is maintained.

Lastly, our software approach permits a structured assessment of the data, for example, sorting and filtering as well as supporting an Excel export of all data and results.



1

DAMAGE EXTRAPOLATION AND SAMPLE SIZE DETERMINATION IN THE HEALTHCARE SECTOR

1 *Example of a calculated warranty loss over an observation period of 20 quarters, based on two performance figures considered*

Investigating authorities and health insurance companies note time and again incorrect or implausible invoices for nursing services and contract physicians. We use statistical extrapolation to assist them in reaching a more efficient settlement.

The common phenomenon of fraud has recently received more attention in the media, especially, in the healthcare sector. Furthermore, there even appear to be connections to organized crime for some eastern European care services. Since May 30, 2016, a law to combat corruption (StGB § 299a, § 299b, SGB V § 197a), has made bribery and corruption illegal in the health services industry.

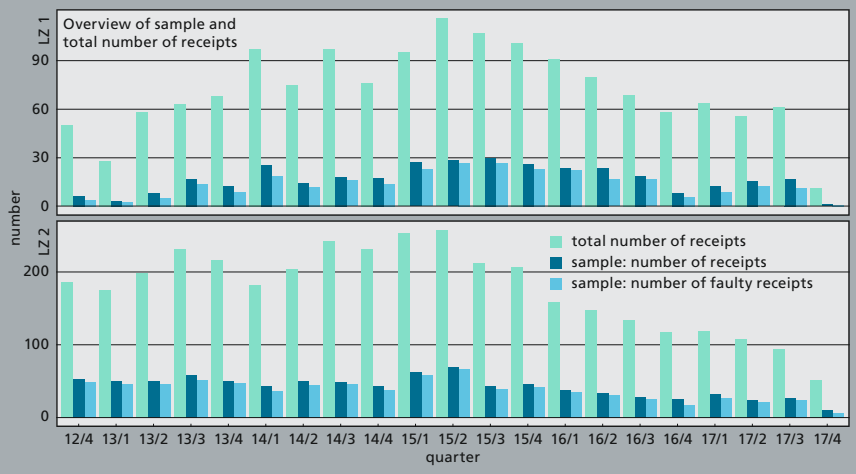
Example: Home care billing fraud

At the same time, the public insurance and law enforcement agencies experience great difficulties in investigating conspicuous cases. This is especially true in suspected fraud cases concerning home care. It is very costly to check all of the individually billed services for correctness while, at the same time, difficult to undoubtedly prove the faultiness of a single bill. This is due to the special situations in outpatient care (possibly demented patients, many "small" services).

To avoid a review of all services, we determine on behalf of the investigating authorities a so-called "guaranteed damage" as a lower limit for the total damage due to the billing fraud. For this, we take a statistical sample from the whole set of billed services. Only this much smaller number of claims is evaluated by the investigating authorities.

On this basis of a few claims, taking into account the resulting statistical uncertainty, we determine a lower bound to extend to the whole population. Only with a very low probability of error will the true total damage lie below this predetermined bound. Our procedure is legally established in court for cases of medical billing fraud. Usually, a confidence interval of 99.5 percent is used. Then on average, only one in 200 cases is below the calculated guaranteed damage.

The greater the statistical uncertainty (quantified by the safety margin) is, the lower the guaranteed bound for the damage becomes. This margin significantly depends, among other things, on the size of the survey sample. At the same time, sample size is one of the few factors that can be directly influenced by the investigative authorities prior to conducting the survey.



2

Consequently, we often perform a sample size determination before conducting the survey. A minimum sample size is determined in such a way that a meaningful guaranteed damage can be calculated for the vast majority of possible realizations of the sample.

New method enables faster billing review

We always take into account the specific structure of the invoices. Nurse and physician cases differ in the choice of a meaningful sample unit. A new method, developed in close cooperation with the investigating authorities, makes it possible to check invoices dealing with nursing care much faster. The period for which services are billed is important for the legal proceedings. Our method also covers this necessary periodization of the claim.

The approach can be used both in home care cases (SGB V and SGB XI) and in medical billing fraud cases (in-patient and out-patient). In particular cases, we specifically adapt the statistical methodology, for example, for very small rates of faulty claims, for cases of clearly observable varying rates, or for smaller but more expensive billing populations.

Our calculation of a guaranteed damage gives investigative agencies the ability to track cases involving a number of small individual claims that cannot be fully investigated simply because of the lack of time and staff. Because of our additional optimization of the number of cases prior to the sample survey, we are able to provide substantial relief to the investigative resources of the authorities. In some cases, an investigator only works one month on a review that used to take up to twelve months to complete.

2 *Example of a settlement profile for a population and the number of claims for a sample that has actually been checked; in light blue, the receipts objected to in this sample.*

NEWS

NEW FACES AND NEW PRODUCTS

The Financial Mathematics department continued to expand in 2017. Four new employees were hired to meet the growing demands of our project work.

This year again the main task of our department was the classification of pension rates for the Pension Product Information Center (PIA). In addition, we successfully marketed two new software packages: the ALMSim Path Generator and the redesigned anomaly detection software. A marketable software product is now available in all three of the department's priority research areas.

The Fraunhofer internal WISA for "Risk management for Insurance Companies" was also successfully completed. Several new customers were acquired, for example, BMW Bank with a project aimed at forecasting the residual value of leased vehicles.

TALENTA PROGRAM – FINANCIAL AID FOR RESEARCH CAREERS

Two staff members, Ria Grindel and Dr. Elisabeth Leoff, were accepted into the Fraunhofer-Gesellschaft TALENTA program. Both appreciate this support at the start of the careers and to further their career planning in applied research. Our department's mathematical competence was also emphasized by several scientific publications and completed doctorates in 2017.

OUTLOOK 2018

Our proposals for major research projects for 2018 in the priority areas of data science and the energy economy were successful. We plan to develop new methods for forecasting time series and to introduce our expertise in the field of machine learning in "ML4P" (Machine Learning for Production), a Fraunhofer showcase project.

The "ENets" project (Stochastic modeling and control of the power grids of the future) combines innovative models for the energy market with the modeling of electrical and gas grids. This project is sponsored by the German Federal Ministry of Education and Research (BMBF).

Front, left to right: Ria Grindel, Franziska Diez, Simon Schnürch, Dr. Andreas Wagner, Philipp Mahler, Prilly Oktoviany, Dr. Elisabeth Leoff, Wieger Hinderks, Christian Laudagé, Prof. Dr. Ralf Korn, Dr. Büşra Temoçin, Dr. Robert Knobloch, Robert Sicks, Dr. Jörg Wenzel, Dr. Johannes Leitner, Dr. Roman Horsky

MATHEMATICAL METHODS IN DYNAMICS AND DURABILITY

Excavators and wheel loaders move many cubic metres of various materials. For many years we have been helping Volvo optimize durability, energy efficiency and human-machine interaction with simulation software and services. Our DEM simulation software GRAPE and the driving simulator RODOS®, which Volvo has been using regularly for years to develop advanced assistance systems, play a special role here.

DR. KLAUS DRESSLER
HEAD OF DEPARTMENT

SIMULATION TECHNOLOGIES FOR VEHICLE ENGINEERING

Usage variability modelling for vehicle design reaches a whole new level with efficient data- and physics-based methods for durability, reliability, and energy efficiency. The VMC® and USim products developed in the "Virtual Measurement Campaign" combine statistical and simulation approaches with geo-referenced databases. Appropriately, we focus our system simulation activities on vehicle-environment-human interaction. We develop tire simulation models, surface-interaction models, and methods of invariant system excitation. Our robot-assisted RODOS® driving simulator enables advanced studies of driver-vehicle-interaction and the development of tools for driver assistance systems (ADAS – advanced driver assistance systems).

The mathematical modelling and simulation of highly deformable structures is the basis of our simulation tools CDTire (for tires) and IPS Cable Simulation (for cable and hoses). CDTire enables the efficient simulation of tires for use in the optimization of driving dynamics, operating loads, and vehicle comfort. IPS Cable Simulation is used for cables and hoses: The virtual design, optimization, and the validation of assembly and operation are supported by interactive simulation.

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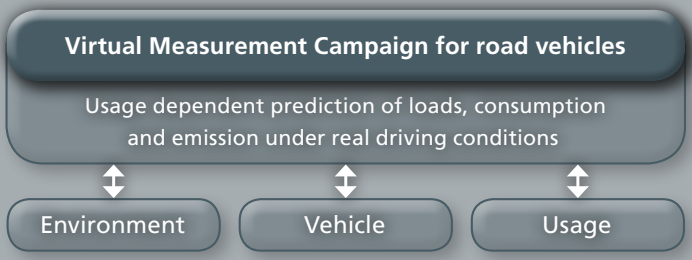
MAIN TOPICS

- Usage Variability and Loading Statistics
- Durability and Reliability
- System Simulation
- Human-in-the-Loop Driving Simulator RODOS®
- Nonlinear Structural Mechanics
- Tire Models – CDTire



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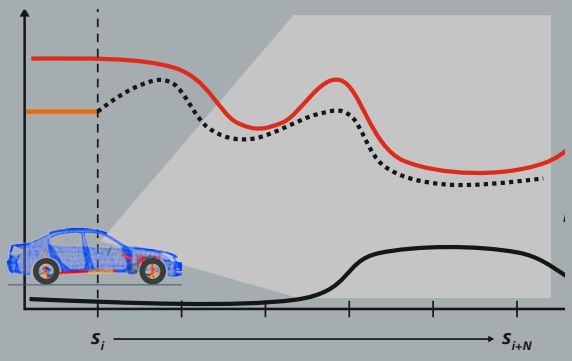


2

VMC® SIMULATION – REPRESENTATIVE PREDICTION OF LOADS AND ENERGY CONSUMPTION

1 *Main components of the Software-Suite VMC®*

2 *Route-, vehicle- and driver-specific calculation of speed profiles*

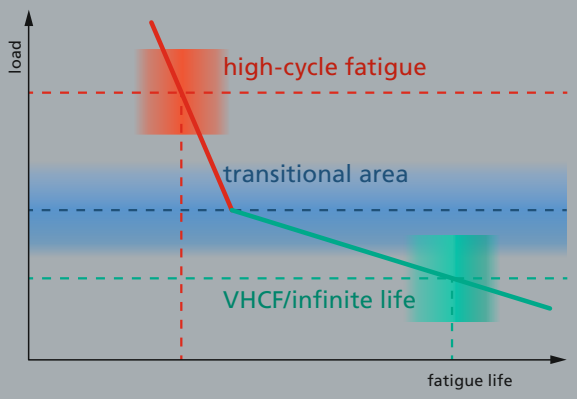
For many years, we have been working on the integration and use of global geo-referenced data in the vehicle development process. This has led to the development of the software suite Virtual Measurement Campaign VMC®. Its fundamental objective is to efficiently analyze the strongly varying usage variability and the resulting variations in the loads and performance requirements. This opens the possibility to take those results into account even at an early stage in the design process.

Most recently, we have designed and implemented several substantial innovations, particularly in the module VMC® Simulation. VMC® Simulation uses a model of the world in which, among others, the worldwide road network, altitude profiles and traffic signs are available. We use simplified vehicle models to predict simulation-based driver- and vehicle-specific loads, energy requirements or vehicle consumption. After defining one or more routes and defining driver and vehicle characteristics, a speed profile is computed by an optimal control approach, from which longitudinal and lateral loads, driving resistances, energy requirements or consumption can be derived.

The results are used, e. g., in the fields of durability and powertrain development, but also in the context of real vehicle consumption and emission determination, to derive customer- and usage-specific reference routes.

New developments with MAN

In projects with MAN Truck & Bus AG, we have implemented improved powertrain models, which allow predictive statements about engine torque, speed and gear distributions on selected routes or in certain regions of the world. Furthermore, we have developed a new algorithm that selects a set of routes and road segments, which are representative for a region with respect to certain criteria (e. g. occuring slopes). In a next step, a route of specified length can be chosen, which is as representative as possible and which can also be actually driven by a real vehicle (campaign planning).



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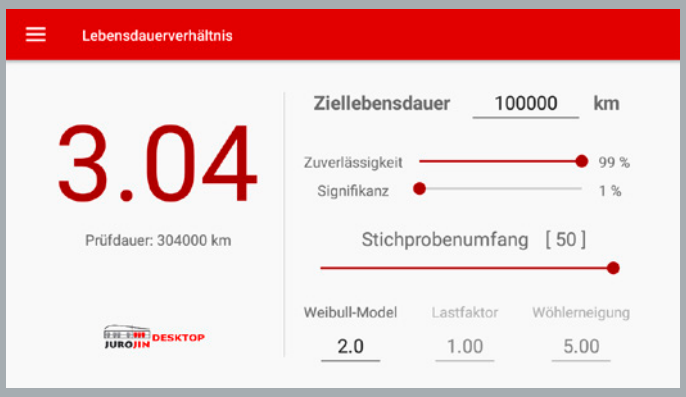


2

JUROJIN – STATISTICAL EVALUATION OF FATIGUE TESTS

Our statistics program JUROJIN supports the planning and evaluation of durability tests. Methodology and program structure are based on projects and practical application cases with car and commercial vehicle industry. A number of vehicle manufacturers and suppliers are using JUROJIN to solve typical tasks quickly and efficiently.

1 *Combined Wöhler model*

2 *Screenshot of the test planning in Jurojin Mobile*

Before components enter production only few and expensive prototypes are available for reliability demonstration. Especially for safety relevant components, this demonstration is crucial.

Reliabilty estimation is expensive

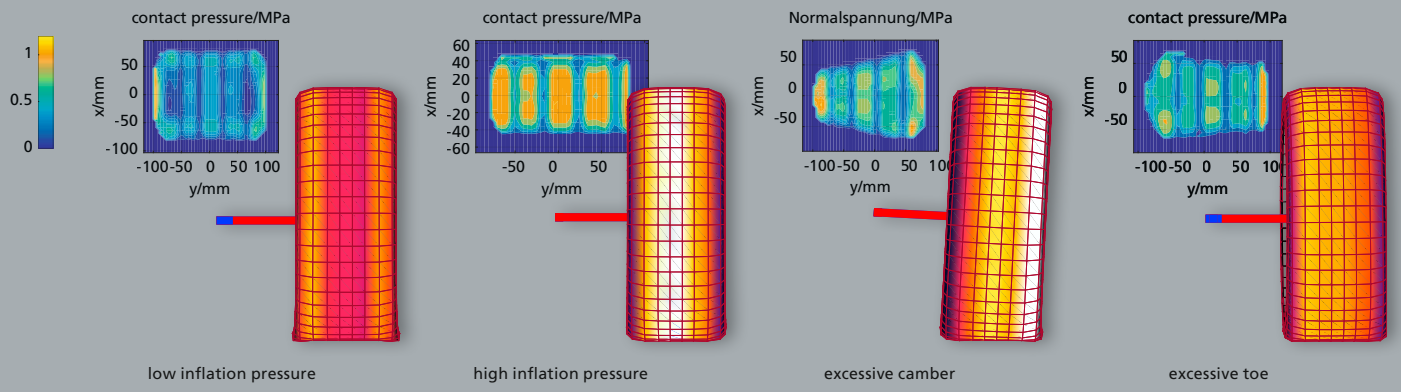
Several typical questions arise: How many prototypes need to be tested? At what test duration? Either many short or few long tests? To evaluate the test results one has to deal with small sample sizes and censored data (i. e. tests without failure).

JUROJIN answers these questions by improving well-tried methods like Maximum Likelihood, depiction in probability papers and Success Runs. Bootstrap algorithms compensate errors from small sizes and utilize all information from censored data. In 2017 we made the module "Design of Test Schedules" available for the Android plattform. Next to the extensive desktop suite there ist now a lean mobile solution answering the questions above.

Efficient Woehler Models

For cyclic loads with medium to high amplitudes, the relationship between load amplitude and fatigue strength (S-N-curve) is often observed to be linear in a double-logarithmic diagram. For lower amplitudes, a nearly horizontal curve is typical. In this range loads may theoretically be applied "infinitely often" (more than one million repetitions). Traditionally, regression in load direction is performed based on the information {component fails/component is durable} to identify the endurance strength.

The fact that fatigue and endurance strength are evaluated separately leads to information loss. Driven by industrial cooperation projects we developed a new stochastic model that allows joint identification of high-cycle fatigue and infinite life or very-high-cycle fatigue behavior.



1

TIRE SIMULATION IN THE FIELD OF TENSION BETWEEN DRIVING DYNAMICS AND TIRE ABRASION

1 *Tire abrasion with different chassis configurations*

Tires play an increasingly important role in the development process for a new vehicle. This is particularly true in the area of driving dynamics. In recent years, enormous progress has been made through the development of new axle concepts, but also through the symbiotic integration of tire development in the chassis development process.

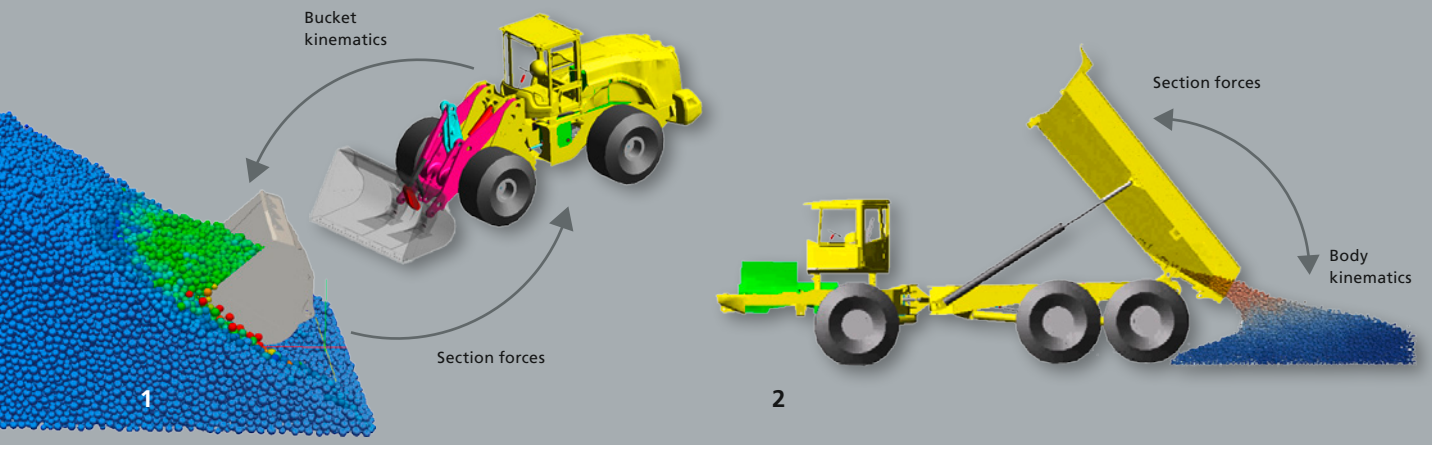
A very good example of the tire/chassis symbiosis is the simultaneous optimization of the vehicle's driving dynamics properties and the resulting tire wear which is caused by the friction of the tire on the road surface. In rolling contact with the tire, this friction can never be completely avoided, even when the tire is rolling freely.

Low abrasion typically has a negative effect on the tire's steering and braking properties. Efforts are therefore being made to optimize both abrasion and steering properties simultaneously and to ensure that the abrasion progresses evenly across the tire width. Toe-in and camber adjustments of the wheel in particular promote uneven tyre wear. But the right choice of tire pressure also has a decisive influence on abrasion. The optimization of the steering properties alone via camber and toe-in can certainly contradict the optimal abrasion behavior.

Structural tire model

In order to find an optimal solution in this area of tension, full vehicle simulations are increasingly used in the early vehicle development phase. Our structural tire model CDTire/3D offers all necessary characteristics to consider the tire in this pocess. It not only calculates the local tire wear, but also analyses the contact area of the tire in all maneuvers relevant to driving dynamics, also depending on tire pressure.

On the one hand, this allows chassis settings to be optimized for both tire abrasion and driving dynamics characteristics, and on the other hand it supports the selection of the optimum tire dimension.



SOIL MODEL GRAPE IN THE VIRTUAL PRODUCT DEVELOPMENT OF VOLVO CONSTRUCTION EQUIPMENT

We have cooperated with Volvo Construction Equipment for more than three years. Within this period, we have integrated our software GRAPE (GRAnular Physics Engine) for particle simulation into Volvo's virtual product development process and continuously promoted the implementation.

1 *Simulation of soil and wheel loader model interaction when charging the bucket*

2 *Simulation of gravel and hauler model interaction when discharging the body*

GRAPE makes it possible to represent soft soil and gravel with realistic material properties on the computer. GRAPE's core functionality is to represent the interaction with a virtual vehicle or machine and predict the corresponding reaction forces from the soil or pile on the machine adequately.

Implementation of a force-displacement-coupling

In close cooperation, we have implemented a force-displacement-coupling between multibody models of Volvo's construction machines and GRAPE material models by means of a co-simulation scheme. Within this simulation environment, Volvo's wheel loader model, for instance, can approach a virtual gravel pile and we obtain the respective forces acting on bushings and joints in the lifting framework when filling the bucket.

Simulation of typical development cycles

Due to our software's performance, we are able to simulate typical development cycles of such maneuvers like charging and discharging of a wheel loader bucket within an appropriate simulation time. Hence, we can particularly predict durability properties and damage of important components, which are essential for the wheel loader's development process.

Furthermore, Volvo simulates the discharging of granular material from an articulated hauler with the help of GRAPE. While discharging the vehicle when lifting the body, forces are acting on axles and tires because of the material flow. These forces can now be predicted and we can draw important conclusions on the development process.

