Fraunhofer
ITWM

FRAUNHOFER INSTITUTE FOR INDUSTRIAL MATHEMATICS ITWM

ANNUAL REPORT 2013/14

Front page

So lifelike are the projections employed by the interactive driving simulator RODOS® shown here: Since the end of 2013, RODOS® can be used to study the impact a vehicle's driver has on energy efficiency, safety, and fatigue life. It supplies important data regarding the human-machine interface to enable more efficient development processes in the automotive sector.

Wachstum durch Innovation — EFRE
RheinlandPfalz

ANNUAL REPORT
2013/14

CONTENT

The year 2013 was a good one for the German economy. Companies invested in R&D and there was a demand for "Mathematics for Innovation". At ITWM, this is reflected with an all-time high of more than 10 million euros in business income for more than a 47 percent share of the operating budget. Obviously, this cooperation with industry takes on a great importance for ITWM.

There are three structural elements of cooperation that characterize and drive the economic success of the institute: The cooperation with SMEs (small and medium size companies), the networking with the regional economy, and the increasing significance of foreign acquisition in the context of globalization.

The long term success of mathematics transfer to business and government is based on long term investment in basic and preliminary research. One indicator of the institute's commitment to basic research is the number of PhD positions supported. Again in 2013, there were more than 60 doctoral candidates working as research associates at ITWM. Over the years, this number has remained stable and is very high in comparison with other Fraunhofer Institutes. The corresponding output of successful dissertations contributes, among other things, to the mathematics department at Kaiserslautern leading the national rankings in the number of completed doctorates.

Another major contributing factor to the institute's growth and success are its future oriented, infrastructure investments in the areas of hardware and software as well as lab equipment. In 2013, we initiated a series of such investment measures as part of the drawdown of the institute's reserves. This includes the renewal of our IT hardware and, especially, the expansion of the computing and storage platform for computationally intensive simulations and software development. The new Linux-Cluster consists of 200 servers based on cutting edge blade technology, which enables highly efficient workflows in development and project management within a tightly integrated environment of high-performance systems and desktop environment.

In addition, a series of investments went into the construction of new and expansion of existing businesses, such as the establishment of a new lab for wood analyses and calculations, the construction of a test vehicle for compiling 3D road and environment data as well as the setup of an exascale storage and scalability lab. The Federal German state of Rhineland-Palatinate and the EU have provided massive support through the use of ERDF funding, for which I take this opportunity to again express my sincerest appreciation.

An example of one successful investment measure applied in the business area "Digital Commercial Vehicle Systems" is the interactive simulator RODOS®, which started operations in 2013 in the department of Mathematical Methods in Dynamics and Durability. The system is designed on the basis of an industrial robot with a 1000 kg payload. A seamless projection of an interactive scene is generated within a spherical projection dome having a diameter of 10 meters. The images from 18 projectors are synchronized and adapted to ensure that a very realistic perception is created by the active stereo projection. The system is used in projects to develop driver models for the improvement of human-machine interfaces as well as the development and validation of assistance systems. The simulator was a highlight at the "Night of Science" in Kaiserslautern as the projection dome was illuminated with the view of the Fritz Walter Stadium and a virtual excavator moving among burning hazardous goods and construction materials.

At the Competence Center for High Performance Computing CC HPC, one highlight of 2013 was the Fraunhofer Prize for "Global Address Space Programming Interface" (GPI). The award winners were ITWM staff members Carsten Lojewski and Rui Machado together with Christian Simmendinger from T-Systems. The most successful innovation to date at CC HPC, GPI marks a paradigm shift in parallel programming that leads to better performance for multicore systems and improved scalability. Projects related to GPI and the publication of an open source version of GPI was the central topic of the year at HPC. GPI-Space, for example, represents a powerful European alternative

to Hadoop in the world of Big Data. CC HPC was able to realize an involvement in three of the seven European exascale projects.

The year 2013 was one of renewed growth for the Optimization department and featured an extraordinarily high industrial return of nearly 60 percent. Three highlights among the industrial orders are: the INES project commissioned by BASF, which develops statistical data processing and reconciliation as a precursor for the simulation and optimization of chemical processes; the continuation of the layout planning of photo-voltaic power plants for Siemens Corporation; and a project for the emirate of Qatar for the optimization of the material flows at a bulk goods port. In the public sector, project SPARTA for adaptive radiotherapy planning began in spring 2013 with funding of more than 1.2 million euros provided by BMBF.