SUCCESS STORY

VEHICLE, ENVIRONMENT, BEHAVIOUR: REAL-TIME SIMULATION

"We see enormous potential in the interactive simulation with RODOS for construction machinery and commercial vehicles, in order to sustainably and profitably expand our development and testing activities in Konz."

Martin Frank
AE Program Leader Machine Intelligence & User Experience

Possibilities and requirements for simulation in vehicle engineering have increased considerably over the last 30 years. From component simulation to system simulation of entire vehicles, additional consideration is now given to the driver and the environment. REDAR and RODOS® support these new challenges in the engineering process, starting with three-dimensional environment acquisition up to test drives in the driving simulator.

Where do we get the environmental data?

The REDAR measuring vehicle (Road&Environmental Data Acquisition Rover) uses two 360-degree laser scanners to record its environment with high accuracy at normal driving speed. As a result of the measurement, a three-dimensional image of the environment in the form of a point cloud is obtained. Data volumes of several terabytes are not unusual. One possible application is, for example, the realistic 3D environment representation in a driving simulator. The greatest challenges are setting up such a complex measuring system and developing suitable algorithms to consistently process the data. The measurement vehicle has been in service, busily collecting data for individual customer projects, since 2015.

What happens to the data?

ITWM's driving simulator RODOS® (RObot based Driving and Operation Simulator) processes the measurement data from REDAR as input for simulation and visualization. Various cabins equipped with control elements like the steering wheel, gas pedal, and brakes can be mounted on the six-axis robot. When navigating interactively through the virtual world, the robot moves the cabin in a way that corresponds to the feelings of acceleration, braking, or taking tight curves normally felt by the driver. The optimization of the perception of reality, currently is the subject of a dissertation in psychology.

The road network as the database

The simulations are supported with information from the Virtual Measurement Campaign VMC® database system. The world's road network with its topography, regulations, weather information and other geo-referenced data is stored there. With the help of special statistical methods, the scenarios that are considered important and representative can be filtered out for more detailed investigations with REDAR and RODOS®. Linking these two worlds is a major step in determining efficient and targeted test scenarios for road vehicle design. The current state of research focuses on the definition of reference routes and the search for the ideal testing environment: for example, is there a real city somewhere that has a representative mix of the major test parameters for various cities or even for all urban scenarios?

On the move with REDAR: 360-degree laser scanners detect the environment with high accuracy.

In addition to virtual testing of driver assistance or autonomous systems, this development environment also allows an efficient and flexible investigation of fuel consumption and emissions: A wide variety of test scenarios can be categorized, weighted and realistically compared. VMC®, REDAR and RODOS® represent a flexible and universally applicable tool chain to describe the interaction between humans, vehicle and environment.

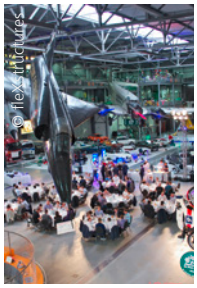
RODOS® technical data

- Design and construction time: 2009 – 2012
- 18 projectors for all-round visibility in the projection dome (diameter: 10 meters)
- Resolution: 11520 × 3600 Pixels
- Six-axis industrial robot enables wide field of maneuver and large tilt angle
- Interchangeable cabins (currently: excavators, cars, tractors)
- Payload: 1000 kg

NEWS

WORLDWIDE INTEREST IN IPS CABLE SIMULATION

Cables and hoses are omnipresent in modern technical products. To optimize the assembly of these highly flexible components in early stages of product development, simulation is used. The Software IPS Cable Simulation, developed in cooperation with the Fraunhofer-Chalmers Centre, is the leading tool for this task and the user group is continually growing. Our spin-off fleXstructures GmbH takes care of the distribution of the software. In the past year alone, 25 new customers could be convinced of our software solution.



3. International IPS Cable Simulation User Conference in Speyer
IPS users from all over the world met in June 2017 at the third IPS Cable Simulation User Conference in the Technik Museum Speyer. Over 90 participants from USA, Asia and Europe stimulated interesting discussions. Contributions from Adam Opel, BMW, Delphi, fleXstructures, Fraunhofer ITWM, Fraunhofer-Chalmers Centre, Komatsu, SCANIA, techViz, Volkswagen and Volvo Cars gave an insight on new applications, requirements and developments from industry and research.

An announcement from BMW illustrates the increasing acceptance of IPS Cable Simulation: at their 100th anniversary, the car manufacturer exhibits 100 IPS Cable Simulation users.

Independent Conferences in China and Japan
The second Chinese IPS Technology Conference took place in Shanghai. About 80 participants from automotive and supply industry, aerospace, rail vehicle industry and research attended the event. Our Chinese distribution partner Pan-i successfully organized this conference.

More than 100 participants from different industries attended the second Japanese IPS Cable Simulation User Conference in Tokyo, organized by our Japanese distribution partner SCSK. With great interest, the participants listened to presentations from SCSK and industrial applications from Japanese customers.

Front, left to right: Vanessa Dörlich, Francesco Calabrese, Christine Biedinger, Dr.-Ing. Michael Roller, Dr. Klaus Dreßler, Caroline Wasser, Dr.-Ing. Joachim Linn, Dr. Michael Burger, Dr. Jochen Fiedler, Eduardo Pena Vina, Tim Rothmann, René Reinhard, Hannes Christiansen, Dr. Andrey Gizatullin, Dr. Fabio Schneider, Dr.-Ing. Michael Kleer, Steffen Polanski, Björn Wagner, Thomas Halfmann, Thomas Stephan, Christoph Mühlbach, Thorsten Weyh, Christine Rauch, Dr. Michael Speckert, Dr. Sascha Feth, Axel Gallrein, Dr. Stefan Steidel, Thomas Jung, Simon Gottschalk

COMPETENCE CENTER HIGH PERFORMANCE COMPUTING

The Chair of Scientific Computing at the University of Kaiserslautern – partner at the Performance Center Simulation- and Software-Based Innovation – and CC HPC are working on behalf of MTU Aero Engines AG to improve and accelerate the design software for engine optimization. The core of our contribution is the software GPI-Space, that helps to realize “Memory Driven Computing” architectures.

DR. FRANZ-JOSEF PFREUNDT
HEAD OF DEPARTMENT

INNOVATION, DISRUPTION AND INTEGRATIVE THINKING IN THE WORLD OF DISTRIBUTED COMPUTING

The department has developed innovative world-class technologies for solving large data problems, specifically BeeGFS, Pre-Stack PRO and the Global Address Space Programming model (GPI) in addition to the Big Data framework called GPI-Space. In recent years, we have gained international attention by successfully combining these technologies with deep learning methods. At its core, it's always about the scalable automatic parallelization of big data problems. This is based on the concept of "Memory Driven Computing" which combines scalability and performance. In the ALOMA and SafeClouds projects, we are further developing industry-specific solutions based on this technology.

The aim of our involvement in EU-sponsored HPC research is to strengthen European technologies and improve the marketability of European HPC software products. In addition, our goal is to bring together microelectronics development and application development in co-design projects. In the application-specific development of computer hardware we see a way to improve Europe's position in the fast-growing market for HPC/Big Data solutions.

The energy systems of the future will consist of millions of distributed IoT computers. These are used to optimize the self-consumption of PV power, regulate the creation of community grids, control large and small power storage systems and coordinate the energy flow in our power grids. Within our projects technologies and solutions are developed to master this distributed computing world. We are committed to find intelligent solutions that work to advance the energy transition.

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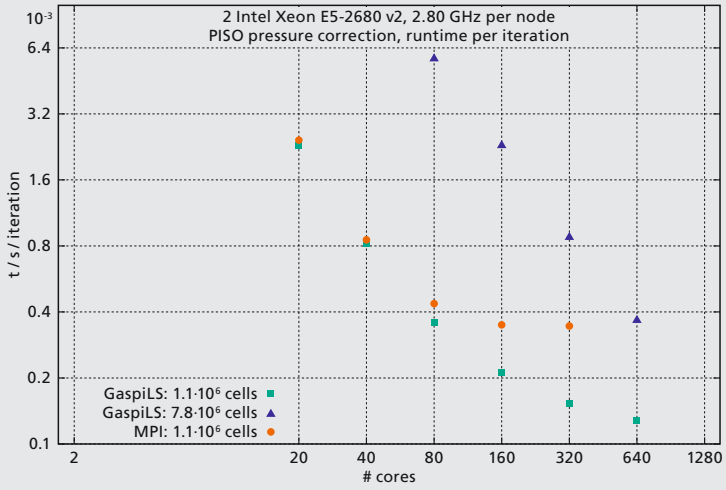
MAIN TOPICS

- Green by IT
- BeeGFS – Parallel Cluster File System
- Visualization
- Seismic Imaging
- Data Analysis and Machine Learning
- Scalable Parallel Programming



1

GaspiLS – SCALABILITY FOR CFD AND FEM SIMULATIONS

1 *Pressure correction computation: GaspiLS (green and blue) has significantly improved performance and scalability in comparison to the MPI based implementation (orange).*

Many simulations in engineering are based on CFD and FEM methods. Examples are the determination of aerodynamic properties of planes or the analysis of the statics of buildings. The vast majority of computation time is spent in the solution of the underlying equations. The performance of the employed iterative solvers has a significant impact on the total run time of these simulations. As such, they also significantly impact the insight which can be generated by those simulations.

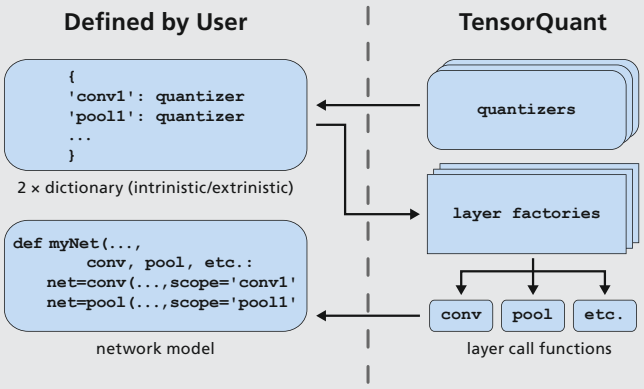
We have developed the linear solver library GaspiLS to gain more insight from the simulations.

Industry uses GaspiLS for better scalability

Scalability measures the parallel efficiency of an implementation. The optimum is the so-called linear scalability. This corresponds to a full utilization of the cores within a single CPU or the CPUs within a cluster, which are interconnected by a network. A better scalability allows to use the compute resources more efficiently which implies a shorter time to gain a solution. Ultimately, better scalability allows for more detailed models, more precise parameter studies and a more cost efficient resource utilization.

Better compute resource utilization

In order to achieve better scalability, GaspiLS uses tools for parallel programming which are developed by our group; these are the communication library GPI-2 and its underlying programming model. The algorithm is split into fine grained sub problems (so-called tasks) with mutual dependencies. This allows for the assignment of executable tasks to free compute resources at any time and guarantees for a continuous stream of compute tasks for every CPU. The avoidance of global synchronization points and the huge amount of generated sub problems allows to hide potential communication latencies and to compensate for imbalances in the compute time. Every single core is maximally emploited at any time.



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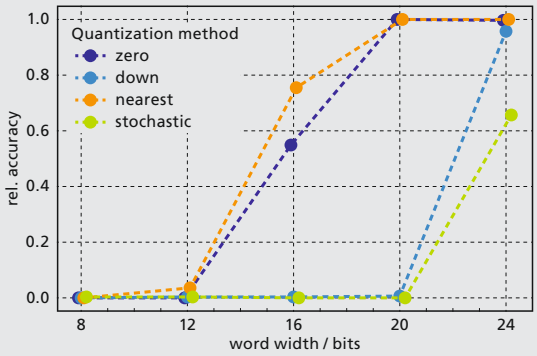


2

TENSORQUANT BRINGS DEEP LEARNING TO MOBILE APPLICATIONS

Machine learning methods are being used more and more in the industrial and service sector. Especially artificial neural networks or Deep Learning (DL) have a high impact on the development of intelligent systems. Research continuously provides new Deep Learning methods, which open a wide range of possibilities for these algorithms in many different practical application scenarios.

However, a significant technological hurdle on the way to such applications in production is the enormous computational effort required to calculate and evaluate the DL models.

This explains why the development of specialized DL hardware has recently come into focus. In the future, new chip and memory architectures will enable the use of high performance hardware components that save energy and, at the same time, expand the use of DL, for example to autonomous vehicles, mobile phones, or integrated production controls.

Learning does not require high precision in numerical processing

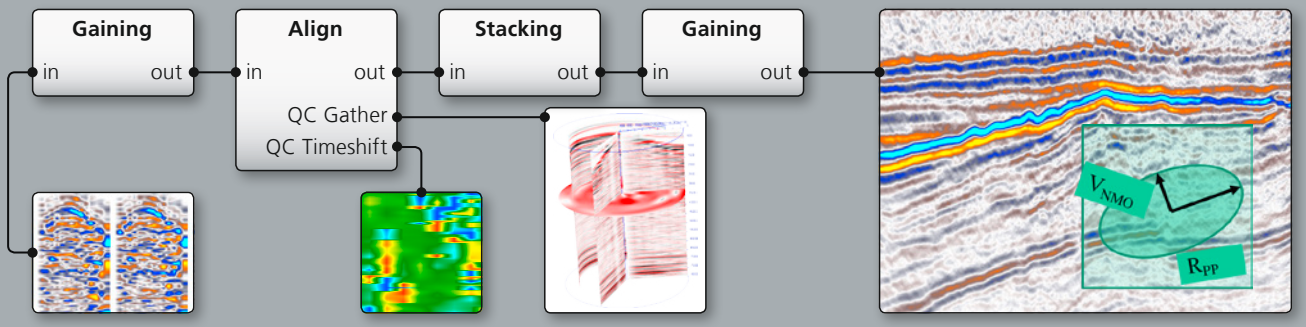
We exploit a mostly mathematical feature of DL: Learning and evaluating models can be reduced to a numerical computation of a small number of operations using tensor-algebra (for example, matrix-multiplications). In addition, tensor calculation works well with much less precision in terms of numerical processing than it is typically the case with physical simulations. In comparison to general computational units such as CPUs and GPUs, these features enable a highly efficient hardware implementation.

TensorQuant allows the emulation of machine learning hardware

In the development of DL applications on specialized hardware, difficulties are encountered as the minimum requirements for computational precision vary significantly between the individual models. As a result, the simultaneous optimization of DL models and hardware is difficult in terms of computational performance, power consumption, and predictive accuracy. Our TensorQuant (TQ) software lets developers identify critical tensor operations and emulate DL models with numerical processing and computing accuracy, which in effect accelerates development. TQ has already been used in collaborative research projects with the automobile industry.

1 *TensorQuant allows the automatic emulation of given TensorFlow models with any number representations of individual tensor operations.*

2 *The evalulation of the well-known ResNet-50 model shows that the concrete choice of the number representation has a considerable influence on the performance of DL applications, which is difficult to estimate in advance without the simulation in TensorQuant.*



1

ALOMA LETS GEOSCIENTISTS FOCUS ON THEIR FIELD OF EXPERTISE

1 *Presentation of a simple workflow with ALOMA: Inbound gatherers are corrected and then stacked. Input and results can be visualized interactively.*

ALOMA lifts the burden of dealing with parallelization, multi-threading, and other challenges in high-performance computing from its users. Instead, the experts for geophysical questions can focus on their area of expertise while ALOMA takes care of efficiently executing their algorithms even on large scale and heterogeneous systems.

The software is a specialized version of GPI-Space which is widely used in fields beyond geophysics such as big data and machine learning.

Complex computations on ever growing amounts of data are characteristic for the geosciences and thus geophysicists are forced to learn about HPC techniques in order to make their software run efficiently on large scale systems. We developed a system that sits in between the geophysicist and the HPC expert. Computer scientists and geophysicists together came up with ideal strategies for parallelization, data partition, and failure tolerance in the context of geophysical applications.

The heart of ALOMA, its failure tolerant runtime system to execute workflows on distributed systems, was then developed by the HPC experts of our group. For its users, the geophysicists and geologists, ALOMA is merely a black box in which they can integrate their latest developments via a well-defined interface. The learning curve for the new approach is easy to manage. Once ALOMA is installed, it takes users not more than a day to port their first module to the new system.

Quick prototype development and scaling

The main benefit of ALOMA is to quickly integrate and test newly developed algorithms and prototypes on production scale real-world problems in no time. Furthermore, existing codes and applications – even in different programming languages such as C/C++, Fortran, Matlab etc. – can be integrated as modules in ALOMA. With a graphical editor, users can combine these modules into workflows and let the software deal with the automatic parallelization and execution.

We were able to prove the feasibility of this concept in various projects with partners in the oil and gas industry, where we managed to make a customer software scale within a few days. The concept is so convincing that a Houston based company has commissioned us with switching over their existing processing software to ALOMA.

1

2

SAFECLOUDS – DISTRIBUTED INFRASTRUCTURE FOR DATA ANALYSIS IN AVIATION

The constantly growing volume of traffic poses major challenges for aviation security organisations, airports and airlines to guarantee the highest possible level of safety. Large amounts of data from various sources such as flight data recorders and radar stations are already being recorded and evaluated.

1 *SafeClouds analyses safety-relevant processes on the ground and in the air.*

2 *Methods of Machine Learning facilitate air traffic management.*

The EU project SafeClouds aims to bring together existing and new data sources in a Europe-wide infrastructure and then efficiently evaluate them using machine learning methods; the aim is to significantly improve air traffic management. A broad consortium consisting of airlines, aviation safety organisations and authorities as well as research institutions is therefore involved in the project.

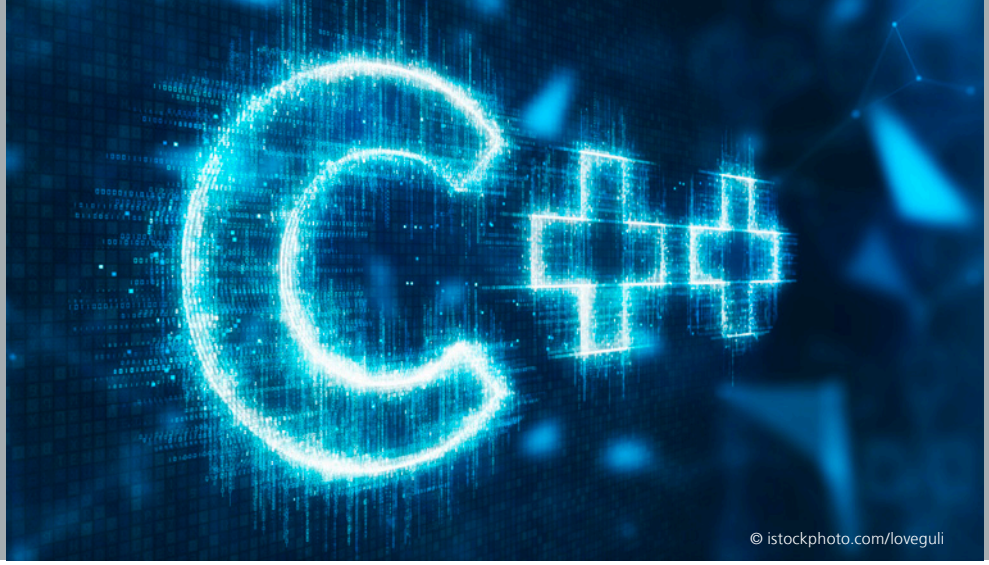
Data exchange with GPI-Space

In CC High Performance Computing, we are building a multi-tier hybrid cloud infrastructure based on Amazon AWS. Our GPI-Space software is available for parallel data processing. The focus is on data and failure safety as well as easy scalability in terms of number of users, memory and computing power.

The data of the following scenarios are analyzed as an example:

- Unstable approach: A predefined range for various parameters such as altitude, speed, sink rate etc. is not maintained and can lead to a hard landing, landing abort or similar.
- Off-road safety warnings: The specified minimum amount was not reached due to geographical conditions.
- AIRPROX (Aircraft Proximity Hazard): Safety has been compromised by the minimum distance between aircraft being undercut.

The runways are also considered: the aim is, of course, their optimum capacity utilisation; in doing so, the exits to the terminals must also be taken into account while maintaining the minimum safety distances.



HIGH PERFORMANCE CONSTRAINT-PROGRAMMING

Increasingly more complex variant configurations (VC) require ever faster algorithms to be able to account for high performance, in-memory platforms like SAP S/4HANA. In a project we are offering C++ consultancy and develop cutting edge constraint solving technology and novel algorithms for SAP.

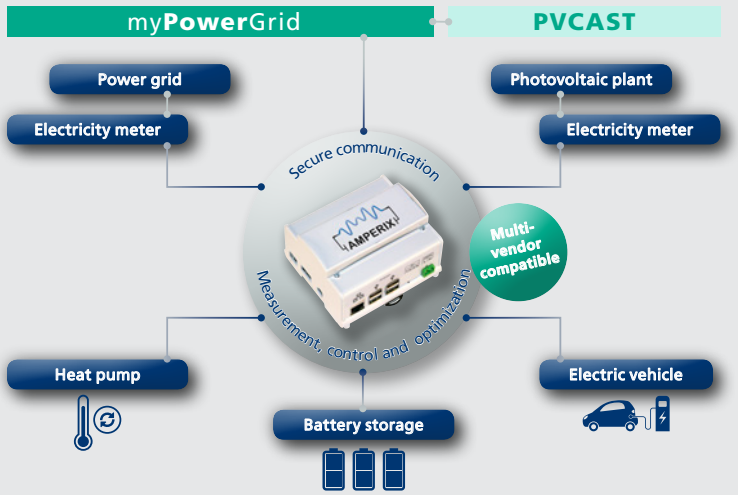
The variant configuration integrated into SAP S/4HANA offers efficient variant configuration for any kind of product lines. It does not matter if the company produces cars or pizzas or aims at merging isolated software products: All kinds of variants are described with a variant model which eventually delivers a product that fits your use case. All variants are supported cross all enterprise processes.

Constraint Solving Backend

To account for the increasing performance and scalability demands the VC Backend is ported to a leading-edge, C++-based Constraint Solving technology. This technology allows the rule-based pruning of variable domains according to the constraint model. For the definition of such models and rules we developed interfaces to be able to specify valid variable domains via variant tables and complex Boolean expressions. Further, we added new types of variables for the processing of strings and highly accurate floating-point numbers.

Challenges

The SAP Variant Configurator is used by many international customers in critical enterprise workflows. We set the highest development standards regarding new algorithms (optimization of memory usage, compute intensity and runtime, correctness) as well as code quality (test driven development, 100% test coverage, code-reviews, continues integration on multiple platforms and compiler combinations, fuzzy testing) to be able to guarantee scalability and robustness of our solutions.



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AMPERIX – A CENTRAL ENERGY HUB

The Amperix energy management system optimizes the operation of battery storage systems, heat pumps, and electric vehicle charging stations by providing an energy hub for home and industrial use. In conjunction with the myPowerGrid platform, it paves the way for new business models.

The Amperix records all energy flows in the household and serves as an aid for control decisions. This includes generation as well as grid demand and feed-in, while taking into account larger consumers such as heat pumps and electric vehicles. An intuitive presentation make the energy flows completely transparent for the user.

Sector coupling of electricity, heat, and electro-mobility

Initial development of the Amperix focused on battery storage systems. The evaluation of pilot installations, however, showed that a significant energy surplus occurs in the summer months despite the battery storage. Today, this surplus can, for example, heat a hot water buffer with a heat pump, or charge electric vehicles with solar power. Sector coupling of electricity, heat, and electromobility holds considerable potential for increasing the supply of locally generated energy.

Forecast-based control

Alongside the intelligent analysis of current measurement data, the Amperix also processes yield forecasts for rooftop photovoltaic systems, as well as load forecasts for household and heat pump consumption – while simultaneously factoring in the residents' wishes as to when the electric vehicle should be charged up for departure. These forecasts allow for a better use of available flexibility in the home.

Manufacturer-independent and scalable

The Amperix is vender-independent and compatible with common products. New components easily fit in the existing infrastructure. In addition, the Amperix not only reliably controls home storage devices, but also large industrial storage systems. The Amperix enables the aggregation of different systems in an internet platform, which fosters the implementation of new business models by facilitating the visualization and management of customer systems as well as the creation of virtual, large-scale battery systems.

1 *The Amperix is connected to energy meters and controllable devices on-site and to the myPowerGrid platform securely over the Internet. Intelligent control algorithms enable optimized operation of all connected devices.*

NEWS

INSECURE CHARGING INFRASTRUCTURE AT CHARGING STATIONS

Mathias Dalheimer's presentation at the annual conference of the CCC in Leipzig was very well received by the media - his topic: Safety problems at charging stations. Some loading cards are unsafe and make it possible to load on someone else's account. The weak point is the identification number; it is publicly available and can be copied at will. Communication between the charging stations and the billing back-end is also poorly protected. With little technical effort, this communication can be intercepted and the card numbers of customers can be obtained. The first shop network operators have confirmed the weak points and are taking the first steps after the great media response. A consortium of experts is also planned to systematically tackle these problems.

NEW BMBF PROJECT ON DEEP LEARNING

Hardly any other field has developed as rapidly and successfully in recent years as Machine Learning, which also includes Deep Learning. However, this procedure, which has been successful for many practical applications, requires enormous computing effort and a great deal of training data. This is why methods and infrastructures must be developed to ensure the practical predictability of increasingly complex neural networks in the future. The BMBF has been funding this since the end of 2017 in the project High Performance Deep Learning Framework – software environment for the efficient design of deep neural networks on high-performance computers with a total of 2 million euros. The project, which will run for three years, is coordinated at the Competence Center High Performance Computing.

EUROPEAN MICROPROCESSOR EPI

Together with Fraunhofer IIS, we are part of the consortium that will develop a European microprocessor by 2021. The European Processor Initiative (www.european-processor-initiative.org) focuses on high-performance computing for next generation supercomputers and embedded processing in the automotive sector. Supported by the European Union, the project is to unite competences in the field of chip development and make the EU more independent of non-European competitors in the future. The framework agreement was signed at the end of last year and development work is expected to begin in fall 2018.

Front, left to right: Farooq Arshad, Dr. Dimitar Stoyanov, Dominik Loroch, Dr. Tiberiu Rotaru, Dr. Rui Machado, Dr. Franz-Josef Pfreundt, Patrick Reh, Dr. Martin Kühn, Dr. Matthias Balzer, Dr. Abel Amirbekyan, Adrien Roussel, Frauke Santacruz, Tina Hill, Dr. Khawar Ashfaq Ahmed, Dr. Norman Ettrich, Matthias Klein, Tobias Götz, Matthias Deller, Christian Mohrbacher, Phoebe Buckheister, Bernd Lörwald, Lukas Ristau, Dr. Jens Krüger, Delger Lhamsuren, Bernd Lietzow, Thomas Olszamowski, Julius Roob, Dr. Valeria Bartsch, Dr. Mirko Rahn, Dr. Alexander Janot, Dr. Dominik Straßel, Dr. Peter Labus, Kai Krüger, Dr. Daniel Grünewald, Javad Fadaie Ghotbi, Dr. Alexander Klauer, Raju Ram, Dr. Dirk Merten

CENTER MATERIALS CHARACTERIZATION AND TESTING

Behind the aircraft nose made of composite material - the radome - is the radar unit. A millimeter-wave terahertz system developed by our institute checks every single radome in the MEGGITT company for defects.

PROF. DR. GEORG VON FREYMANN
HEAD OF DEPARTMENT

OPTICAL MEASUREMENT TECHNOLOGY – NON-DESTRUCTIVE MEASUREMENT WITH TERAHERTZ AND MILLIMETER WAVES

Contact
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We develop industrial measuring and testing systems for the quality control of composite materials and coatings. The scientists, engineers and technicians fall back on competences from optical system and measurement technology, spectroscopy and the development of crystal and semiconductor components.

The technologies range from optical coherence tomography (OCT) in the visible spectral range to time domain spectroscopy in the terahertz frequency range and electronic system concepts in the millimeter wave range. Our systems are tailor-made for the customer. This includes both the application and the evaluation software, which clearly presents the main target variables. Throughout the entire development process, our customers benefit from our employees' understanding of the process.

In quality control, our systems detect defects in ceramics, plastics or fibre-reinforced composites non-destructively. Particular interest is shown in non-contact coating thickness measurement, for example in painting processes. In addition to OCT, terahertz and millimeter wave measurement technology is an alternative to ultrasonic measurements and X-ray technology: No mechanical contact with the sample is necessary and the radiation energy is non-ionizing. In addition to determining the thickness, our measuring systems also determine the material parameters of the individual layers. Chemometric evaluation methods clearly and reliably identify the composition of the materials.

MAIN TOPICS

- Non-destructive Testing
- Layer Thickness Measurement
- Analysis of Chemicals

1

EXAMINATION OF VERY THIN LAYERS WITH INTERFEROMETRIC IMAGING

1 *Enamelled wire is used for the construction of electric coils and transformers. We measure the layer thickness of the insulating varnish on the wire without contact.*

Coatings often not only enhance aesthetics, but also have functional properties; these include protection against mechanical influences and harmful weather influences or the improvement of the haptics. Coating thickness is therefore of particular importance in industry.

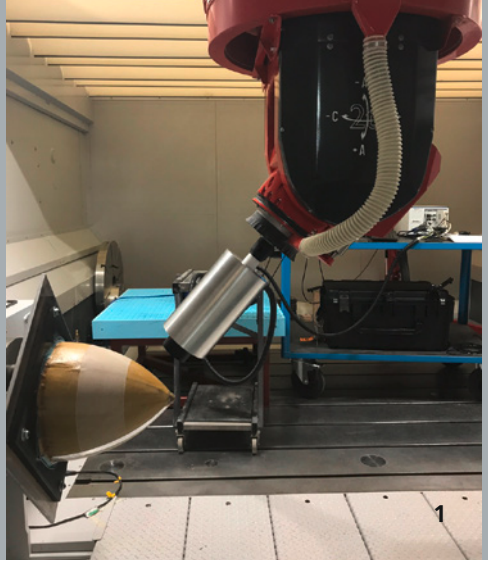
Functional properties require a minimum thickness, unnecessary thick layers waste resources and thus increase production costs. There is now a solution for measuring very thin, semitransparent layers: optical coherence tomography (OCT). This method has been originally developed for the depth-resolved visualization of biological and medical materials. Thanks to intensive research, it has now also established itself outside medicine. High-resolution sample cross-sections, which are generated completely non-destructively in real time with visible or infrared light, make the OCT the ideal non-contact inspection technology for many applications.

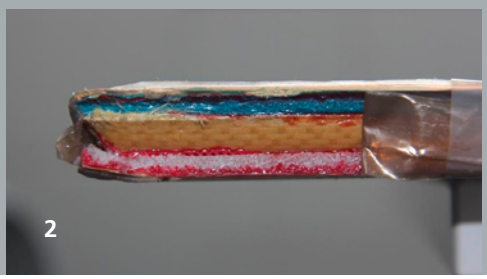
Reflection provides information

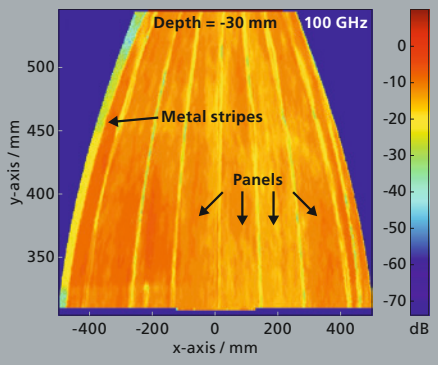
The physical principle behind this method is the interferometric superposition of a light beam, which is reflected from different sample depths, with a reference boundary beam. From the intensity and temporal shift of the reflected beam, the depth information of the sample can be determined mathematically and displayed as a cross-sectional image. The resolution is between 1 and 20 µm, depending on the spectral width. Optical coherence tomography is suitable for all materials that are at least partially transparent to visible or near-infrared light. These are many plastics, composite materials, glasses, ceramics or semiconductor materials.

Inspection of enamelled wire

Enamelled wire, also known as winding wire, is a metal wire coated with an electrically insulating enamel layer during production. The thickness and weight of this lacquer insulation is very low compared to other insulating materials with the same effect. This wire is therefore preferred for the construction of electrical coils, transformers and machines. We successfully use OCT to measure the enamel thickness on copper wires. The thinnest wire had a diameter of 50 µm and a coating thickness of 3 µm.







QUALITY CONTROL IN THE AEROSPACE INDUSTRY: RADOME INSPECTION WITH TERAHERTZ

Imaging with terahertz waves is ideal for the nondestructive inspection of glass-fiber-reinforced composites. Such structures are used, for example, for the radar domes (radomes) of aircraft, among other things to protect sensitive radar technology. Terahertz technology enables contactless testing of structural integrity in the field or during production.

Radar domes must withstand harsh weather conditions and impacts. They are routinely tested in use, but it is important to optimize their structural integrity and transmission properties for radio-signals during manufacture. Previously used testing techniques such as ultrasound procedures and knocking tests can often only be used to a limited extent and if necessary only under special conditions.

Terahertz imaging allows a non-contact and non-destructive examination of the external and internal structure of composite materials at every manufacturing step or even in the field. Furthermore, image-processing methods can be used for the automatic detection of defects or other characteristics.

Spiral scanning of the radome

For the British company Meggitt Polymers & Composites we developed an industrial 3D Terahertz imaging system for the inspection of radar domes. The simple integration of the measuring unit into the company's production plant enables the entire radome, which can be up to two metres long, to be scanned in a spiral.

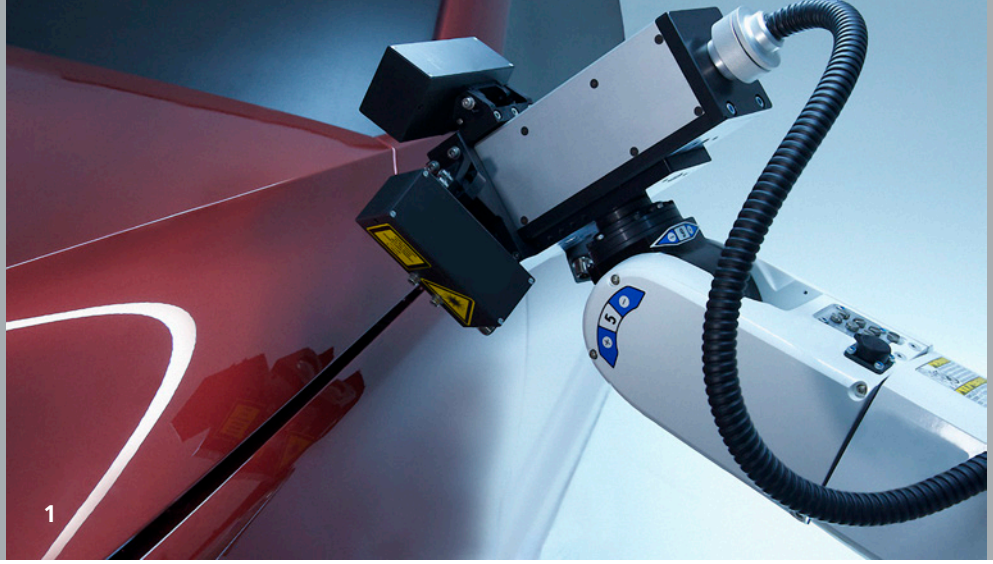
Depending on the type of radome, the thickness and composition of the structure can vary greatly. This has a significant influence on the penetration depth of the terahertz measurement signal. The choice of sensors often requires a compromise between image resolution and penetration depth. We have integrated two different terahertz sensors with adjacent frequency ranges into one measuring system so that both, structures with a few centimeters thickness as well as thinner ones, can be examined with the best possible resolution. For improved depth resolution, the measurement data of both sensors are combined with each other.

1 *Sensor unit in the tool holder of the production machine*

2 *The structure of the radome consists of different layers of different materials (e. g. aramid and foam structures).*

3 *Terahertz measuring unit with connected data connection and power supply*

4 *Reconstructed image of the radome at 100 GHz showing the back of the radome. The elements of the radome can be clearly recognized.*



TERAHERTZ FILM THICKNESS MEASUREMENT FOR THE SELF-PROGRAMMING PAINTING CELL

1 *Robot-guided terahertz measuring head with three positioning sensors for measuring the layer thickness on a car body*

The painting process presents many entrepreneurs with great challenges, as automation and individualization of the products do not yet match when it comes to painting technology. In many industries, well over half of all components are therefore painted by hand - the variety of variants is simply too large.

Programming a painting robot is only worthwhile if numerous identical parts have to be spray-painted. The automatic coating system SelfPaint offers companies a compromise between automation and individualization for the first time - and also offers numerous potential savings: 20 percent less coating, 15 percent less energy, five percent less production time - its advantages over the previously dominant manual coating process are enormous. And for the first time it is also suitable for individual pieces.

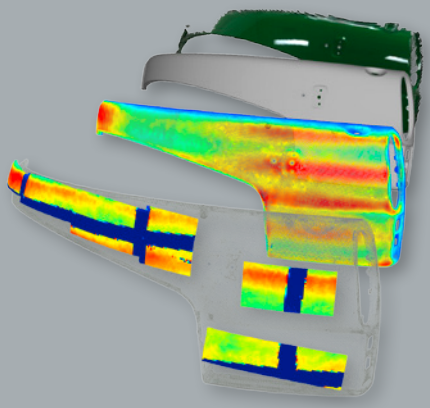
We developed the self-programming painting cell together with the Fraunhofer Institute for Manufacturing Engineering and Automation IPA and the Swedish Fraunhofer-Chalmers Research Centre for Industrial Mathematics FCC.

Algorithms calculate optimal robot path

The automatic painting process consists of five steps. First of all, the component is scanned in three dimensions, whereupon the scan data form the basis for a fluid dynamic simulation. Algorithms simulate the trajectory of the coating particles and determine which coating and air quantities are optimal for the desired coating thickness. In a third step, the system uses this simulation data to determine the best possible robot path for the painting process. Now follows the actual painting process, which is controlled in the last step using terahertz technology. In the project we realize the three-dimensional recording of the component and the terahertz layer thickness measurement.

Three-dimensional object and position detection

In order for the painting cell to know the position of the object for simulation and painting, it must be recorded in three dimensions. However, systems designed for industrial use for 3D object acquisition are usually designed for very precise topographic measurements of unknown objects, which makes them expensive.



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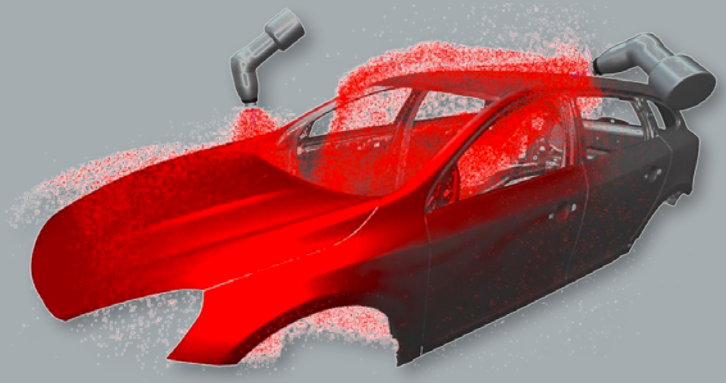


3

© FCC

If object geometry information is a priori available in the form of CAD data, very cost-effective products from the field of consumer electronics can be used. All that is needed here is to determine the position of the components in the room.

The self-programming painting cell uses 3D sensors that were originally developed to control video games - a global mass market. The accuracy of the position detection is more exact than the deviations of common components from the CAD data and is therefore within the manufacturing and positioning tolerances. This high resolution is made possible by tailor-made algorithms for data processing. The pure three-dimensional image, which is captured by the sensor and is available as a point cloud or network, cannot normally be used directly for position detection. However, if filters are used that make use of the imaging properties of the sensor system and automatically remove faulty information from the measurement, the point clouds can be reworked so that they are of high quality. High enough to perform fully automated 3D position detection for paint simulation and painting.

Terahertz technology for quality control

In the final process step of automated painting, the quality is finally checked: Is the thickness of the coating as desired? For this quality-control we use terahertz waves. With this technology developed by us wet and coloured lacquers can be measured without contact. The quality of the paint layers can already be checked during or after the painting process.

The method used enables non-contact measurement of even single layer thicknesses of a multilayer system, which is also used in many painting processes. Substrates – the basis of the coating layers – do not have to be metallic, but can also consist of other materials. The measuring systems for this quality control have reached and proven industrial maturity in recent years.

In everyday painting, everything will soon be automatic: The component is scanned, painted and checked for quality by robots - without the intervention of an employee.

2 *Sequence of the automated painting process (from back to front: 3D recording of the component, adjustment with CAD model, simulation of the painting result, result of the terahertz measurement - blue areas masked for comparison measurements)*

3 *Multiphysical simulation of a high rotation atomizer with contact charging for calculating the droplet trajectory using a Volvo V60 body as an example*

NEWS

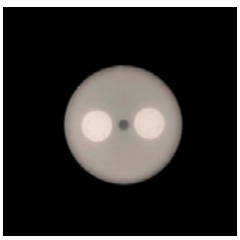
INTELLECTUAL PROPERTY RIGHTS FOR INTERFEROMETRIC DISTANCE CONTROL

The interferometric distance control allows the correction of vibrations that inevitably occur during terahertz layer thickness measurement under industrial conditions. Both the paths within the spectrometer and the distance to the sample to be measured (e. g. a car body) are measured quasi in real-time in order to determine correction values for the layer thickness measurement. Especially for the measurement of industrially relevant thin films (< 20 µm), this method is indispensable for the determination of error-free measured values. We hold the industrial property rights for both correction procedures.

THE SLAPCOPS LASER – A NEW LIGHT SOURCE FOR TERAHERTZ TIME DOMAIN SPECTROSCOPY

For terahertz time-domain spectroscopy, two variable delayed laser pulses are required in order to be able to scan the measurement signal in a time-resolved manner. The time delay is usually provided by a mechanical displacement unit. Newer approaches use two laser sources that either operate with slightly detuned repetition frequencies or also actively control the repetition rate of one laser. Disadvantage of the mechanical control is the inertia and vibration susceptibility of the systems, disadvantage of the approaches based on two lasers are the high costs.

We have now developed a laser system that works without a mechanical displacement unit and still uses only one laser. The system emits laser pulses with orthogonal polarization. Each polarization propagates at a different speed, resulting in different repetition rates. A scanning delay can also be realized by a specific detuning of the resonator length for one of the two polarizations. A mechanically robust and at the same time cost-effective process. The intellectual property rights are owned by us and our client Hübner GmbH & Co. KG.