The Transport Processes department built an outstanding reputation in the area of simulation of manufacturing processes for the production of filaments and non-wovens – even among international competitors. This is evidenced not only by the numerous publications about topics like spunbonded processes, filament dynamics in turbulent flows, and deposit processes, but also by the wide and still growing spectrum of customers in the area of "technical textiles" and the associated plant and equipment engineering. The department continues the development of its own grid-free process, the Finite Pointset Method (FPM). The past year was characterized by the increasing complexity of the problems in continuum-mechanics that can be investigated using FPM. One spectacular example is the simulation of a water passage for a complete vehicle model.

The Flow and Material Simulation department, in spite of great personnel turbulence, had its most successful year ever. In 2013, through cooperation and fostering of long term customer relationships, a good basis was also established to achieve business success in the coming year. One example worthy of note is the productive division of labor with the spinoff company Math2Market for the marketing and advanced development of the microstructure software, GeoDict. The current combination of the microstructure simulation technology and traditional manufacturing and system simulation for complete components enables the department to accept diverse application projects in the design of filters, mixers, and mills, from innovative batteries or fuel cell elements to the functional design of fiber or particle reinforced lightweight construction materials.

I express my appreciation once again to the entire ITWM team for using their expertise so successfully over the past year in a variety of projects and with a high degree of motivation and autonomy and, in effect, ensured the scientific and economic success of ITWM.

I also say "thank you" to our customers and project partners for their continuing trust in us. We look forward to taking on new tasks and challenges with you in 2014 and I now wish you an enjoyable time reading the rest of our annual report.

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

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1 *Even the Chancellor was interested in the Patient-Navi.*

2 *Almost as nice as the child's room at home: the new parent-child office at the institute.*

ITWM DIRECTOR ONCE AGAIN WTR CHAIRPERSON

In February, Prof. Dr. Dieter Prätzel-Wolters was elected for another three year term as chairperson of the scientific and technical council (WTR) of the Fraunhofer-Gesellschaft. He has performed the duties of this office since April 2006. The WTR represents the interests of the 67 directors and their 20,000 employees and advises the executive board of Fraunhofer-Gesellschaft in matters of strategic importance. This includes, for example, recommendations regarding human resource policies and the direction of future research. Prof. Prätzel-Wolters will also have a voice in the establishment of any new Fraunhofer-Institute.

GIRLS´DAY WITH THE CHANCELLOR

On the eve of the national Girls' Day, Federal Chancellor Angela Merkel once again invited girls from Berlin's schools to a kick-off event in the Office of the Chancellor. In a career round robin with exciting exhibits, the 24 students were able to get hands on experience testing and trying out various technologies. The Fraunhofer Institute for Industrial Mathematics ITWM presented "Patient-Navi" – a fun, but realistic simulation of patient transport logistics in hospitals, which even held the interest of the Chancellor. The Girls'Day participants played the role of the dispatcher, responsible for ensuring that the patients are moved on time from one station to another and that work is distributed fairly among the transporters. They quickly learned that mathematics is not some boring arithmetic, but rather, something that helps achieve computer aided optimization of processes involving large amounts of data within complex structures.

OPENING OF THE PARENT-CHILD OFFICE

In April, ITWM achieved another milestone towards improving the compatibility of family and career: Dr. Marion Schulz-Reese, head of administration, dedicated the parent-child office in the institute building. The 17 square meter office provides the ITWM staff with an opportunity to bring their offspring to work with them in the event of a child care problem or an emergency. In case of a school cancellation or the illness of the babysitter, employees can look after their child in the parent child office while tending to their duties on the job. In addition to the work station, the parent child office is equipped with a child play area and a quiet area. There is a changing table and a pull out sofa bed, which easily converts to a crib for the little ones.

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PLAKAT WAND KUNST – A WIDE OPEN FIELD

Together with the local artistic community, a group from Karlsruhe called "Plakat Wand Kunst" organized 21 billboards along Trippstadter street and the TU campus. The views and positions expressed relative to the content and the location of the posters were those of the individual artists – the only guideline issued was the format of the billboard. This common format and overall structure of the arrangement still produced a uniform impression that greeted drivers and pedestrians with some visual variety for seven weeks as they commuted to their jobs or classes.