Front, left to right: Jens Klier, Nina Schreiner, Robert Kranz, Dr. Joachim Jonuscheit, Prof. Dr. Georg von Freymann, Claudia Busch-Crolly, Andreas Keil, Ph.D., Christoph Kaiser, Alexander Theis, Dr. Daniel Molter, Ute Rein-Rech, Raphael Hussong, Caroline Cappel, Wladimir Zwetow, Shiva Mohammadzadeh, Oliver Boidol, Dmytro Kharik, Maris Bauer, Sebastian Bachtler

Asprion, N.; Blagov, S.; Böttcher, R.; Schwientek, J.; Burger, J.; Harbou, E. von; Bortz, M.
Simulation and multi-criteria optimization under uncertain model parameters of a cumene process
In: Chemie-Ingenieur-Technik 89 (2017), Nr.5, S.665-674

Asprion, N.; Böttcher, R.; Pack, R.; Stavrou, M.-E.; Höller, J.; Schwientek, J.; Bortz, M.
Greybox models -new opportunities for the optimization of entire processes
In: Espuña, A.: 27th European Symposium on Computer Aided Process Engineering 2017. Pt.A: Held in Barcelona, Spain, 1st to 5th of October, 2017 Amsterdam: Elsevier, 2017, S.97-102 (Computer-aided chemical engineering 40)

Baccouche, B.; Agostini, P.; Mohammadzadeh, S.; Kahl, M.; Weisenstein, C.; Jonuscheit, J.; Keil, A.; Loeffler, T.; Sauer-Greff, W.; Urbansky, R.
Three-dimensional terahertz imaging with sparse multistatic line arrays
In: IEEE Journal of Selected Topics in Quantum Electronics 23 (2017), Nr.4, Art. 8501411, 11 S.

Baccouche, B.; Agostini, P.; Schneider, F.; Sauer-Greff, W.; Urbansky, R.; Friederich, F.
Comparison of digital beamforming algorithms for 3D terahertz imaging with sparse multistatic line arrays
In: Advances in radio science. Online journal 15 (2017), S.283-292

Baccouche, B.; Sauer-Greff, W.; Urbansky, R.; Friedrich, F.
Application of the phase coherence method for imaging with sparse multistatic line arrays
In: Shiroma, W. (Ed.) ; Institute of Electrical and Electronics Engineers: IEEE MTT-S International Microwave Symposium, IMS 2017: 06-08 June 2017, Honolulu, Hawaii Piscataway, NJ: IEEE, 2017, S.1214-1217

Bartsch, V.; Machado, R.; Rahn, M.; Merten, D.; Pfreundt, F.-J.
GASPI/GPI in-memory check pointing library
In: Rivera, F.F.: Euro-Par 2017. Parallel processing. 23rd International Conference on Parallel and Distributed Computing: Santiago de Compostela, Spain, August 28 – September 1, 2017; Proceedings Cham: Springer International Publishing, 2017, S.497-508

Bauer, B.; Cai, X.; Peth, S.; Schladitz, K.; Steidl, G.
Variational-based segmentation of bio-pores in tomographic images
In: Computers and geosciences 98 (2017), S.1-8

Berger, M.; Lindroth, P.; Welke, P.
Rule-based optimization and multicriteria decision support for packaging a truck chassis
In: Engineering optimization 49 (2017), Nr.6, S.1057-1077

Bitsch, G.; Dreßler, K.; Kleer, M.; Pena Vina, E.
Absicherung von Fahrzeugfunktionen unter Berücksichtigung der Umgebung und des Fahrzeugverhaltens
In: Deutscher Verband für Materialforschung und -prüfung e.V., Berlin; Arbeitskreis Betriebsfestigkeit: (R)Evolution des Antriebs -Auswirkung auf die Betriebsfestigkeit der Bauteile in der Wirkungskette: 44. Tagung des Arbeitskreises Betriebsfestigkeit, 11.-12.10.2017, Friedrichshafen Berlin: DVM, 2017, S.31-41 (DVM-Bericht 144)

Björkenstam, S.; Nyström, J.; Carlson, J.; Roller, M.; Linn, J.; Hanson, L.; Högberg, D.; Leyendecker, S.
A framework for motion planning of digital humans using discrete mechanics and optimal control
In: Wischniewski, S. ; Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Dortmund: 5th International Digital Human Modeling Symposium 2017. Proceedings: June 26-28, 2017, Wachtberg Dortmund: BAuA, 2017, S.64-71

Bonacker, Esther; Gibali, Aviv; Küfer, Karl-Heinz; Süss, Philipp
Speedup of lexicographic optimization by superiorization and its applications to cancer radiotherapy treatment
In: Inverse problems 33 (2017), Nr.4, Art. 044012, 20 S.

Borgwardt, Steffen; Loera, Jesús A. de; Finhold, Elisabeth
The diameters of network-flow polytopes satisfy the Hirsch conjecture
In: Mathematical programming. Series A (2017), Online First, 27 S.

Bortz, Michael
Modellierung, Simulation und Optimierung von Prozessen
In: InnoVisions (2017), Nr.3, S.1-3

Burger, Jakob; Asprion, Norbert; Blagov, Sergej; Bortz, Michael
Simple perturbation scheme to consider uncertainty in equations of state for the use in process simulation
In: Journal of Chemical and Engineering Data 62 (2017), Nr.1, S.268-274

Burger, M.; Dreßler, K.; Ekevid, T.; Steidel, S.; Weber, D.
Coupling a DEM material model to multibody construction equipment
In: Valasek, M. ; Czech Technical University, Prag; European Community on Computational Methods in Applied Science -ECCOMAS-: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Conference Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.417-424

Burger, M.; Gerdts, M.
A survey on numerical methods for the simulation of initial value problems with sDAEs
In: ilchmann, A.: Surveys in Differential-Algebraic Equations IV Cham: Springer International Publishing, 2017, S.221-300 (Differential-Algebraic Equations Forum)

Calabrese, F.; Bäcker, M.; Gallrein, A.; Leister, G.
SIMULATION -Simulation of a tire blow-out in a full vehicle scenario
In: Pfeffer, P.E.: 7th International Munich Chassis Symposium 2016: Chassis.tech plus; 14 and 15 June 2016, Munich Wiesbaden: Springer Vieweg, 2017, S.869-898

Calabrese, F.; Ludwig, C.; Bäcker, M.; Gallrein, A.
A study of parameter identification for a thermal-mechanical tire model based on flat track measurements
In: Spiryagin, M. ; International Association for Vehicle System Dynamics: Dynamics of Vehicles on Roads and Tracks. Vol.1: Proceedings of the 25th Intern. Symposium on Dynamics of Vehicles on Roads and Tracks, IAVSD 2017, 14-18 August 2017, Rockhampton, Queensland, Australia Boca Raton, Fla.: CRC Press, 2017, S.156-161 und VDI-Bericht 2296 , pp. 57-75

Cristofani, E.; Friederich, F.; Vandewal, M.; Jonuscheit, J.
Nondestructive testing of aeronautics composite structures using ultrawideband radars
In: Taylor, J.: Advanced ultrawideband radar. Signals, targets, and applications Boca Raton, Fla.: CRC Press, 2017, S.237-270

Damm, T.; Benner, P.; Hauth, J.
Computing the stochastic H∞-norm by a netwon iteration
In: IEEE control systems letters 1 (2017), Nr.1, S.92-97

Desmettre, S.; Grün, S.; Seifried, F.T.
Estimating discrete dividends by no-arbitrage
In: Quantitative finance 17 (2017), Nr.2, S.261-274

Dobrovolskij, D.
Ultraschall-Simulationsverfahren zur Berechnung des Gefügerauschens in polykristallinen Werkstoffen
In: ZfP-Zeitung 154 (2017), S.39-42

Dobrovolskij, D.; Gospodnetic, P.
Umlaufende Inspektion - Robotergestütztes System inspiziert automatisch Oberflächenfehler
In: Qualität und Zuverlässigkeit: QZ (2017), Nr.11, S.52-54

Dörlich, V.; Cesarek, P.; Linn, J.; Diebels, S.
Experimental investigation and numerical modeling of resultant-based bending plasticity in cables
In: Valasek, M. ; Czech Technical University, Prag; European Community on Computational Methods

in Applied Science -ECCOMAS-: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Conference Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.37-46

Dreßler, K.; Stephan, T.
Kabel und Schläuche simulationsgestützt optimieren und absichern: Wie flexibel sind sie?
In: Elektronik automotive (2017), Sonderausgabe Bordnetz 2017, S.14-17

F. Küsters, D. Patil and S. Trenn
Switch observability for a class of inhomogeneous switched DAEs
In: 2017 IEEE 56th Annual Conference on Decision and Control (CDC) December 12-15, 2017, Melbourne, Australia; Pages 3175-3180

F. Küsters, S. Trenn, A. Wirsen
Switch-observer for switched linear systems
2017 IEEE 56th Annual Conference on Decision and Control (CDC), December 12-15, 2017, Melbourne, Australia; Pages 1749 – 1754

Farsadpour, S.; Taghizadeh Ghoochany, L.; Kaiser, C.; Freymann, G. v.
Organische, nicht lineare optische Chromophore
Priorität: DE 102015116293 A1: 20150925

Fischer, T.; Pfetsch, M.E.
Monoidal cut strengthening and generalized mixed-integer rounding for disjunctions and complementarity constraints
In: Operations research letters 45 (2017), Nr.6, S.556-560

Fitschen, J.H.; Losch, K.; Steidl, G.
Unsupervised multi class segmentation of 3D images with intensity inhomogeneities
In: Journal of visual communication and image representation 46 (2017), S.312-323

Fliegener, S.; Kennerknecht, T.; Kabel, M.
Investigations into the damage mechanisms of glass fiber reinforced polypropylene based on micro specimens and precise models of their microstructure
In: Composites. Part B, Engineering 112 (2017), S.327-343

Forte, E.; Harbou, E. v.; Burger, J.; Asprion, N.; Bortz, M.
Optimal design of laboratory and pilot-plant experiments using multiobjective optimization
In: Chemie-Ingenieur-Technik 89 (2017), Nr.5, S.645-654

Foss, S.-K.; Karlsen, E.S.; Mispel, J.; Straith, K.R.; Merten, D.; Ettrich, N.
From seismic reflections to diffractions -case study of interpretation for development of a complex gas reservoir
In: European Association of Geoscientists and Engineers -EAGE-: Energy, technology, sustainability -time to open a new chapter. 79th EAGE Conference and Exhibition 2017. Vol.3: Paris, France, 12-15 June 2017 Red Hook, NY: Curran, 2017, S.2178-2182

Fraunhofer-Institut für Techno-und Wirtschaftsmathematik -ITWM-, Kaiserslautern
Jahresbericht 2016/2017
Kaiserslautern: Fraunhofer ITWM, 2017, 92 S.

Fütterling, V.; Lojewski, C.; Pfreundt, F.-J.; Hamann, B.; Ebert, A.
Accelerated single ray tracing for wide vector units
In: Association for Computing Machinery; Special Interest Group on Computer Graphics and Interactive Techniques -SIGGRAPH-; Europ. Assoc. for Computer Graphics -EUROGRAPHICS-: HPG 2017, High Performance Graphics. Proc.: Los Angeles, California, July 28 -30, 2017 New York: ACM, 2017, Art. 6, 9 S.

Gallrein, A.; Bäcker, M.; Calabrese, F.
Dynamic simulation of the inflation gas of a tire under operational conditions
In: Valasek, M. ; Czech Technical University, Prag; European Community on Computational Methods in Applied Science -ECCOMAS-: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Conference Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.407-416

Gilberg, D.; Klar, A.; Steiner, K.
A hydrodynamic model for granular material flows including segregation effects
In: Radjai, F. ; Association for the Study of Micromechanics of Granular Media: Powders and Grains 2017. 8th International Conference on Micromechanics on Granular Media: Montpellier, France, July 3-7, 2017 Les Ulis: EDP Sciences, 2017, Art. 11008, 4 S. (EPJ Web of Conferences 140)

Göbel, M.; Godehardt, M.; Schladitz, K.
Multi-scale structural analysis of gas diffusion layers
In: Journal of power sources 355 (2017), S.8-17

Godehardt, M.; Schladitz, K.; Dietrich, S.; Meyndt, R.; Schulz, H.
Segmentation of collagen fiber bundles in 3D by waterfall on orientations
In: Angulo, J.: Mathematical morphology and its applications to signal and image processing. 13th international symposium, ISMM 2017: Fontainebleau, France, May 15-17, 2017; Proceedings Cham: Springer International Publishing, 2017, S.447-454 (Lecture Notes in Computer Science 10225)

Goldberg, N.; Ospald, F.; Schneider, M.
A fiber orientation-adapted integration scheme for computing the hyperelastic Tucker average for short fiber reinforced composites
In: Computational mechanics 60 (2017), Nr.4, S.595-611

Gramsch, S., Kontak, M., Michel, V.
Three-dimensional simulation of nonwoven fabrics using a greedy approximation of the distribution of fiber directions
(2017) ZAMM Zeitschrift fur Angewandte Mathematik und Mechanik; DOI: 10.1002/zamm.201600188

Griso, G.; Migunova, Anastasia; Orlik, Julia
Asymptotic analysis for domains separated by a thin layer made of periodic vertical beams
In: Journal of elasticity 128 (2017), Nr.2, S.291-331

Häbel, H.; Rajala, T.; Marucci, M.; Boissier, C.; Schladitz, K.; Redenbach, C.; Särkkä, A.
A three-dimensional anisotropic point process characterization for pharmaceutical coatings
In: Spatial statistics 22 (2017), Pt.2, S.306-320

Haehnle, J.; Süss, P.; Landry, G.; Teichert, K.; Hille, L.; Hofmaier, J.; Nowak, D.; Kamp, F.; Reiner, M.; Thieke, C.; Ganswindt, U.; Belka, C.; Parodi, K.; Küfer, K.-H.; Kurz, C.
A novel method for interactive multi-objective dose-guided patient positioning
In: Physics in medicine and biology 62 (2017), Nr.1, S.165-185

Harbou, E. v.; Ryll, O.; Schrabback, M.; Bortz, M.; Hasse, H.
Reactive distillation in a dividing-wall column: Model development, simulation and error analysis
In: Chemie-Ingenieur-Technik 89 (2017), Nr.10, S.1315-1324

Hauck, M.; Klar, A.; Orlik, J.
Design optimization in periodic structural plates under the constraint of anisotropy
In: Zeitschrift für angewandte Mathematik und Mechanik: ZAMM 97 (2017), Nr.10, S.1220-1235

Heieck, F.; Hermann, F.; Middendorf, P.; Schladitz, K.
Influence of the cover factor of 2D biaxial and triaxial braided carbon composites on their in-plane mechanical properties
In: Composite structures 163 (2017), S.114-122

Hellmann, A.; Rief, S.; Schmidt, K.; Kocaman, R.T.; Aibibu, D.; Cherif, C.; Ripperger, S.; Antonyuk, S.
Simulation der Partikelabscheidung und des Druckverlustes von Schutz-und Filtertextilien bei einer Gasdurchströmung
In: Filtrieren und Separieren: F & S 31 (2017), Nr.4, S.268-274

Hettesheimer, T.; Thielmann, A.; Neef, C.; Möller, K.-C.; Wolter, M.; Lorentz, V.; Gepp, M.; Wenger, M.; Prill, T.; Zausch, J.; Kitzler, P.; Montnacher, J.; Miller, M.; Hagen, M.; Fanz, P.; Tübke, J.

Entwicklungsperspektiven für Zellformate von Lithium-Ionen-Batterien in der Elektromobilität
Pfinztal: Fraunhofer-Allianz Batterien, 2017, 48 S.

Hoffmann, A.; Bortz, M.; Welke, R.; Burger, J.; Küfer, K.-H.; Hasse, H.
Stage-to-stage calculations of distillation columns by fixed-point iteration and application of the Banach fixed-point theorem
In: Chemical Engineering Science 164 (2017), S.188-201

Hoffmann, A.; Küfer, K.-H. (Hrsg.); Biegler, L. T. (Hrsg.)
Integrated simulation and optimization of distillation-based flowsheets
Stuttgart: Fraunhofer Verlag, 2017, XII, 179 S. (Zugl.: Kaiserslautern, TU, Diss., 2016) (ISBN 978-3-8396-1179-1)

Hofmaier, J.; Haehnle, J.; Kurz, C.; Landry, G.; Maihoefer, C.; Schüttrumpf, L.; Süss, P.; Teichert, K.; Söhn, M.; Spahr, N.; Brachmann, C.; Weiler, F.; Thieke, C.; Küfer, K.-H.; Belka, C.; Parodi, K.; Kamp, F.
Multi-criterial patient positioning based on dose recalculation on scatter-corrected CBCT images: Dose guided positioning
In: Radiotherapy & oncology 125 (2017), Nr.3, S.464-469

Hofmaier, J.; Haehnle, J.; Kurz, C.; Landry, G.; Maihöfer, C.; Süss, P.; Teichert, K.; Traulsen, N.; Brachmann, C.; Weiler, F.; Thieke, C.; Küfer, K.-H.; Parodi, K.; Kamp, F.
Multi-criterial patient positioning based on dose recalculation on scatter-corrected CBCT images
In: Radiotherapy & oncology 123 (2017), Supplement 1, S.S257-S25830926-X)

Hofmann, T.; Müller, R.; Andrä, H.
A fast immersed interface method for the Cahn-Hilliard equation with arbitrary boundary conditions in complex domains
In: Computational materials science 140 (2017), S.22-31

Hofmann, Tobias; Andrä, H.; Müller, R.; Zausch, J.
Stress simulation in lithium-ion batteries
In: Scheven, M. von ; German Association for Computational Mechanics -GACM-: 7th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry 2017. Proceedings: 11 -13 Oct. 2017, Stuttgart, Germany Stuttgart: University Stuttgart, 2017, S.432-435

Hübner, F.; Leithäuser, C.; Bazrafshan, B.; Siedow, N.; Vogl, T.J.
Validation of a mathematical model for laser-induced thermotherapy in liver tissue
In: Lasers in medical science 32 (2017), Nr.6, S.1399-1409

Iliev, D.; Iliev, O. (Hrsg.); Margenov, S. (Hrsg.)
Numerical algorithms for fluid interaction with a thin porous structure
Stuttgart: Fraunhofer Verlag, 2017, IX, 97 S. (Zugl.: Kaiserslautern, TU, Diss., 2016) (ISBN 978-3-8396-1152-4)

Iliev, O.; Lakdawala, Z.; Neßler, K. H. L.; Prill, T.; Vutov, Y.; Yang, Y.; Yao, J.
On the pore-scale modeling and simulation of reactive transport in 3D geometries
In: Mathematical modelling and analysis 22 (2017), Nr.5, S.671-694

Iliev, O.; Nikiforova, M. A.; Semenov, Y. V.; Zakharov, P. E.
Splitting algorithm for numerical simulation of Li-ion battery electrochemical processes
In: Egorov, I.E.: 8th International Conference on Mathematical Modeling, ICMM 2017. Proceedings: Yakutsk, Russia, 4-8 July 2017 Melville/NY: AIP Publishing, 2017, Art. 030019 (AIP Conference Proceedings 1907)

Isetti, C.; Nannei, E.; Lazzari, S.; Hariri, S.; Iliev, O.; Prill, T.
New climate-control units for more energy-efficient Electric Vehicles: The innovative Three-Fluids Combined Membrane Contactor
In: Institute of Electrical and Electronics Engineers -IEEE-: Twelfth International Conference on Ecological Vehicles and Renewable Energies, EVER 2017: Monte-Carlo, Monaco 11-13 April 2017 Piscataway, NJ: IEEE, 2017, S.679-683

Jami, Neil
Container fleet management in closed-loop supply chains
Stuttgart: Fraunhofer Verlag, 2017, VII, 231 S. (Zugl.: Kaiserslautern, Univ., Diss., 2016) (ISBN 978-3-8396-1210-1)

Jörg, C.; Letscher, F.; Fleischhauer, M.; Freymann, G. von
Dynamic defects in photonic Floquet topological insulators
In: New journal of physics. Online journal 19 (2017), Nr.8, Art. 083003, 11 S.

Kabel, M.; Fink, A.; Schneider, M.
The composite voxel technique for inelastic problems
In: Computer methods in applied mechanics and engineering 322 (2017), S.396-418

Kabel, M.; Kirsch, R.; Rief, S.; Staub, S.; Osterroth, S.
Coupling of CFD and structural mechanics simulation for the prediction of manufacturing effects on filter media
In: Internat. Association for the Engineering Analysis Community.: NAFEMS World Congress 2017. Proc.: Incorporating the 3rd Intern. Conf. on SPDM, 2017; Stockholm, Sweden, 2017, Paper NWC17-412-M

Kameswara Rao, P. V.; Rawal, A.; Kumar, V.; Rajput, K. G.
Compression-recovery model of absorptive glass mat (AGM) separator guided by X-ray micro-computed tomography analysis
In: Journal of power sources 365 (2017), S.389-398

Kleinert, J.; Simeon, B.; Dreßler, K.
Nonsmooth contact dynamics for the large-scale simulation of granular material
In: Journal of computational and applied mathematics 316 (2017), S.345-357

Klier, J.; Jonuscheit, J.; Freymann, G. von; Weber, S.
Jede Schicht entscheidet
In: InVision (2017), Nr.5, S.58-59

Korn, R.; Temocin, B.Z.; Wenzel, J.
Applications of the central limit theorem for pricing Cliquet-style options
In: European actuarial journal 7 (2017), Nr.2, S.465-480

Krebs, J.
A Bernstein inequality for exponentially growing graphs
In: Communications in statistics. Theory and methods (2017), Online First, 10 S.

Krebs, J.
Consistency and asymptotic normality of stochastic Euler schemes for ordinary differential equations
In: Statistics & probability letters 125 (2017), S.1-8

Krebs, J. T. N.; Franke, J. (Hrsg.); Sachs, R. von (Hrsg.)
Sieve estimators for spatial data: Nonparametric regression and density models with wavelets for strong mixing random fields
Stuttgart: Fraunhofer Verlag, 2017, 123 S. (Zugl.: Kaiserslautern, TU, Diss., 2017) (ISBN 978-3-8396-1186-9)

Kühn, M.; Keuper, J.; Pfreundt, F.-J.
Using GPI-2 for distributed memory parallelization of the caffe toolbox to speed up deep neural network training
In: International Academy, Research, and Industry Association: Seventh International Conference on Advanced Communications and Computation, INFOCOMP 2017: June 25 -29, 2017, Venice, Italy IARIA, 2017, S.75-79

Kurnatowski, M. von; Bortz, M.; Klein, P.; Kintzel, B.; Cremers, C.
Quantitative kinetic analysis of a $PdAu_3$ alloy catalyst for oxygen electro-reduction
In: Journal of the Electrochemical Society 164 (2017), Nr.14, S.H1072-H1080

Kurnatowski, M. von; Bortz, M.; Scherrer, A.; Hoffmann, A.; Lorenz, H.-M.; Caraucan, M.; Grützner, T.; Künzle, N.; Küfer, K.-H.

Multi-criteria optimization of an industrial world-scale process
In: Chemie-Ingenieur-Technik 89 (2017), Nr.11, S.1471-1478

Küsters, F.; Patil, D.; Tesi, P.; Trenn, S.
Indiscernible topological variations in DAE networks with applications to power grids
In: IFAC-PapersOnLine 50 (2017), Nr.1, S.7333-7338

Küsters, F.; Trenn, S.; Wirsen, A.
Switch observability for homogeneous switched DAEs
In: IFAC-PapersOnLine 50 (2017), Nr.1, S.9355-9360

Leithäuser, C.; Pinnau, R.
The production of filaments and nonwoven materials: The design of the polymer distributor
In: Ghezzi, L. ; European Consortium for Mathematics in Industry: Math for the Digital Factory Cham: Springer International Publishing, 2017, S.321-340 (Mathematics in industry 27)

Leithäuser, C.; Pinnau, R.; Feßler, R.
Approximate controllability of linearized shape-dependent operators for flow problems
In: Control, optimisation and calculus of variations: COCV 23 (2017), Nr.3, S.751-771

Lindner, F.; Marheineke, N.; Stroot, H.; Vibe, A.; Wegener, R.
Stochastic dynamics for inextensible fibers in a spatially semi-discrete setting
In: Stochastics and Dynamics 17 (2017), Nr.2, Art. 1750016, 29 S.

Linn, J.; Dreßler, K.
Discrete cosserat rod models based on the difference geometry of framed curves for interactive simulation of flexible cables
In: Ghezzi, L. ; European Consortium for Mathematics in Industry: Math for the Digital Factory Cham: Springer International Publishing, 2017, S.289-319 (Mathematics in industry 27)

Linn, J.; Hermansson, T.; Andersson, F.; Schneider, F.
Kinetic aspects of discrete cosserat rods based on the difference geometry of framed curves
In: Valasek, M.; Czech Technical University, Prag; European Community on Computational Methods in Applied Science: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Conference Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.163-176

Liu, P.; Yao, J.; Couples, G.D.; Ma, J.; Iliev, O.
3-D modelling and experimental comparison of reactive flow in carbonates under radial flow conditions
In: Scientific Reports 7 (2017), Art. 17711, 10 S.

Loroch, D.; Pfreundt, F.-J.; Wehn, N.; Keuper, J.
TensorQuant: A simulation toolbox for deep neural network quantization
In: Association for Computing Machinery -ACM-: MLHPC 2017, Machine Learning on HPC Environments. Proceedings: Denver, CO, USA, November 12 -17, 2017 New York: ACM, 2017, Art. 1, 8 S.

Lu, Y.; Marheineke, N.; Mohring, J.
Interpolation strategy for BT-based parametric MOR of gas pipeline-networks
In: Benner, P.: Model Reduction of Parametrized Systems Cham: Springer International Publishing, 2017, S.387-401 (Modeling, simulation & applications 17)

Maag, Volker
Designing hybrid energy systems for buildings
In: Herskovits, J. ; Federal University of Rio de Janeiro, Brazil: EngOpt 2016, 5th International Conference on Engineering Optimization. Proceedings: Iguassu Falls, June 19 to 23, 2016 Rio de Janeiro, 2017, S.178-187

Merten, Dirk; Pfreundt, Franz-Josef
ALOMA – an auto-parallelization tool for seismic processing
In: European Association of Geoscientists and Engineers: Energy, technology, sustainability -time to open a new chapter: 79th EAGE Conference and Exhibition 2017; Paris France, 12-15 June 2017 Red Hook, NY: Curran, 2017, S.399-403

Michel, I., Bathaeian, S.M.I., Kuhnert, J., Kolymbas, D., Chen, C.-H., Polymerou, I., Vrettos, C., Becker, A.
Meshfree generalized finite difference methods in soil mechanics-part II: numerical results
(2017) GEM - Internat. Journal on Geomathematics, 8 (2), pp. 191-217

Migunova, Anastasia
Outer-plane properties of thin heterogeneous periodic layers
Stuttgart: Fraunhofer Verlag, 2017, VI, 110 S. (Zugl.: Kaiserslautern, TU, Diss., 2016) (ISBN 978-3-8396-1159-3)

Molter, D.; Trierweiler, M.; Ellrich, F.; Jonuscheit, J.; Freymann, G. von
Interferometry-aided terahertz time-domain spectroscopy
In: Optics Express 25 (2017), Nr.7, S.7547-7558

Nickel, Stefan; Velten, Sebastian
Optimization problems with flexible objectives: A general modeling approach and applications
In: European Journal of Operational Research 258 (2017), Nr.1, S.79-88

Niedziela, D.; Rau, S.; Steiner, K.; Vita, S. de; Lutsche, M.; Richter, M.; Schmidt, M.; Stoltz, C.
Virtual characterization of dense granular flow through a vertically rotating feeding experiment
In: Chemical Engineering and Technology 40 (2017), Nr.9, S.1599-1604

Niedziela, M., Wlazło, J.
Notes on computational aspects of the fractional-order viscoelastic model
(2017) Journal of Engineering Mathematics, pp. 1-15. DOI: 10.1007/s10665-017-9911-0

Noroozi, S.; Alamdari, H.; Arne, W.; Larson, R.G.; Taghavi, S.M.
Regularized string model for nanofibre formation in centrifugal spinning methods
In: Journal of Fluid Mechanics 822 (2017), S.202-234

Obentheuer, M.; Roller, M.; Björkenstam, S.; Berns, K.; Linn, J.
Human like motion generation for ergonomic assessment - a muscle driven Digital Human Model using muscle synergies
In: Valasek, M. ; Czech Technical University, Prag; European Community on Computational Methods in Applied Science: 8th ECCOMAS Thematic Confer. on Multibody Dynamics 2017. Confer. Proc.: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.847-856

Oden, Lena; Fröning, Holger
InfiniBand-Verbs on GPU: A case study of controlling an InfiniBand network device from the GPU
In: International Journal of high Performance Computing Applications 31 (2017), Nr.4, S.274-284

Orlik, J.; Andrä, H.; Argatov, I.; Staub, S.
Does the weaving and knitting pattern of a fabric determine its relaxation time?
In: The quarterly journal of mechanics and applied mathematics: QJMAM 70 (2017), Nr.4, S.337-361

Osterroth, S.; Iliev, O.; Pinnau, R.
On efficient approaches for solving a cake filtration model under parameter variation
In: Benner, P.: Model Reduction of Parametrized Systems Cham: Springer International Publishing, 2017, S.455-470 (Modeling, simulation & applications 17)

Phutane, U.; Roller, M.; Björkenstam, S.; Linn, J.; Leyendecker, S.
Kinematic validation of a human thumb model
In: Valasek, M. ; Czech Technical University, Prag; European Community on Comp. Methods in Applied Science: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Confer. Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.857-866

Prill, T.; Jeulin, D.; Willot, F.; Balach, J.; Soldera, F.
Prediction of effective properties of porous carbon electrodes from a parametric 3D random morphological model

In: Transport in porous media: TIPM 120 (2017), Nr.1, S.141-165

Rawal, A., Kumar, V., Hietel, D., Dauner, M.
Modulating the Poisson's ratio of articular cartilage via collagen fibril alignment
(2017) Materials Letters, 194, pp. 45-48

Rawal, A.; Kumar, V.; Saraswat, H.; Weerasinghe, D.; Wild, K.; Hietel, D.; Dauner, M.
Creating three-dimensional (3D) fiber networks with out-of-plane auxetic behavior over large deformations
In: Journal of Materials Science: JMS 52 (2017), Nr.5, S.2534-2548

Reinhard, R.; Kleer, M.; Dreßler, K.
The impact of subjective simulator experiences on usability and driving behavior in a state of the art driving simulator
In: Kemeny, A. ; Driving Simulation Association.: DSC 2017 Europe VR, Driving Simulation Conference & Exhibition 2017. Proceedings: University of Stuttgart, Germany, September 6-8, 2017 Antony/ France: DSA, 2017, S.123-124

Reinhard, R.; Rutrecht, H.M.; Hengstenberg, P.; Tutulmaz, E.; Geissler, B.; Hecht, H.; Muttray, A.
The best way to assess visually induced motion sickness in a fixed-base driving simulator
In: Transportation research. Part F, Traffic psychology and behaviour 48 (2017), S.74-78

Reséndiz-Flores, E.; Kuhnert, J.; Saucedo-Zendejo, F.
Application of a generalized finite difference method to mould filling process
In: European journal of applied mathematics (2017), Online First, 20 S.

Roller, M.; Björkenstam, S.; Linn, J.; Leyendecker, S.
Optimal control of a biomechanical multibody model for the dynamic simulation of working tasks
In: Valasek, M. ; Czech Technical University, Prag; European Community on Computational Methods in Applied Science: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Conference Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.817-826

Roller, M.; Gallrein, A.; Linn, J.; Betsch, P.
A tire model based on geometrically exact shells for modal analysis in steady state rolling
In: Ambrósio, J.A.C.; European Mechanics Society: Rolling contact mechanics for multibody system dynamics: EUROMECH Colloquium 578, Funchal, Madeira, Portugal, 10-13 April 2017 Funchal, 2017, Paper 44, 23 S.

Schappals, M.; Mecklenfeld, A.; Kröger, L.; Botan, V.; Köster, A.; Stephan, S.; García, E.J.; Rutkai, G.; Raabe, G.; Klein, P.; Leonhard, K.; Glass, C.W.; Lenhard, J.; Vrabec, J.; Hasse, H.
Round robin study: Molecular simulation of thermodynamic properties from models with internal degrees of freedom
In: Journal of chemical theory and computation: JCTC 13 (2017), Nr.9, S.4270-4280

Scheuerlein, C.; Rack, A.; Schladitz, K.; Huwig, L.
Synchrotron microtomography investigation of the filament microstructure in differently processed Bi-2212 wires
In: IEEE transactions on applied superconductivity 27 (2017), Nr.4, Art. 6400205, 5 S.

Schießl, S; Marheineke, N. (Hrsg.); Meister, A. (Hrsg.)
Jet and fiber dynamics with high elongations: Models, numerical strategies and applications
Stuttgart: Fraunhofer Verlag, 2017, 187 S. (Zugl.: Erlangen-Nürnberg, Univ., Diss., 2017) (ISBN 978-3-8396-1241-5)

Schladitz, K.; Büter, A.; Godehardt, M.; Wirjadi, O.; Fleckenstein, J.; Gerster, T.; Hassler, U.; Jaschek, K.; Maisl, M.; Maisl, U.; Mohr, S.; Netzelmann, U.; Potyra, T.; Steinhauser, M. O.
Non-destructive characterization of fiber orientation in reinforced SMC as input for simulation based design
In: Composite structures 160 (2017), S.195-203

Schmeißer, A.; Burkhart, D.; Linn, D.; Schnebele, J.; Ettmüller, M.; Gramsch, S.; Arne, W.
Ensight4Matlab: read, process, and write files in EnSight® Gold format from C++ or MATLAB®
In: The journal of open source software: JOSS. Online journal 2 (2017), Paper 217

Schneider, F.; Burger, M.; Arnold, M.; Simeon, B.
A new approach for force-displacement co-simulation using kinematic coupling constraints
In: Zeitschrift für angewandte Mathematik und Mechanik: ZAMM 97 (2017), Nr.9, S.1147-1166

Schneider, F.; Linn, J.; Hermansson, T.; Andersson, F.
Cable dynamics and fatigue analysis for digital mock-up in vehicle industry
In: Valasek, M. ; Czech Technical University, Prag; European Community on Computational Methods in Applied Science: 8th ECCOMAS Thematic Conference on Multibody Dynamics 2017. Conference Proceedings: Prague, June 19 -22, 2017 Prag: Czech Technical University, 2017, S.763-769

Schneider, M.
An FFT-based fast gradient method for elastic and inelastic unit cell homogenization problems
In: Computer methods in applied mechanics and engineering 315 (2017), S.846-866

Schneider, M.
Beyond polyconvexity: An existence result for a class of quasi-convex hyperelastic materials
In: Mathematical Methods in the Applied Sciences 40 (2017), Nr.6, S.2084-2089

Schneider, M.
The sequential addition and migration method to generate representative volume elements for the homogenization of short fiber reinforced plastics
In: Computational mechanics 59 (2017), Nr.2, S.247-263

Schneider, Matti; Merkert, Dennis; Kabel, Matthias
FFT-based homogenization for microstructures discretized by linear hexahedral elements
In: International journal for numerical methods in engineering 109 (2017), Nr.10, S.1461-1489

Schreiner, N.; Baccouche, B.; Sauer-Greff, W.; Urbansky, R.; Friederich, F.
High-resolution FMCW millimeter-wave and terahertz thickness measurements
In: Institute of Electrical and Electronics Engineers; European Microwave Association; Institution of Engineering and Technology: 47th European Microwave Conference, EuMC 2017: European Microwave Week 2017, 10-12 October 2017, Nuremberg, Germany Piscataway, NJ: IEEE, 2017, S.339-342

Schuler, F.; Breit, W.; Schnell, J.; Schladitz, K.
Computertomografie -den Fasern auf der Spur: Untersuchungen zum Faktor zur Berücksichtigung der Faserorientierung Î° F f nach DAfStb-Richtlinie „Stahlfaserbeton" am Beispiel von Tunneltübbings
In: Bautechnik 94 (2017), Nr.10, S.689-696

Schütte, J.; Fridgen, G.; Prinz, W.; Rose, T.; Urbach, N.; Hoeren, T.; Guggenberger, N.; Welzel, C.; Holly, S.; Schulte, A.; Sprenger, P.; Schwede, C.; Weimert, Birgit; Otto, B.; Dalheimer, M.; Wenzel, M.; Kreutzer, M.; Fritz, Michael; Leiner, U.; Nouak, A.; Prinz, W. (ed.); Schulte, A. T. (ed.)
Blockchain und Smart Contracts: Technologien, Forschungsfragen und Anwendungen
München: Fraunhofer-Gesellschaft, 2017, 50 S.

Shiryaev, Vladimir; Orlik, Julia
A one-dimensional computational model for hyperelastic string structures with Coulomb friction
In: Mathematical Methods in the Applied Sciences 40 (2017), Nr.3, S.741-756

Sliseris, J.; Andrä, H.; Kabel, M.; Dix, B.; Plinke, B.
Virtual characterization of MDF fiber network

SCIENTIFIC GRADUATION THESES

In: European journal of wood and wood products 75 (2017), Nr.3, S.397-407

Steidel, S.; Burger, M.
Co-simulation in the vehicle development process
In: Scheven, M. von ; German Association for Computational Mechanics: 7th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry 2017. Proceedings: 11-13 October 2017, Stuttgart, Germany: University Stuttgart, 2017, S.363-366

Stephani, H.; Weibel, T.; Moghiseh, A.
Modellbasiertes Lernen in der Oberflächeninspektion
In: Automatisierungstechnik: AT 65 (2017), Nr.6, S.406-415

Suchde, P.; Kuhnert, J.; Schröder, S.; Klar, A.
A flux conserving meshfree method for conservation laws
In: International journal for numerical methods in engineering 112 (2017), Nr.3, S.238-256

Temocin, B.Z.; Korn, R.; Selcuk-Kestel, A.S.
Constant proportion portfolio insurance in defined contribution pension plan management
In: Annals of operations research (2017), Online First, 20 S.

Tröltzsch, J.; Schäfer, K.; Niedziela, D.; Ireka, I.; Steiner, K.; Kroll, L.
Simulation of RIM-process for polyurethane foam expansion in fiber reinforced sandwich structures
In: Procedia CIRP 66 (2017), S.62-67

Walter, R.
A note on minimizing the sum of squares of machine completion times on two identical parallel machines
In: Central European journal of operations research: CEJOR 25 (2017), Nr.1, S.139-144

Walter, R.; Wirth, M.; Lawrinenko, A.
Improved approaches to the exact solution of the machine covering problem
In: Journal of scheduling 20 (2017), Nr.2, S.147-164

Weber, S.; Waller, E.H.; Kaiser, C.; Freymann, G. von
Time-stretched real-Time measurement technique for ultrafast absorption variations with TS/s sampling-rate
In: Optics Express 25 (2017), Nr.13, S.14125-14133

Weber, S.; Ellrich, F.; Paustian, S.; Güttler, N.; Tiedje, O.; Jonuscheit, J.; Freymann, G. von
Thickness determination of wet coatings using self-calibration method
In: Institute of Electrical and Electronics Engineers -IEEE-; IEEE Microwave Theory and Techniques Society: 42nd International Conference on Infrared, Millimeter, and Terahertz Waves 2017: Cancun, Quintana Roo, Mexico, August 27-September 1, 2017 Piscataway, NJ: IEEE, 2017, 2 S.

Weisenstein, C.; Kahl, M.; Friederich, F.; Bolivar, P.H.
Conception and realization of a semiconductor based 240 GHz full 3D MIMO imaging system
In: Sadwick, L.P. ; Society of Photo-Optical Instrumentation Engineers -SPIE-, Bellingham/Wash.: Terahertz, RF, Millimeter, and Submillimeter-Wave Technology and Applications X: 30 January-2 February 2017, San Francisco, California, United States Bellingham, WA: SPIE, 2017, Paper 101030B, 7 S. (Proceedings of SPIE 10103)

Werth, S.; Stöbener, K.; Horsch, M.; Hasse, H.
Simultaneous description of bulk and interfacial properties of fluids by the Mie potential
In: Molecular physics 115 (2017), Nr.9-12, S.1017-1030

Wirjadi, O.; Kim, Y.-J.; Stech, F.; Bonfert, L.; Wagner, M.
Bayesian model for detection and classification of meningioma nuclei in microscopic images
In: Journal of microscopy 265 (2017), Nr.2, S.159-168

Yakut, Nataliya; Krüning, Kai; Foltin, Gregor; Burger, Jakob; Krauss, Michael; Asprion, Norbert; Bortz, Michael; Roth, Matthias
Modelldurchgängigkeit in der Prozessindustrie am Beispiel virtueller Inbetriebnahme
In: Chemie-Ingenieur-Technik 89 (2017), Nr.11, S.1444-1453

Zhang, X.X.; Wang, D.; Xiao, B.L.; Andrä, H.; Gan, W.M.; Hofmann, M.; Ma, Z.Y.
Enhanced multiscale modeling of macroscopic and microscopic residual stresses evolution during multi-thermo-mechanical processes
In: Materials and design 115 (2017), S.364-378

Complete bibliographic information can be found at: publica.fraunhofer.de/institute/itwm/2017

Bacchouche, Bessem
FMCW Terahertz Volumetric Imaging with Sparse Multistatic Line Arrays
Doctoral thesis, University Kaiserslautern, Dept. of Electrical Engineering

Berner, Tim
Verteilte Algorithmen für gewichtete Matchings
Bachelor thesis, University Kaiserslautern, Dept. of computer science

Coskun, Sema
Application of the Heath-Platen Estimator in Pricing Barrier and Bond Options
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Derouet, Maximilian
PF-MPC approach for the Furuta pendulum
Master thesis, University Kaiserslautern, Dept. of Mathematics

Easwaran, Prakash
Stochastic Geometry Models for Interacting Fibers
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Eckstein, Christian
Ermittlung repräsentativer Lastkollektive zur Betriebsfestigkeit von Ackerschleppern
Doctoral thesis, University Kaiserslautern, Dept. of Mechanical Engineering

Eimer, Matthias
High order numerical schemes for district heating
Master thesis, University Kaiserslautern, Dept. of Mathematics

Frevel, Thorsten
Erzeugen und Kolorieren von 3D-Punktwolken mittels Messdaten des mobilen Multi-Sensor-Messsystems REDAR
Bachelor thesis, University of Applied Sciences Kaiserslautern, Dept. of Applied Engineering Sciences

Gräf, Benedict
Charakterisierung der Verstärkung polarisationsgemultiplexter fs-Pulse in Erbium-dotierten Glasfasern

Diploma thesis, University Kaiserslautern, Dept. of Physics

Grün, Sarah
Discrete Dividends: Modeling, Estimation and Portfolio Optimization
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Hoffmann, Daniel
Aspects of Pricing Cliquet Options
Master thesis, University Kaiserslautern, Dept. of Mathematics

Jaeger, Philippe
Constant Proportion Portfolio Insurance
Master thesis, University Kaiserslautern, Dept. of Mathematics

Jami, Neil
Container Fleet Management in Closed-Loop Supply Chains
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Jung, Christian
Bildanalytische Erkennung von Rissen in Asphalt basierend auf dem Dijkstra-Algorithmus
Bachelor thesis, University Kaiserslautern, Dept. of Mathematics