1 *Billboard art on display at Fraunhofer-Center: "Sequenz K" by Susanne Adam and Angelika Steinmacher plus "Starlight" by Ralph Gelbert (right)*

2 *Expected to grow with the challenges: the Fraunhöfchen Lab at ITWM*

OPENING OF THE FRAUNHÖFCHEN LAB

The Fraunhöfchen Lab is an experimentation laboratory for school children, currently used by the children in the ITWM primary school care group. Once a week, six and seven year olds meet after the homework period for some project time in the lab. There are some exciting activities in the program, like learning about microscopes or growing crystals. In addition, children use their project time to learn about what their parents do on the job at the institute. The lab is equipped with work tables, microscopes and various arts and crafts materials. There is also a collection of books conveniently located next to the seating area. The acquisition of several tablet PCs is planned for the future. Over the longer term, the Fraunhöfchen Lab should also serve as a computer and experimentation lab for school groups, for example, "Jugend forscht."

FOUNDER'S PRIZE GOES TO ITWM AND IESE

"KL gründet", an initiative of the local governments, businesses, and research institutes in the Western Palatinate region is intended to seek out people with innovative business concepts and the courage to start a business. To facilitate the step towards self-employment, promoters of innovation are also important – companies and institutions that encourage their employees to develop their own business ideas. This year, the Diemersteiner prize for supporting entrepreneurial initiative was awarded jointly to Fraunhofer Institute for Industrial Mathematics and Fraunhofer Institute for Experimental Software Engineering. Prof. Dieter Prätzel-Wolters, Director, Fraunhofer ITWM, accepted the award on behalf of both Kaiserslautern-based institutes. A listing of the spin-offs from ITWM is shown on pages 10 and 11.

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FRAUNHOFER PRIZE 2013 FOR GPI – GLOBAL ADRESS SPACE PROGRAMMING INTERFACE

1 *The award and...*

2 *... its winners: Dr. Carsten Lojewski, Dr. Christian Simmendinger, Dr. Rui Machado*

The demand for even faster, more effective, and also energy-saving computer clusters is growing in every sector. The new asynchronous programming model GPI from Fraunhofer ITWM might become a key building block towards realizing the next generation of supercomputers.

High-performance computing is one of the key technologies for numerous applications that we have come to take for granted – everything from Google searches to weather forecasting and climate simulation to bioinformatics requires an ever increasing amount of computing ressources. Big data analysis additionally is driving the demand for even faster, more effective, and also energy-saving computer clusters. The number of processors per system has now reached the millions and looks set to grow even faster in the future. Yet something has remained largely unchanged over the past 20 years and that is the programming model for these supercomputers. The Message Passing Interface (MPI) ensures that the microprocessors in the distributed systems can communicate. For some time now, however, it has been reaching the limits of its capability. "I was trying to solve a calculation and simulation problem related to seismic data," says Dr. Carsten Lojewski from the Fraunhofer Institute for Industrial Mathematics ITWM. "But existing methods weren't working. The problems were a lack of scalability, the restriction to bulk-synchronous, two-sided communication, and the lack of fault tolerance. So out of my own curiosity I began to develop a new programming model." This development work ultimately resulted in the Global Address Space Programming Interface – or GPI – which uses the parallel architecture of high-performance computers with maximum efficiency.

GPI is based on a completely new approach: an asynchronous communication model, which is based on remote completion. With this approach, each processor can directly access all data – regardless of which memory it is on and without affecting other parallel processes. Together with Rui Machado, also from Fraunhofer ITWM, and Dr. Christian Simmendinger from T-Systems Solutions for Research, Dr. Carsten Lojewski is receiving a Joseph von Fraunhofer prize this year. Like the programming model of MPI, GPI was not developed as a parallel programming language, but as a parallel programming interface, which means it can be used universally. The demand for such a scalable, flexible, and fault-tolerant interface is large and growing, especially given the exponential growth in the number of processors in supercomputers.

Even though GPI is a tool for specialists, it has the potential to revolutionize algorithmic development for high-performance software. It is considered a key component in enabling the next generation of supercomputers – exascale computers, which are 1,000 times faster than the mainframes of today.