Kelly, Una
A Statistical Analysis of 3D Wire Shapes in Rutherford Cables
Master thesis, University Kaiserslautern, Dept. of Mathematics

Koslow, Viktor
Automatisiertes Generieren von Straßennetzwerken für den virtuellen Fahrversuch anhand von realen Messdaten
Bachelor thesis, University of Applied Sciences Kaiserslautern, Dept. of Applied Engineering Sciences

Krebs, Johannes Nikolas
Sieve Estimators for Spatial Data
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Lange, Eike
Automatisierung der optischen Inspektion von Einfadenstents
Bachelor thesis, University of Applied Sciences Kaiserslautern

Losch, Katharina
Stochastic Modeling of Multiphase Materials Based on Digital Image Data
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Mahler, Philipp
Einfluss der Handelshäufigkeit bei Anwendungen von CPPIs
Master thesis, University Kaiserslautern, Dept. of Mathematics

Manvelyan, Diana
Niche competition in acute leukemia: Mathematical modeling and model order reduction using POD Method
Bachelor thesis, University Kaiserslautern, Dept. of Mathematics

Narendrakumar, Manoj Kumar
Real-time implementation of an undercarriage model of a wheeled excavator
Master thesis, University Kaiserslautern, Dept. of mechanical engineering

Nurkanovic, Merima
The Split Tree for Option Pricing
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Osterroth, Sebastian
Mathematical models for the simulation of combined depth and cake filtration processes
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Pfeiffer, Tobias
Interferometric vibration correction for thickness measurements using terahertz technology in industrial environments
Master thesis, University Kaiserslautern, Dept. of Physics

Schießl, Stefan
Jet and fiber dynamics with high elongations: Models, numerical strategies and applications
Doctoral thesis, FAU Erlangen-Nürnberg, Dept. of Mathematics

Schuh, Janina
Varianten der Vermögensentwicklung eines Lebensversicherungsvertrags
Master thesis, University Kaiserslautern, Dept. of Mathematics

Schwalbach, Christian
Interaktive Pkw-Simulation mit RODOS – Einfluss der Modellkomplexität auf die Immersion
Master thesis, University Kaiserslautern, Dept. of Mechanical Engineering

Seifarth, Tobias
Numerische Algorithmen für gitterfreie Methoden zur Lösung von Transportproblemen
Doctoral thesis, University Kassel, Dept. of Mathematics

Theis, Alexander
Design und Optimierung eines FMCW Terahertz-Messsystems für die Schichtdickenmessung
Diploma thesis, University Kaiserslautern, Dept. of Physics

Vogg, Richard
Quantitative 3D Image Analysis of Foreign Body Giant Cells
Master thesis, University Kaiserslautern, Dept. of Mathematics

Wilhelm, Carl
Worst-Case Portfolio-Optimierung im Binomialmodell
Master thesis, University Kaiserslautern, Dept. of Mathematics

Winarske, Jens
Bildsegmentierung mit Gaußschen Mischungsmodellen
Bachelor thesis, University Kaiserslautern, Dept. of Mathematics

Wlazlo, Jaroslaw
Medical Image Registration with Exact Mass Preservation
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Zurloh, Corinna
PDE-basierte Grauwertmorphologie zur Erweiterung des Ansatzes auf Farbbilder
Bachelor thesis, University Kaiserslautern, Dept. of Mathematics

Arne, W.; Feßler, R.; Wegener, R.; Wieland, M.
Modeling and simulation of dry spinning processes
International Textile Conference, Stuttgart, December

Arne, W.; Marheineke, N.; Wegener, R.; Wieland, M.
Setup and numerical solution of a viscous Cosserat rod model describing electrospinning
NART 2017, Liberec (CZ), October

Baccouche, B., Friederich, F.
Bildgebende Terahertz-Prüfung für die Inline-Kontrolle
DGZFP Jahrestagung, Koblenz, May

Baccouche, B.; Agostini, P.; Friederich, F.
Digital Beamforming Algorithms for 3D Terahertz Imaging with Sparse Line Arrays,
German Terahertz Conference, Bochum, March

Baccouche, B.; Agostini, P.; Mohammadzadeh, S.; Kahl, M.; Weisenstein, C.; Jonuscheit, J.; Keil, A., Löffler, T.; Sauer-Greff, W.; Urbansky, R.; Haring Bolívar, P.; Friederich, F.
Sparse multistatic line-array-based 3D terahertz imaging system with real-time capability for industrial applications
SPIE Photonics West 2017, San Francisco (USA), January

Baccouche, B.; Sauer-Greff, W., Urbansky, R.; Friederich, F.
Application of the Phase Coherence Method for Imaging with Sparse Multistatic Line Arrays
IEEE MTT-S Intern. Microwave Symposium, Honolulu (USA), June

Baccouche, B.; Sauer-Greff, W., Urbansky, R.; Friederich, F.
Enhanced 3D CW Terahertz Imaging With Ultra Sparse Arrays Using A Phase Coherence Method
42nd International Conference on Infrared, Millimeter, and Terahertz Waves, Cancun (Mex), August

Bäcker, M.; Burger, M.; Steidel, S.
Local Extrapolation in a Parallel Coupling Scheme with an Application to Vehicle–Tire Interaction
Darmstadt, September

Bastian, P.; Engwer, C.; Göddeke, D.; Iliev, O.; Ippisch, O.; Ohlberger, M.;. Turek, S.
Latest Advances in ExaDUNE. Flexible PDE Solvers, Numerical Methods and Applications
HPC Summit Barcelona (E), May

Beck, J.; Matuschczyk, U.; Jonuscheit, Joachim, Friederich, Fabian
Inline-Produktionskontrolle bei der Herstellung von Pressmänteln mittels Terahertz-Messtechnik
3. Fachseminar des FA MTHz: Mikrowellen- und Terahertz-Prüftechnik in der Praxis, Würzburg, April

Bitsch, G.; Dreßler, K.
Kooperationsprogramm Mechatronik/Qualifikation von Simulationsmodellen
München, May

Bitsch, G.; Dreßler, K.; Kleer, M.; Pena Vina, E.
Absicherung von Fahrzeugfunktionen unter Berücksichtigung der Umgebung und des Fahrzeugverhaltens
Friedrichshafen, October

Björkenstam, S.; Nyström, J.; Carlson, J.; Roller, M.; Linn, J.; Hanson, L.; Högberg, D.; Leyendecker, S.
A framework for motion planning of digital humans using discrete mechanics and optimal control
Bonn, June

Bortz, M.; Babutzka, J.; Dinges, A.; Foltin, G.; Süss, P.; Teichert, K.
Models from Experiments: Tools supporting Product Development in the Lab
Tag der Verfahrenstechnik, Kaiserslautern, October

Bramble, J.; Savage, N.; Jonuscheit, Joachim; Friederich, Fabian
Berührungslose, zerstörungsfreie Prüfung von Radomen mittels Terahertz-Messechnik
3. Fachseminar des FA MTHz: Mikrowellen- und Terahertz-Prüftechnik in der Praxis, Würzburg, April

Burger, M.; Speckert, M.
Speed Profile Generation based on geo-referenced Data using Optimal Control Methods
Weimar, March

Burger, M.; Dreßler, K.; Ekevid, T.; Steidel, S.; Weber, D.
Coupling a DEM material model to multibody construction equipment
Prag (CZ), June

Calabrese, F.; Bäcker, M.; Gallrein, A.
Advanced tire simulation with CDTire in VI-CarRealTime
Turin (I), May

Calabrese, F.; Bäcker, M.; Gallrein, A.; Ludwig, C.
A study of parameter identification for a thermal-mechanical tire model based on Flat Track Measurements
Hannover, October und Queensland (AUS), August

Dalheimer, Mathias
Ladeinfrastruktur für Elektroautos: Ausbau statt Sicherheit
34. Chaos Communication Congress, Leipzig, December

Dalheimer, Mathias
The power grid is vulnerable – and it's really hard to fix this.
DeepINTEL, Wien, September

Deshpande Ruturaj; Kabel, M.; Kirsch, R.; Rief, S.; Staub, S.; Osterroth, S.
Vom Filtermedium zum Filterelement - Simulation unter Berücksichtigung von Fertigungseinflüssen
Industrieworkshop Digitale Technologien für Fasern, Vliesstoffe und technische Textilien, Kaiserslautern, September

Diller, Rolf; Hauth, Jan
Modelling and assessment of spectroscopic data by Bayesian estimation methods
4th BioComp Symposium, Münchweiler an der Alsenz, October

Dobrovolskij, D.; Spies, M.; Hirsekorn, S.
Ultraschall-Simulation unter Berücksichtigung einfacher Streuvorgänge auf Basis eines Mikrostruktur-Modells für polykristalline Werkstoffe
DGZfP Jahrestagung 2017, Koblenz, May

Dobrovolskij, Dascha
Charakterisierung der Mikrostruktur von Faserverbundwerkstoffen
FVTT, Kaiserslautern, September

Dobrovolskij, Dascha
Modelling of Ultrasonic Scattering in Polycrystalline Materials
12th European Congress for Stereology and Image Analysis 2017

Dörlich, V.; Andersson, F.; Linn, J.
Piecewise linear elastic behavior of Bowden cables
Speyer, June

Dörlich, V.; Cesarek, P.; Linn, J.; Diebels, S.
Experimental investigation and numerical modeling of resultant-based bending plasticity in cables
Prag (CZ), June

Dreßler, K.; Speckert, M.
Environmental Data and Usage Variability in Vehicle Engineering
Speyer, June und Stuttgart, July

Dreßler, K.; Speckert, M.
How to handle usage variability in durability engineering
Hanau, April

Dreßler, K.; Stephan, T.
Simulationsgestützte Optimierung und Absicherung flexibler Bauteile
Landshut, September

Eisenträger, Almut; Kuhnert, Jörg; Wächtler, Timo
MESHFREE: General Finite Differences for Fluid Flow and Continuum Mechanics with Three Industrial Applications
USNCCM 14, Montreal (CAN), July

Ellrich, F.; Klier, J.; Weber, S.; Jonuscheit, J.; von Freymann, G.
Thickness Determination of Wet Coatings Using Self-Calibration Method
SPIE Photonics West, San Francisco (USA), January

Feth, S.; Christiansen, H.
Flexible & effiziente Wöhlermodelle
Ottobrunn, January

Feth, S.; Speckert, M.
Schätzung von 3-Parameter-Weibull-Verteilungen mit Konfidenz bei Durchläufer
München, November

Feth, S.; Speckert, M.
Zwei oder drei Parameter? Vergleich von Weibull-Modellen an einem Anwendungsbeispiel
München, November

Fiedler, J.
Distance correlation for spatial stochastic processes
Helsinki (FIN), July

Föhst, Sonja
Investigation of Fibrosis in Capillary Vessels of Murine Organs
12th European Congress for Stereology and Image Analysis 2017

Friederich, Fabian
Terahertz Imaging in Industry
9th THz-Days, Dunkirk (F), June

Friederich, F.; Jonuscheit, J.
Industrial Radome Inspection with Terahertz Waves
10th UK-Europe-China Workshop on Millimetre Waves and THz Technologies (UCMMT 2017), Liverpool (GB), September

Fuetterling, Valentin
Accelerated single ray tracing for wide vector units
High-Performance Graphics 2017, Los Angeles (USA), July

Fuetterling, Valentin
Efficient Ray Tracing Kernels for Modern CPU Architectures
ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games, San Francisco (USA), February

Gallrein, A.
Advanced Tire Modelling from Multi Body Dynamics to Linearization of the Rotating Tire
Frankenthal, June

Gallrein, A.; Bäcker, M.; Calabrese, F.
Dynamic simulation of the inflation gas of a tire under operational conditions
Prag (CZ), June

Gallrein, A.; Bäcker, M.; Calabrese, F.
Influence of the inflation gas dynamics of a tire on operational conditions
Hannover, October

Gospodnetic, P.; Spies, M.; Rauhut, M.
Image Based Surface Microgeometry Reconstruction - Modeling and Validation
7th European-American Workshop on Reliability of NDE, Potsdam, September

Gramsch, Simone
Virtual nonwoven production processes
INDEX 2017, Genf (CH), April

Griso, G.; Migunova, A.; Orlik, J.
Asymptotic analysis for domains separated by a thin layer made of periodic vertical beams
SIAM Conference on Mathematical and Computational Issues in the Geosciences 2017, Minisymposium über „Effective models for porous media containing thin structures", Erlangen, September

Griso, Georges; Migunova, Anastasia; Orlik, Julia; Sivak, Olena
Asymptotic Analysis and stability for Thin Layer of Beams
Intern. Conference on Elliptic and Parabolic Problems, Minisymposium „Spectral analysis and homogenization of PDEs", Gaeta (I), May

Griso, G.; Orlik, J.; Sivak, O.
Stability end estimates for plates, made of thin periodic beams
Workshop Homogenization Theory and Applications (HomTAp), WIAS, Berlin, October

Grünewald, Daniel
Fault tolerance mechanisms in GASPI/GPI
SC17, BoF. Resilient Programming Environments Denver (USA), November

Grünewald, Daniel
Gaspi Tutorial
Warwick University, Coventry (GB), March

Hering, Julian; Waller, Erik H.; von Freymann, Georg
Additive Fertigung dreidimensionaler Bauteiloberflächen
SFB 926 Doktoranden-Retreat 2017, Mannheim, June

Hering, Julian; Waller, Erik H.; von Freymann, Georg
Automated aberration compensation in high NA systems for arbitrary laser modes
SPIE Photonics West 2017, San Francisco (USA), January and DPG Frühjahrstagung 2017, Mainz, March

Hietel, Dietmar; Arne, Walter
Modeling, simulation and optimization of viscoelastic filaments for spinning processes
INDEX 2017, Genf (CH), April

Hietel, Dietmar; Arne, Walter
Modelling and simulation of spinning processes: fundamentals and comparison for melted and solved Polymers
MFC, Dornbirn (A), September

Hietel, D.; Leithäuser, C.
Simulation und Adaption von Vernadelungsstrukturen
AFBW Symposium Simulation von Nadelvliesstoffen, Albstadt, May

Hinderks, Wieger
Factor Models in the German Electricity Market
International Ruhr Energy Finance Conference, Essen, September

Hirsekorn, S.; Dobrovolskij, D.; Spies, M.
Modelling of Ultrasonic Scattering in Polycrystalls Aiming for Tools to Simulate Experiments in NDT&E
9th Workshop „NDT in Progress"

Hofmann, Tobias
BatteryDict, BEST and beyond
GeoDict User-Meeting, Kaiserslautern, September

Hofmann, Tobias
Lisa Lithium – Wo Ionen wohnen
Fraunhofer Alumni Summit, Stuttgart

Hofmann, Tobias
Stress simulation in lithium-ion batteries
GACM, Stuttgart, October

Hofmann, Tobias
Stress simulation of phase-separating cathode materials
ModVal, March und ACOMEN, Gent (B), September

Iliev, O.; Mohring, J.; Shegunov, N.; Milk, R.; Ohlberger, M.; Klein, O.; Bastian, P.
Toward Exascale Computations of Uncertainty Quantification for Porous Media Flow Using Multilevel Monte Carlo
Large Scale Scientific Computation, Sozopol (BG), June und Invited Seminar Dept. Computer Science, University Uppsala (S), October

Iliev, O.; Prill, T.; Nessler (Leonard), K. H. L. ; Lakdawala, Z.; Printsypar, G.; Andrä, H.; Kabel, M.; Enzmann, F.; Wiegmann, A.; Schwarz, J.-O.
On Digital Rock Physics extended with Chemistry
Invited seminar at SkolTech, Moscow (RUS), November

Iliev, Oleg
Multiscale problems, reactive flows in porous media, uncertainty quantification
Seminar Environmental Science of University Utrecht (NL), August

Iliev, Oleg
On modeling and simulation of multiscale electrochemical processes in Li-ion battery
Invited talk at Interdisciplinary Colloquium University of Uppsala (S), October und Invited talk at IDarcy Center, University of Eindhoven (NL), October

Iliev, Oleg
On simulation of multiscale electrochemical processes in Li-ion battery
Multiscale Methods and Large Scale Scientific Computing, Yakutsk (RUS), August

Iliev, O.; Prill, T.; Mikelic, A.
Different scaling regimes for modeling and simulation of reactive transport in 3D porous media
InterPore, Rotterdam (NL), May

Ireka, I.; Niedziela, D.; Orlik, J.; Rief, S.; Steiner, K.; Tröltzsch, J.; Schäfer, K.; Helbig, F.; Kroll, L.
Modeling and Simulation of polyurethane foam injection moulding to produce fiber reinforced sandwich structures
9th International Conference on Porous Media, Rotterdam (NL), May

Ireka, I.; Niedziela, D.; Orlik, J.; Rief, S.; Steiner, K.
Simulationstechniken zur virtuellen Auslegung textilverstärkter Verbundwerkstoffe
Industrieworkshop: Digitale Technologien für Fasern, Vliesstoffe und technische Textilen, Kaiserslautern, September

Jonuscheit, Joachim
Bildgebende Verfahren zur Detektion von Gefahrstoffen
Carl-Cranz-Gesllschaft, Seminar: 17VS 10.06 Detektion von Explosivstoffen, Pfinztal, November

Jonuscheit, Joachim
Einführung in die Terahertzprüftechnik
3. Fachseminar Mikrowellen- und Terahertz-Prüftechnik in der Praxis, Fürth, April

Jonuscheit, Joachim
Inspektion von glasfaserverstärkten Composite- Materialien: Vergleich der Terahertz-Technik mit klassischen Prüfverfahren
8. Landshuter Leichtbau-Kolloquium, Landshut, March

Jonuscheit, Joachim
Künftige Entwicklungen der Terahertz-Technik zur zerstörungsfreien Prüfung von Verbundmaterialien
DGZfP-Seminar Zerstörungsfreie Prüfung an GFK und GFK-Klebeverbindungen, Wittenberge, August

Jonuscheit, Joachim
Terahertz-Imaging in der Qualitätssicherung und Sicherheitstechnik
Fraunhofer Vision Technologietag October 2017/Jubiläumskongress, Fürth, October

Jonuscheit, Joachim
Terahertz-Mess- und Prüftechnik für den Leichbau
„Qualität im faserverstärkten Leichtbau - CFK, GFK, FVK, Stuttgart, March

Jörg, C.; Letscher, F.; Fleischhauer, M., von Freymann, G.
Temporal Defects in Photonic Topological Insulators
CLEO: QELS-Fundamental Science 2017, San Jose (USA), May

Jörg, C.; Letscher, F.; Fleischhauer, M.; von Freymann, G.
Time-dependent defects in photonic topological insulators
DPG Frühjahrstagung 2017, Dresden, March

Kabel, Matthias
Automatic Derivation of Material Laws for ABAQUS using GeoDict and FeelMath
GeoDict User Meeting, Kaiserslautern, September

Kabel, Matthias
GeoDict for Composites
GeoDict User-Meeting, Tokio (J), October und GeoDict User-Meeting, Nagoya (J), October

Kabel, Matthias
New Developments in GeoDict and FeelMath for Composites
GeoDict User-Meeting (Subcommitee Composite), Tokio (J), October

Kabel, Matthias
Two-Phase Model-Reduction for Two-Scale Simulations of Components
27th International Workshop on Computational Mechanics of Materials (IWCMM-27), Leuven (B), September und 7th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry, Stuttgart, October

Keuper, Janis
Alternative Optimierungsmethoden für Deep Learning
Seminar Uni Freiburg, January

Keuper, Janis
Alternative Optimization Methods for Deep Learning
SEG Data Analytics Workshop, Houston (USA), September

Keuper, Janis
Distributed Training of DNNs
OG-HPC Symposium, Houston (USA), March

Keuper, Janis
Skalierbare Lösungen fürs Deep Learning
IBM Userforum, Frankfurt, April und Volkswagen Entwicklerforum, Wolfsburg, June

Kins, Stefan; Hauth Jan
A refined quantitative model of APP processing
4th BioComp Symposium, Münchweiler an der Alsenz, October

Klein, Matthias
Green by IT – Software für die Energiewende
Sommerreise von Anton Hofreiter (MdB), Kaiserslautern, September

Klein, Matthias
GreenPowerGrid AuDept. ofau eines dezentralen PV-Speicherkraftwerks zur regionalen Grünstromversorgung
Zukunftsinitiative Smart Grids Rheinland-Pfalz, Alzey, May

Klein, Matthias
Kaiserslautern – vom Industrie- zum Wissenschaftsstandort
Karriereforum der Energiewirtschaft, Essen, February

Klein, Matthias
Podiumsdiskussion: Perlen der Energiewende
Heinrich-Böll-Stiftung, Kaiserslautern, November

Klein, Peter
Round Robin study of Molecular Dynamics: Lessons learned from a Translators perspective
EC Expert-Workshop on „Modelling Translators", Brüssel (B), September

Klier, J.; Weber, S.; Molter, D.; Jonuscheit, J.; von Freymann, G.
Berührungslose, robotergestützte Schichtdickenmessung im industriellen Umfeld
DGZFP-Jahrestagung, Koblenz, May

Kolano, M.; Gräf, B.; Molter, D., Ellrich, F.; von Freymann, G.
All-Polarization-Maintaining, Polarization-Multiplexed, Gain-Coupled, Mode-Locked Fiber Laser
Advanced Solid State Lasers Conference (ASSL), Nagoya (J), October

Korn, Ralf
A Monte Carlo Approach for Pricing Cliquet-Options in the Heston Framework
Recent Developments in Numerical Methods with Applications in Statistics and Finance, June

Korn, Ralf
A real-life MC-simulation application: Chance-Risk Classification of Pension Products
Graz Summer School on Application of Quasi Monte Carlo methods, June

Korn, Ralf
Applications of the Central Limit Theorem for Pricing Cliquet-Options
Japanese-German Open Conference on Stochastic Analysis 2017" Kaiserslautern, September

Korn, Ralf
Basic principles, tasks, and ideas of financial mathematics
Graz Summer School on Application of Quasi Monte Carlo methods, June

Korn, Ralf
Chance-Risiko-Klassifikation von Altersvorsorgeprodukten: Konzepte, Erfahrungen, Herausforderungen
BVI Investment Hochschultag, May

Korn, Ralf
Chance-Risk Classification of German Pension Products: Concepts, Experience and Research Challenges
DAV-Jahrestagung, Scientific day, April

Korn, Ralf
Chance-Risk Classification of Pension Products: Scientific Concepts and Challenges
Innovations in Insurance, Risk- and Asset Management, April

Korn, Ralf
Continuous-time portfolio optimization: An approach for meeting (long-term) liabilities of insurance companies
Swiss Risk and Insurance Forum, Rüschlikon (CH), May

Korn, Ralf
Save for the Bad Times or Consume as Long as You Have?
Finance and Energy Seminar, Univ. Duisburg-Essen, November, Center for Mathematical Economics: Math. Finance Seminar, Bielefeld, November und CERMICS Seminar, ENPC, Paris (F), October

Korn, Ralf
Simulation von Altersvorsorgeprodukten - Wie es wirklich funktioniert ...
DWS Altersvorsorge Spezial, September

Korn, Ralf
Simulations of stochastic differential equations and option pricing in continuous time
Graz Summer School on Application of Quasi Monte Carlo methods, June

Korn, Ralf
Statistics with one observation?
Bio-Comp Progress Seminar, Kaiserslautern, June

Kronenberger, Markus
Segmentation of Fibers in Cracked Steel Fiber Reinforced Concrete (SFRC) using Differential Quantities
12th European Congress for Stereology and Image Analysis 2017

Kuehn, Martin; Keuper, Janis
Bottlenecks towards Scalable Deep Learning on HPC Systems
Deep Learning Workshop, Leibniz-Rechenzentrum der Bayerischen Akademie der Wissenschaften, Garching, September

Kuehn, Martin; Keuper, Janis; Pfreundt, Franz-Josef
Using GPI-2 for Distributed Memory Parallelization of the Caffe Toolbox to Speed up Deep Neural Network Training
The Seventh International Conference on Advanced Communications and Computation (INFOCOMP 2017), Venice (I), June

Küfer, Karl-Heinz
Industrial Applications of Multicriteria Decision Support
LONZA, Visp (CH), July und Workshop Recent Advances in Multi-Objective Optimization, University Kaiserslautern, October

Küfer, Karl-Heinz
Mathematik in der Anwendung
20. Forum für Begabtenförderung in Mathematik, Hochschule, Darmstadt, March

Kuhnert, Jörg; Michel, Isabel
Different ways of Fluid Structure Interaction (FSI) in the MESHFREE Finite-Pointset-Method (FPM)
9th International Workshop Meshfree Methods for Partial Differential Equations, Bonn, September

Küsters, Ferdinand; Patil, Deepak; Tesi, Pietro; Trenn, Stephan
Indiscernible topological variations in DAE networks with applications to power grids
20th IFAC World Congress, Toulouse (F), July

Küsters, Ferdinand; Patil, Deepak; Trenn, Stephan
Switch observability for a class of inhomogeneous switched DAEs
56th IEEE Conference on Decision and Control, Melbourne (AUS), December

Küsters, F.; Trenn, S.; Wirsen, A.
Switch observability for homogeneous switched DAEs
20th IFAC World Congress, Toulouse (F), July

Küsters, F.; Trenn, S.; Wirsen, A.
Switch-observer for switched linear systems
56th IEEE Conference on Decision and Control, Melbourne (AUS), December

Leithäuser, Christian
Simulation-based analysis and optimization of spin packs
INDEX 2017, Genf (CH), April

Leithäuser, C.; Hietel, D.
Perfekte Nadeleinstichmuster durch simulationsbasierte Adaption
Hofer Vliesstofftage, Hof, November

Liebscher, A.; Osterroth, S.; Redenbach, C.; Rief, S.; Steiner, K.
Flow and deposition simulation related to chromatographic separation processes
12th European Congress for Stereology and Image Analysis, Kaiserslautern, September

Linn, J.
Ergo-dynamic Moving MAnikin with Cognitive Control – EMMA-CC: Innovative digitale Menschmodellierung für ergonomische Arbeitsplätze
München, February and Stuttgart, February

Linn, J.
Modeling and simulation of slender flexible structures for assembly simulation and digital validation in automotive industry
Grenoble (F), September

Linn, J.
Simulation of flexible cables in car assembly
Berlin, March

Linn, J.
Various aspects of modeling slender flexible structures for assembly simulation and digital validation in automotive industry
Liège (B), August

Linn, J.; Carlson, J.; Obentheuer, M.; Roller, M.; Björkenstam, S.; Madberg, P.
The Fraunhofer research project EMMA-CC: Ergo-dynamic Moving MAnikin with Cognitive Control
Speyer, June

Linn, J.; Hermannsson, T.; Andersson, F.; Schneider, F.
Kinetic aspects of discrete Cosserat rods based on the difference geometry of framed curves
Prag (CZ), June

Linn, J.; Roller, M.; Obentheuer, M.
Simulationsgestützte ergonomische Gestaltung von Montagearbeitsplätzen
Mannheim, April

Matheis, C.; Baccouche, B.; Friederich,F.; Jonuscheit, J.
Terahertz-Messtechnik als komplementäre Prüftechnik bei Verbundwerkstoffen
Seminar des FA Ultraschallprüfung, Berlin, November

Merten, Dirk
ALOMA - An Auto-Parallelization Tool for Seismic Processing
79th EAGE Conference & Exhibition 2017 Workshop Program, Paris (F), June

Michel, Isabel
FPM: Finite Pointset Method vs Familien-Planung Modern
Workshop Women in Computational Engineering, University Kaiserslautern, August

Michel, I.; Kuhnert, J.; Mack, R.
MESHFREE simulations for turbine applications
9th International Workshop Meshfree Methods for Partial Differential Equations, Bonn, September

Michel, I.; Kuhnert, J.; Nick, F.; Metsch, B.
MESHFREE simulation in continuum and fluid mechanics: From geomechanical to medical applications
Workshop Geomathematics Meets Medical Imaging, Speyer, September

Molter, D.; Trierweiler, M.; Ellrich, F.; Jonuscheit, J.; von Freymann, G.
Improvement of Terahertz Time-Domain Spectroscopy Precision by Interferometrically Tracked Delay-Lines
SPIE Photonics West 2017, San Francisco (USA), January

Molter, D.; Trierweiler, M.; Ellrich, F.; Jonuscheit, J.; von Freymann, G.
Precision Enhancement in Terahertz Time-Domain Spectroscopy
32nd URSI GASS, Montreal (CDN), August

Molter, Daniel; Trierweiler, Manuel; Ellrich, Frank; Jonuscheit, Joachim; von Freymann, Georg
Stability and Precision Enhancement of Terahertz Time-Domain Spectroscopy Systems by Interferometry-Aided Delay Lines
German THz Conference 2017, Bochum, March

Neusius, David; Orlik Julia; Shiryaev, Vladimir
Computational truss model for large knitted structures of hyperelastic strings with Coulomb friction and adhesion
International Symposium on Multiscale Computational Analysis of Complex Materials, Kopenhagen (DK), August und 5th International Conference on Computational Contact Mechanics, Lecce (I), July

Niedziela, Dariusz; Rau, Sebastian; Steiner, Konrad
Simulation von Schüttgutströmungen zur Auslegung verfahrenstechnischer Apparate und Prozesse
Fachausschuss »Prozesssimulation« der DKG, Freiburg, March

Obentheuer, M.; Roller, M.; Björkenstam, S.; Berns, K.; Linn, J.
Human like motion generation for ergonomic assessment - a muscle driven Digital Human Model using muscle synergies
Prag (CZ), June

Osterroth, S.; Steiner, K.
Modeling and simulation of chromatographic processes
Tag der Verfahrenstechnik, Kaiserslautern, October

Pfreundt, Franz-Josef
BeeGFS
16th HLRS/hww Workshop on Scalable Global Parallel File Systems - „Memory Class Storage, March

Pfreundt, Franz-Josef
BeeGFS and BeeOND – Progress and Experience
HP-CAST 28, Frankfurt, June and HP-CAST 29, Denver (USA), November

Pfreundt, Franz-Josef
Memory Driven Computing
Invited talk: Third EAGE Workshop on High Performance Computing for Upstream, Athen (GR), October

Pfreundt, Franz-Josef
Thoughts about the future of I/O
Challenges and Opportunities of User-Level File Systems for HPC, Schloss Dagstuhl, Wadern, May

Phutane, U.; Roller, M.; Björkenstam, S.; Linn, J.; Leyendecke, S.
Kinematic validation of a human thumb model
Prag (CZ), June

Pierrat, S.; Liu, C.; Kamps, J.H.; Leenders, C.; Guise, O.; Cheng, X.; Schladitz, K.
Glass fibers pull out length measurement
EMRS, May

Prill, Torben; Iliev, Oleg
Reactive Flow in Random Porous Media
12th European Congress for Stereology and Image Analysis 2017

Prill, Torben; Iliev, Oleg; Printsypar, Galina; Ladawala, Zahra
Simulation of Reactive Transport in Porous Media
Tag der Verfahrenstechnik, Kaiserslautern, October

Rahn, Mirko
Datenmanagement bei High Performance Anwendungen
FZ Jülich, January

Rahn, Mirko
ExaGASPI
ISC 2017, Frankfurt, June

Rahn, Mirko
The old challenge: How to support users?
Dagstuhl Seminar 17541 „New challenges in parallelism", November

Rau, Sebastian
Kontinuumsmechanische Simulation von Granulaten mit der Anwendung pneumatischer Transport
Schüttgut Messe Dortmund, May

Rau, Sebastian
Simulation von Granulaten Simulationsanwendung: Rührgerät
GVT Zukunftsworkshop AK1, November

Reinhard, R.; Kleer, M.; Dreßler, K.
Interactive simulations to prove and validate safety critical onboard systems
Mainz, October

Reinhard, R.; Kleer, M.; Dreßler, K.
The impact of subjective simulator experiences on usability and driving behavior in a state of the art driving simulator
Stuttgart, September

Reinhard, R.; Kleer, M.; Dreßler, K.
The impact of subjective simulator experiences on usability evaluations
Braunschweig, November

Renner, M.; Angermann, Marie-Christin; Muschol, Daniel; von Freymann, Georg
A deterministic aperiodic approach to 3D photonic structures with tailored disorder
Spring School SPP 1839, Karlsruhe, May

Roller, M.; Björkenstam, S.; Linn, J.; Leyendecker, S.
Optimal control of a biomechanical multibody model for the dynamic simulation of working tasks
Prag (CZ), June

Roller, M.; Gallrein, A.; Linn, J.; Betsch, P.
A Tire Model Based on Geometrically Exact Shells for Modal Analysis in Steady State Rolling
Funchal (E), April

Rösch, Ronald
Blick über den Tellerrand der klassischen Oberflächeninspektion
Fraunhofer IOSB Karlsruhe, December

Rösch, Ronald
Innovation durch Algorithmik
10. Fraunhofer Vision Technologietag, Fürth, October

Rösch, Ronald
Modellierung und optische Kontrolle geflochtener Stents
FVTT, Kaiserslautern, September

Schladitz, Katja
3D Bildanalyse für die Strukturoptimierung
Fraunhofer-Leichtbautagung, Halle, November

Schladitz, Katja
Analyse von Faserdicke, Faserorientierung und Wolkigkeit anhand mikroskopischer Bilder mit MAVIfiber2d
FVTT, Kaiserslautern, September

Schmeißer, Andre
Modeling and simulation of contacts and laydown in lightweight nonwoven production processes
Nonwovens Innovation Academy, Chemnitz, November

Schneider, F.; Burger, M.; Arnold, M.; Simeon, B.
Force-displacement co-simulation by the use of kinematic coupling constraints
Darmstadt, September

Schneider, F.; Kleer, M.; Pena Vina, E.; Linn, J.; Weyh, T.; Mühlbach, C.
Introduction to MeSOMICS
Speyer, June

Schneider, F.; Linn, J.; Dreßler, K.
Simulation-based dynamic stress analysis for cables and hoses
Hanau, April

Schneider, F.; Linn, J.; Dreßler, K.; Roller, M.; Sadiku, V.; Stephan, T.
Integration of Cable Dynamics and Fatigue Analysis into IPS Cable Simulation
Speyer, June

Schneider, F.; Linn, J.; Hermansson, T.; Andersson, F.
Cable Dynamics and Fatigue Analysis for Digital Mock-Up in Vehicle Industry
Prag (CZ), June

Schreiner, N. S.; Baccouche, B., Sauer-Greff, W.; Urbansky, R.; Friederich, F.
A Transfer Matrix Modification for Accurate Terahertz FMCW Thickness Measurements
10th UK-Europe-China Workshop on Millimetre Waves and THz Technologies (UCMMT2017), Liverpool (GB), September

Schreiner, N. S.; Baccouche, B., Sauer-Greff, W.; Urbansky, R.; Friederich, F.
An accurate frequency-modulated continuous-wave method for fast terahertz thickness measurements
SPIE Photonics West 2017, San Francisco (USA), January

Schreiner, N. S.; Baccouche, B., Sauer-Greff, W.; Urbansky, R.; Friederich, F.
High-Resolution FMCW Terahertz Thickness Measurements
47th European Microwave Conference (EuMC), Nürnberg, October

Schreiner, N. S.; Friederich, F.
Dickenmessungen mittels Terahertz-Radar
DGZFP Jahrestagung, Koblenz, May

Schröder, Simon
STRING 3: Zukunftsweisende 3D-Visualisierung instationärer Strömungsfelder
delta h Ingenieurgesellschaft Jubiläumstagung 40 Jahre SPRING, Witten, December

Schwientek, Jan
Numerical Methods for General (ized) Semi-infinite Optimization
Seminar on Nonlinear Optimization and Inverse Problems, WIAS, Berlin, April

Schwientek, J.; Nowak, D.; Bortz, M.
Advances in Pareto Frontier Approximation and Navigation
Tag der Verfahrenstechnik, Fraunhofer-Zentrum Kaiserslautern, October

Shah, K.; Reinhard, R.; Christmann, C.; Lachmann, T.
The effects of virtual reality avatar embodiment on real life walking speed: The temporal stability of the Proteus Effect
Dresden, March

Steidel, S.; Burger, M.
Co-simulation in the vehicle development process
Stuttgart, October

Stephani, Henrike
Typischer Aufbau und Beispiele für Algorithmen von Oberflächeninspektionssystemen
Fraunhofer IOSB Karlsruhe, December

Suchde, P.; Kuhnert, J.; Tiwari, S.
Accuracy in Meshfree GFDM Schemes for the Incompressible Navier-Stokes Equations
USNCCM 14, Montreal (CAN), July

Vogel, M.; Aßmann, R., Pirro, P.; Chumak, A.V.; Hillebrands, B., von Freymann, G.
Spin-Wave Mode Conversion via Optically Induced Landscapes of the Saturation Magnetization
DPG Frühjahrstagung 2017, Dresden, March

Vogel, Marc; Aßmann, R.; Pirro, P, Chumak, A.V.; Hillebrands, Burkhard, von Freymann, Georg
Optically Reconfigurable Magnetic Landscapes for the Control of Spin-Wave Propagation
SPIN+X YRC Student-Only Retreat, 2017, Kaiserslautern

TEACHING ACTIVITIES

von Freymann, Georg
Terahertz-Bildgebung: Aus dem Labor in die Anwendung
64. Workshop des Heidelberger Bildverarbeitungsforums: 3D-Bildaufnahme mit durchdringender Strahlung, Fürth, March

Wächtler, Timo; Kuhnert, Jörg
Towards a meshfree Finite Difference Model for Reactive Mixing Problems
USNCCM 14, Montreal (CAN), July

Walczak, M.; Heese, R.; Bortz, M.
Modelle aus Simulationsdaten: Mit Machine Learning Fließbildsimulatoren verbessern
Tag der Verfahrenstechnik, Fraunhofer-Zentrum Kaiserslautern, October

Waller, E. H.; Hering, J.; von Freymann, G.
Optimized nanostructures via direct laser writing: physical and chemical approaches
META 2017, Incheon (ROK), July

Waller, Erik, H.; Hering, Julian; Jörg, Christina ; von Freymann, Georg
Spatial light modulator based 3D direct laser writing
634. WE-Heraeus-Seminar: Merging Micro- and Nano-Optics: 3D Printing of Advanced and Functional Optics, Bad Honnef, January und 15th Fraunhofer IISB Lithography Simulation Workshop 2017, Behringersmühle, September

Weber, Peter K.; Friederich, Fabian
Aktuelle Ergebnisse bildgebender Verfahren an Skulpturen
Workshop Zerstörungsfreie Prüf- und Analysemethoden in der Restaurierung und Oberflächentechnik, Berlin, April

Weber, Stefan; Klier, Jens; Ellrich, Frank; Paustian, S.; Guetller N.; Tiedje, O.; Jonuscheit, Joachim; von Freymann, Georg
Thickness Determination of Wet Coatings Using Self-Calibration Method
Infrared, Millimeter, and Terahertz Waves (IRMMW-THz), 42nd International Conference Cancun (Mex), August

Weisenstein, C.; Kahl, M., Friederich, Fabian, Haring Bolívar, P.
Conception and realization of a semiconductor based 240 GHz full 3D MIMO imaging system,
SPIE Photonics West 2017, San Francisco (USA), January

Zausch, Jochen; Hofmann, Tobias
Advanced Simulation Topics with BEST
BatteryDict/BEST Short Course, Kaiserslautern, September und GeoDict User-Meeting (Subcommitee Electrochemistry), Tokio (J), October

Zausch, Jochen; Hofmann, Tobias
Lithium ion batteries with BatteryDict and BEST
GeoDict User-Meeting, Tokio (J), October und GeoDict User-Meeting, Nagoya (J), October

Andrä, Heiko
Höhere Mathematik in der Anwendung
DHBW Mannheim

Andrä, Heiko
Kontaktmechanik
University Kaiserslautern, Winter term 2017/18

Andrä, Heiko; Kabel, Matthias
Ausgewählte Kapitel aus der Mechanik
University Kaiserslautern

Bitsch, Gerd
Professur für Mechatronik, Robotik und CAE-Simulation
University of Applied Sciences Kaiserslautern, Dept. of Applied Engineering Sciences

Bortz, Michael
Datenauswertung und Versuchsplanung
University Kaiserslautern, Summer term 2017

Bortz, Michael
Modellierung, Simulation und Optimierung in der Verfahrenstechnik
University Kaiserslautern, Winter term 2017/18

Bortz, Michael
Ringvorlesung „Smart Systems Engineering"
University Kaiserslautern, January 2017

Dreßler, Klaus
Durability Load Data Analysis
University Kaiserslautern, Summer term 2017

Friederich, Fabian
Millimeterwellen und Terahertz Technologien
University Kaiserslautern, Dept. of Physics, Winter term 2017/18

Kleer, Michael
Robotik 1
University of Applied Sciences Kaiserslautern, Winter term 2016/2017 und 2017/2018

Korn, Ralf
Professur für Stochastische Steuerung und Finanzmathematik
University Kaiserslautern, Dept. of Mathematics

Küfer, Karl-Heinz
Probability and Algorithms
University Kaiserslautern, Winter term 2017/18

Küfer, Karl-Heinz
Theory of Scheduling Problems
University Kaiserslautern, Summer term 2017

Prätzel-Wolters, Dieter
Professur für Technomathematik
University Kaiserslautern, Dept. of Mathematics

Rau, Sebastian
Mathematik-Tutorien
DHBW Mannheim

Rau, Sebastian
Simulationstechnik
DHBW Mannheim

von Freymann, Georg
Professur für Optische Technologien und Photonik
University Kaiserslautern, Dept. of Physics,

von Freymann, Georg; Friederich, Fabian; Molter, Daniel; Kaiser, Christoph
Hauptseminar II: Terahertz-Physik
University Kaiserslautern, Dept. of physics, Winter term 2017/18

PARTICIPATION IN FAIRS AND CONFERENCES

ACM SIGGRAPH Symposium on Interactive 3D Graphics and Games
San Francisco (USA), February, Lecture

Advanced Solid State Lasers Conference (ASSL)
Nagoya (J), October, Lecture

ADept. ofW Symposium Simulation von Nadelvliesstoffen
Albstadt, May, Lecture

Altair Technology Conference 2017
Frankenthal, June, Exhibitor

Automotive CAE Grand Challenge 2017
Hanau, April, Exhibitor, Lecture

BDVA Annual Summit
Versailles, November

64. Bildverarbeitungsforum »3D-Bildaufnahme mit durchdringender Strahlung«
Fürth, March

65. Bildverarbeitungsforum »Embedded Vision Systeme: Leistungsfähigkeit und Programmierung«
Mannheim, July

66. Bildverarbeitungsforum »Mensch-Maschine-Interaktion mit Vision«
Freiburg, October

Bordnetz Kongress 2017
Landshut, September, Exhibitor, Lecture

2. Bremer Faserverbundtage
Bremen, September

Bunsentagung 2017
Kaiserslautern, May, Poster

Carl-Cranz-Gesllschaft, Seminar: 17VS 10.06 Detektion von Explosivstoffen
Pfinztal, November, Lecture

CeBIT
Hannover, March, Exhibitor

CLEO: QELS-Fundamental Science 2017
San Jose (USA), May, Lecture

Conference on Lasers and Electro-Optics/Europe and the European Quantum Electronics Conference CLEO Europe
München, June

Control 2017
Stuttgart, May, Exhibitor

Cooperation Symposium for TioP Universities and Institutes
Jiangsu (CDN), July, Exhibitor

CVC-Jahrestagung
Mainz, March, Exhibitor, Lecture

CVC-Jahrestagung
Boppard, October, Exhibitor

Daimler EDM-CAE Forum 2017
Stuttgart, July, Exhibitor

DGZFP Jahrestagung
Koblenz, May, Lecture

DGZfP-Seminar Zerstörungsfreie Prüfung an GFK und GFK-Klebeverbindungen
Wittenberge, August, Lecture

Discrete, Nonlinear and Disordered Optics (DINDOS17
Dresden, May, Poster

DPG-Frühjahrstagung 2017
Mainz, March, Lecture, Poster

DSC 2017 Driving Simulation Conference 2017 Europe
Stuttgart, September, Lecture

DVM-Tagung: (R)Evolution des Antriebs – Auswirkung auf die Betriebsfestigkeit der Bauteile in der Wirkungskette
Friedrichshafen, October, Exhibitor, Lecture

DVM-Workshop: Prüfmethodik für Betriebsfestigkeitsversuche in der Fahrzeugindustrie
Ottobrunn, January, Lecture

DVM-Workshop: Zuverlässigkeit und Probabilistik
München, November, Lecture

EAGE 2017
Paris (F), June, Exhibitor, Lecture

ECCOMAS
Prag (CZ), June, Lecture

EGU General Assembly 2017
Wien (A), April, Poster

20. Energietag Rheinland-Pfalz
Bingen, September, Exhibitor

ERA-NET SG+ Knowledge Community Working Group Meeting
Bukarest (RO), June

EUROMECH
Funchal (PT), April, Lecture

12th European Congress for Stereology and Image Analysis
Kaiserslautern, September, Lecture

European Meeting of Statisticians (EMS)
Helsinki (FIN), July

47th European Microwave Conference (EuMC)
Nürnberg, October, Lecture

European Radar Conference EuRAD 2017
Nürnberg, October

E-World Energy & Water 2017
Essen, February, Exhibitor

3. Fachseminar des FA MTHz: Mikrowellen- und Terahertz-Prüftechnik in der Praxis
Würzburg, April, Exhibitor, Lecture

7. Fachtagung Smart Grids und Virtuelle Kraftwerke
Worms, March, Exhibitor

Forschen in Europa
Mannheim, January

15th Fraunhofer IISB Lithography Simulation Workshop 2017
Behringersmühle, September, Lecture

10. Fraunhofer-Vision Technologietag
Fürth, October, Exhibitor, Lecture

Fraunhofer-Symposium Netzwert
München, February, Lecture

7th GACM Colloquium on Computational Mechanics (GACM2017)
Stuttgart, October, Lecture

88th GAMM Annual Meeting
Ilmenau, March, Lecture

GeoDict User-Meeting
Kaiserslautern, September, Lecture

GeoDict User-Meeting
Nagoya (J), October, Lecture

GeoDict User-Meeting
Tokio (J), October, Lecture

German Terahertz Conference
Bochum, March, Lecture

Hannover Messe
Hannover, April, Exhibitor

High-Performance Graphics 2017
Los Angeles (USA), July, Lecture

HiPEAC Spring CSW
Zagreb (HR), April

Hofer Vliesstofftage
Hof, November, Exhibitor, Lecture

HP CAST 28
Frankfurt, June, Lecture

HP CAST 29
Denver (USA), November, Lecture

IAVSD 2017
Queensland (AUS), August, Lecture

IEEE MTT-S International Microwave Symposium
Honolulu (USA), June, Lecture

20th IFAC World Congress 2017
Toulouse (F), July, Poster

INDEX 2017
Genf (CH), April, Exhibitor, Lecture

Industrieworkshop Digitale Technologien für Fasern, Vliesstoffe und technische Textilien
Kaiserslautern, September, Exhibitor, Lecture

42nd International Conference on Infrared, Millimeter, and Terahertz Waves
Cancun (MEX), August, Lecture

International Conference on Porous Media, Intpore
Rotterdam (NL), May, Poster

International Ruhr Energy Finance Conference
Essen, September, Lecture

International Textile Conference
Stuttgart, November/December, Lecture

AWARDS AND PRIZES

International Workshop Adhesion and Friction: Simulation, Experiment, Applications
Berlin, November

16. Internationale VDI-Tagung ‚Reifen-Fahrwerk-Fahrbahn' 2017
Hannover, October, Lecture

Intersolar 2017
München, June, Exhibitor

IPS Cable Simulation User Conference 2017
Speyer, June, Exhibitor, Lecture

IQPC Non Road Mobile Machinery: Functional Safety
Mainz, October, Lecture

ISC High Performance 2017
Frankfurt, June, Exhibitor, Lecture, Poster

IUTAM Symposium
Darmstadt, September, Lecture

Jahresworkshop Fraunhofer-Allianz Verkehr
Dortmund, May

Kaiserslautern Research Matching (karema)
Kaiserslautern, December, Lecture, Workshop

Kooperation Fraunhofer mit HS angewandte Wissenschaft
München, May

8. Landshuter Leichtbau-Colloquium
Landshut, April, Lecture

Laser World of Photonics
München, June

Magnonics 2017
Oxford (UK), August, Poster

MathFinance
Frankfurt, April

META 2017
Incheon (ROK), July, Lecture

MFC 2017
Dornbirn (A), September, Lecture

Mikrowellen- und Terahertz-Prüftechnik in der Praxis
Fürth, April, Lecture

MINT-EC-Schulleitertagung
Kaiserslautern, November, Exhibitor

Modval KA
Karlsruhe, March

NART 2017
Liberec (CZ), September, Lecture

Nonwovens Innovation Academy
Chemnitz, October, Lecture

Optence Jahrestagung
Mainz, March, Exhibitor

OSCAR Retreat
Marienburg, July, Poster

Qualität im faserverstärkten Leichtbau - CFK, GFK, FVK
Stuttgart, March, Lecture

SC 17, Supercomputing 2017
Denver (USA), November, Exhibitor

Schüttgutmesse
Dortmund, May, Lecture

SEG International Exposiotion 2017
Houston (USA), October, Exhibitor

Seminar »Inspektion und Charakterisierung von Oberflächen mit Bildverarbeitung«
Karlsruhe, December, Exhibitor, Lecture

Seminar des FA Ultraschallprüfung
Berlin, November, Lecture

SDept. of 926 Doktorandenretreat 2017
Mannheim, June, Lecture

SIGGRAPH 2017
Los Angeles (USA), August

SPIE Photonics West 2017
San Francisco (USA), January, Lecture

SPIN+X YRC Student-Only Retreat, 2017
Kaiserslautern, March, Lecture

Spring School SPP 1839
Karlsruhe, May, Lecture, Poster

2. Symposium „Digitale Menschmodelle in industriellen Anwendungen"
Stuttgart, February, Lecture

3rd Symposium Driving Simulation 2017
Braunschweig, November, Lecture

Tag der Verfahrenstechnik
Kaiserslautern, October, Lecture

TeaP 2017 - 59th Conference of Experimental Psychologists
Dresden, March, Lecture

Techtextil 2017
Frankfurt/Main, May, Exhibitor

TERATEC Conference
Palaiseau cedex (F), June, Poster

9th THz-Days
Dunkirk (F), June, Lecture

Tire Technology Expo 2017
Hannover, February, Lecture

14th U.S. National Congress on Computational Mechanics
Montreal (CDN), July, Exhibitor, Lecture

10th UK-Europe-China Workshop on Millimetre Waves and THz Technologies (UCMMT 2017)
Liverpool (GB), September, Lecture

32nd URSI GASS
Montreal (CDN), August, Lecture

VI-grade Users Conference
Turin (I), May

634. WE-Heraeus-Seminar: Merging Micro- and Nano-Optics: 3D Printing of Advanced and Functional Optics
Bad Honnef, January, Lecture, Poster

64. Workshop des Heidelberger Bildverarbeitungsforums: 3D-Bildaufnahme mit durchdringender Strahlung
Fürth, March, Lecture

8th Workshop on the Mathematical Foundations of Traffic
Rom (I), March

Workshop: Recent Advances in Multi-Objective Optimization
Kaiserslautern, October, Lecture

Workshop: Zerstörungsfreie Prüf- und Analysemethoden in der Restaurierung und Oberflächentechnik
Berlin, April, Lecture

Dreßler, Klaus; Stephan, Thomas
Article of the year 2017
Journal "Elektronik"
September

Roller, Michael
Best paper award
ECCOMAS Thematic conference on MULTIBODY DYNAMICS
June

OWN EVENTS

bild der wissenschaft: Vorstellung »Volumenoptimierung beim Edelsteinschliff« als Teil einer Leserreise
Kaiserslautern, May

Bildhauersymposium 2017 des Kunstvereins Skulpturen Rheinland-Pfalz e. V.: Vernissage
Kaiserslautern, June

Die Sendung mit der Maus: Mausöffnertag in der Bildverarbeitung
Kaiserslautern, October

ECSIA
Kaiserslautern, September

Gesundheitstage am Fraunhofer-Zentrum
Kaiserslautern, April, August

Industrieworkshop: Digitale Technologien für Fasern, Vliesstoffe und Technische Textilien
Kaiserslautern, September

International Autumn Workshop: Networks and Uncertainty
Kaiserslautern, September

International Workshop: Models and Methods of Robust Optimization
Kaiserslautern, March

IPS Cable Simulation User Conference 2017
Technikmuseum Speyer

Jahrestagung der Felix-Klein-Akademie: Modellierungsworkshop
Kaiserslautern, September

KL-Regelungstechnik: Seminarreihe zu Regelungsthemen, mathematischen Methoden und technische Umsetzung
Kaiserslautern, ganzjährig, einmal im Monat

Kurs: Deep Learning
Kaiserslautern, achtmalig im Jahr

Kurs: Python für wissenschaftliche Anwendungen
Kaiserslautern, February

Mathe-Camp des Felix-Klein-Zentrums für Mathematik
Kaiserslautern, March

Schulung: Data Scientist for Smart Energy Systems
Kaiserslautern, June, November

Semina: Statistische Methoden in der Betriebsfestigkeit
Kaiserslautern, September

Seminar: Lastdaten-Analyse, Bemessung, Simulation
Kaiserslautern, September

Short Course: BatteryDict / BEST
Kaiserslautern, September

Strategisches Netzwerktreffen mit Alumniveranstaltung
Kaiserslautern, December

Tag der Verfahrenstechnik
Kaiserslautern, October

Technologietag: Jurojin – Statistik für Versuche zur Betriebsfestigkeit
Kaiserslautern, September

Technology day on geo-referenced analysis and usage simulation for vehicle development
Kaiserslautern, September

Workshop: PIA-Basismodell
Kaiserslautern, June

Lecturesreihe »Blick über den Tellerrand«
Kaiserslautern

Klassischer Chor der University Kaiserslautern und Frieder Reininghaus
Musikpublizist, Köln
Franz Schuberts „Winterreise" – Melancholie und Biedermeier oder musikalischer Ausdruck des VorMarch?
January

Sturm, Volker
Hirnchirurg, Universitysklinikum Würzburg
Tief im Hirn – Chirurgie in höchster Präzision
February

Zimmerli, Walther Ch.
Philosoph, Humboldt-University zu Berlin
Künstliche Intelligenz oder Cyborg? Digitalisierung als Koevolution von Mensch und Technologie
March

GUESTS

Matz, Sandra
Psychologin, University Cambridge (UK)
Big Data, Psychografisches Profiling und die Zukunft digitalen Marketings. Wie Präsidenten gemacht und Waren beworben werden
May

Eifler, Dietmar
Materialwissenschaftler, University Kaiserslautern
Life unlimited – Gibt es unendlich lange lebende Bauteile?
June

Klassischer Chor der University Kaiserslautern
Sunday Lunch with Henry and Emilio
July

Ströfer, Eckhard
Verfahrenstechniker, University Kaiserslautern
Im Risiko – Warum Innovation so schwierig ist
July

Lengauer, Thomas
Informatiker, Max-Planck-Institut für Informatik, Saarbrücken
Big Data - Macht, Suggestivität, Grenzen und Risiken
September

Springel, Volker
Astrophysiker und Kosmologe, University Heidelberg
Simulierte Universen: Ursprung und Schicksal unserer Milchstraße
October

Trischler, Helmuth
Technikhistoriker, Deutsches Museum, München
Anthropozän – das menschengemachte Zeitalter
November

Moldaschl, Manfred F.
Sozioökonom, Zeppelin University, Friedrichshafen
Wo bestellt man eigentlich geistige Freiheit?
December

Arnold, Martin
(Martin-Luther-University Halle-Wittenberg)
Cosserat rod modeling
March

Bruls, Olivier
(University Lüttich (B))
Cosserat rod modeling
March

Celledoni, Elena
(NTNU Trondheim (N))
Cosserat rod modeling
March

Ciegis, Raimondas
(Vilnius Gediminas Technical University, Vilnius (LT))
Numerical algorithms for problems with fractional powers of elliptic operators
September

den Hertog, Dick
(Tilburg, University (NL))
Tutorial on robust optimization
March

Franke, Jürgen
(University Kaiserslautern, AG Statistik)
Machine Learning – Grundlagen und Beispiele
March

Fritzen, Felix
(University Stuttgart)
Computer assisted material modeling: ROM and DATA
December

Gerstmayr, Johannes
(University Innsbruck (A))
Cosserat rod modeling
March

Gerstmayr, Johannes
(University Innsbruck (A))
Recent developments on absolute coordinate formulations
August

Griso, Georges
(University Pierre und Marie Curie, Paris (F))
Numerical algorithms for problems with fractional powers of elliptic operators
March

COLLABORATION IN BOARDS, EDITORSHIP

Hecht, Heiko
(Johannes Gutenberg-University Mainz)
RODOS / REDAR
February

Henrion, René
(Weierstrass Institut for Applied Analysis and Stochastics Berlin)
On a joint model for probabilistic/robust constraints with an application to gas networks under uncertainties
March

Lakdawala, Zahra
(DHI WASY GmbH, Berlin)
Hydro-Mechanical Coupling in Fractured and Granular Media: Modeling and numerical simulation
December

Latz, Arnulf
(Helmholtz Insitut, Ulm)
Batteriesimulation
April

Lavrov, Alexander
(Fachhochschule Kaiserslautern-Pirmasens)
Discrete Event Simulation / Plant Simulation
May

Lazarov, Raytcho
(Texas AM University (USA))
Numerical methods for fractional advection-dispersion equations
January

Leyendecker, Sigrid
(Friedrich-Alexander-University Erlangen-Nürnberg)
Cosserat rod modeling
March

Meier, Christoph
(MIT, Massachusetts (USA))
Geometrically exact finite element formulations for slender beams: Kirchhoff-Love theory vs. Simo-Reissner theory
July

Nagapetyan, Tigran
(Oxford University (GB))
Stochastic Gradient Optimization Method
March

Owren, Brynjulf
(NTNU Trondheim (N))
Cosserat rod modeling
March

Pflug, Georg
(University of Vienna (A))
Distributionally robust stochastic optimization
March

Porta, Giovanni
(Polytecnico di Milano (I))
Characterization of solute transport and mixing in porous media through pore-scale information
September

Printsypar, Galina
(WIAS Institut, Berlin)
Multiscale modelling of the filter efficiency experiments using homogenization theory
August

Pudasaini, Shiva
(Rheinische Friedrich-Wilhelms-University Bonn, Steinmann-Institut, Bonn (D))
Unified modelling of complex multi-phase mass flows
September

Rawal, Amit
(Indian Institute of Technology, Delhi (IND))
Analytische Modelle für Vliesstoffe
January - July

Rossi, Davide
(Universita di Bologna, Bologna (I))
Neurostream: Scalable and Energy Efficient Deep Learning with Smart Memory Cubes
September

Schöbel, Anita
(University Göttingen)
New concepts in robust optimization
March

Schultz, Rüdiger
(University of Duisburg-Essen)
Approaches to Stochastic Programming Beyond Convexity
March

Siena, Martina
(Polytecnico di Milano (I))
Characterization of channeling phenomena in pore-scale flow fields
March

Zielinski, Pawel
(Wroclaw University of Science and Technology (PL))
Robust discrete optimization under discrete and interval uncertainty
March

Gramsch, Simone
- Fachgremium Fachinformationen der Fraunhofer-Gesellschaft (Member)
- KOMMS – Kompetenzzentrum für mathematische Modellierung in MINT-Projekten in der Schule (Member of Scientific Board)
- Wissenschaftlich-Technischer Rat (WTR) der Fraunhofer-Gesellschaft (Member)

Iliev, Oleg
- CAMWA (Reviewer)
- Computational and Applied Mathematics (Reviewer)
- DFG (Reviewer)
- ETNA (Reviewer)
- Dept. of Mathematics Univ. Heidelberg (Reviewer of PhD thesis, member of examination committee)
- International Society of Porous Media, InterPore (Chair of Event Committee)
- Journal of Porous Media (Editor)
- Mathematical Methods and Analysis (Editor)
- Transport in Porous Media (Reviewer)

Kabel, Matthias
- International Journal for Numerical Methods in Engineering (Reviewer)
- Journal of Applied Geophysics (Reviewer)
- Materials and Design (Reviewer)
- Mathematical Modelling and Analysis (Editor)
- Modelling Simul. Mater. Sci. Eng. – MSMSE (Reviewer)
- Swiss National Science Foundation (Appraiser)

PATENTS

Keuper, Janis
- "Machine Learning in HPC« Workshop, ACM SIG HPC 2017 (Member im ISC High Performance Steering Committee)
- Arbeitsgruppe »Maschinelles Lernen« im Fachbeirat »Data Science« FhG Zertifizierungsstelle Chair für den DL Track bei der ISC High Performance Konferenz Co-Chair (Speaker)

Kirsch, Ralf
- Scientific Committee American Filtration Society (AFS)

Klein, Peter
- BMBF-Programm »ERA.Net RUS Plus - Novel functional nanomaterials based on design and modelling« (Reviewer)
- DFG-Programm »Materials for Additive Manufacturing - Bewertung der Prozessfähigkeit teilkristalliner Thermoplaste im Fused Deposition Modeling mittels eines mikroskaligen Berechnungsansatzes« (Reviewer)
- Heat and Mass Transfer (Reviewer)

Korn, Ralf
- European Actuarial Journal (Co-Editor)
- Quantitative Finance Series, Imperial College Press, World Scientific (Editor)
- Wissenschaftlicher Beirat DISC, University Kaiserslautern (Member)
- DFG-Graduiertenkolleg 1932 "Stochastic Models for Innovations in the Engineering Sciences" (Speaker)
- Deutsche Aktuarvereinigung (Member of the Executive Board)
- Deutscher Verein für Versicherungswissenschaften (Member of the Executive Board)
- Deutsche Gesellschaft für Versicherungs- und Finanzmathematik (Chair of the Executive Board)

Krüger, Jens
- Fachausschuss Fraunhofer Data Scientist Zertifizierung (Member)

Küfer, Karl-Heinz
- BMBF-Programm »Mathematik für Innovationen in Industrie und Dienstleistungen« (Reviewer)

Maasland, Mark
- Fraunhofer-Allianz Vision (Member)
- International Journal of Telemedicine and Clinical Practices (IJTMCP), (Reviewer)

Michel, Isabel
- Computers and Mathematics with Applications (Reviewer)

Prätzel-Wolters, Dieter
- Applied Mathematics Committee (AMC) of the European Mathematical Society (Member)
- BMBF Strategiekommittee für mathematische Modellierung, Simulation und Optimierung (KoMSO) (Member)
- European Research Centres on Mathematics ERCOM (Member)
- Felix-Klein-Zentrum für Mathematik (Chair)
- Forschungszentrum »Center of Mathematical and Computational Modeling CM²« der University Kaiserslautern (Member)
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- Stiftungsrat »Fraunhofer-Zukunftsstiftung« (Member)

Prill, Torben
- Steering Comittee des InterPore German Chapter (Member)

Rösch, Ronald
- Deutsche Gesellschaft für Materialkunde e.V. (DGM, Member)
- Deutsche Gesellschaft für Zerstörungsfreie Prüfung e.V. (DGZfP, Member)
- DGM-Arbeitskreis Tomographie (Member)
- DGM-Fachausschuss Strahllinien (Member)
- Fraunhofer-Allianz Leichtbau (Member)
- Fraunhofer-Allianz Vision (Member of Coordinating Council)
- Heidelberger Bildverarbeitungsforum (Advisory Board)

Schladitz, Katja
- Composite Structures (Reviewer)
- Image Analysis & Stereology (Reviewer)
- Journal of the Science of Food and Agriculture (Reviewer)
- Leichtbau-Cluster (Member)
- Materials Characterization (Reviewer)
- Methodology and Computing in Applied Probability (Reviewer)

Stephani, Henrike
- International Conference on Pattern Recognition (Reviewer)
- Sensors (ISSN 1424-8220; CODEN: SENSC9, Reviewer)

Fütterling, Valentin
Methods, Computer Program and Apparatus for an Ordered Traversal of a Subset of Nodes of a Tree Structure and for Determining an Occlusion of a Point along a Ray in a Raytracing Scene
US 15/814,441

Trinkaus, Hans; Malschofsky, Ralf
Steuerung eines Produktionsprozesses für extrudierte Profilbauteile
European Patent 1 719 603 B1

EDITORIAL NOTES

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