1 *Kick-off event for the Innovation Center in February 2010*

INNOVATION CENTER APPLIED SYSTEM MODELING

In December 2013, the 4-year term of the Innovation Center "Applied System Modeling – Science Meets Engineering" ended. The effort focused on bringing together expertise in the areas of research and teaching. The participants included TU Kaiserslautern and the Fraunhofer Institutes IESE, ITWM as well as the IPM department of Materials Characterization and Testing. At the TU, the main focus was in the departments of computer science and mathematics, although cooperation took place with other departments too, in particular the engineering sciences. The aim was to establish an efficient means of knowledge transfer between the disciplines and actual research projects. The Innovation Center concept received a positive evaluation in March 2012, by an external panel of experts representing the scientific and business communities. The success of the first Kaiserslautern Innovation Center is evident not only in the amount of external funding made available, but also in the diverse joint scientific and economic projects that are reflected in the form of joint doctoral dissertations and publications generated over the term of the funding. In addition, the project results illustrate the networks established between the participating disciplines. It must be noted that these results were possible because of the multidisciplinary approach that recognized the need for expertise from several domains.

The Innovation Center for Applied System Modeling for Computational Engineering (ASM4CE, 2014-2016) focuses on the industrial application of innovative research achievements in the engineering fields: hierarchical multi-scale modeling of complex technical processes, virtual design of lightweight components, prognosis and control of embedded systems, and cyber-physical systems. ASM4CE contributes to the increasing importance of mathematics and computer science in the engineering sciences. The innovation in these fields is increasingly based on software and information systems. Modeling, simulation, optimization, and their use in software and safety-related systems are all essential today as cross domain components in the context of quality assurance, forecasting, and decision support in product development and process optimization.

In addition to Fraunhofer-Gesellschaft Kaiserslautern, participation in the ASM4CE includes the TU Kaiserslautern Departments of Computer Science, Mathematics, Mechanical and Process Engineering, Electrical Engineering and Information Systems as well as Civil Engineering. The total cost of the ASM4CE Innovation Center amounts to 4.8 million euros for a period of three years, with funding provided 50 percent by the state of Rhineland-Palatinate and 50 percent by the Fraunhofer-Gesellschaft.

SPIN-OFFS

1 *Neighbors: Fraunhofer ITWM and the Business + Innovation Center*

The Kaiserslautern Business + Innovation Center BIC is located in the vicinity of the Fraunhofer Center and supports entrepreneurs in taking their first step towards self-employment as well as leasing office space to small companies. Fraunhofer ITWM also makes use of this service as reflected by the fact, of the ten companies currently operating out of the BIC, four are spin-offs from the institute.

fleXstructures

Since January 2013, fleXstructures has been housed at the BIC. The start-up is a spin-off from the department of Mathematical Methods in Dynamics and Durability and mainly markets the IPS software, which is developed in collaboration with the Fraunhofer-Chalmers Research Centre for Industrial Mathematics in Göteborg (S). IPS Cable Simulation is a support tool used in both the automotive and commercial vehicle sectors as well as in the aerospace and mechanical engineering fields to insure the efficient installation of flexible components such as cables and hoses. Within each of these sectors there are three major processes that benefit greatly from IPS Cable Simulation: Design, Virtual Assembly, and Digital Security. Another module, IPS Virtual Paint, is ready to market and is useful for the analysis and optimization of coating processes on complex surfaces like vehicle bodies. FleXstructures now employs three permanent staff and three research assistants.

Sharp Reflections

ITWM teamed with Norwegian oil and gas company StatOil Hydro to develop a software product for the evaluation of geophysical data that can be deployed in the oil industry. Sharp Reflections was established in 2009 as a spin-off from the Competence Center High Performance Computing for the purpose of marketing this software. The great advantage of the ITWM software compared to other products is its use of parallel computing systems in place of large scale mainframes as well as the high speed at which firms can interactively evaluate their own data. A subsidiary, Sharp Reflections AS, serves customers and partners in Norway where, mainly, services like training and consulting are provided to customers in how to use the software and evaluate the geophysical data. Further foreign expansion is already planned for 2014. In Germany and Norway, Sharp Reflections employs six permanent staff as well as two consultants in the UK.

2 *The Math2Market team at the award ceremony for the 1,2,3, Go Awards in Kaiserslautern*

Math2Market

Math2Market was spun-off in 2011 from the department of Flow and Material Simulation and is now the largest of the ITWM spin-offs with nine employees and four external staff. The company is specialized in computer aided materials development with the virtual material lab GeoDict. The software is characterized by three main features: First, the capability of importing 2-dimensional and 3-dimensional images of actual materials; second, the option of geometrically modeling existing and new materials and, third, the possibility to predict the properties of existing and new materials. The latter can be performed either by exporting the structures to third party software or directly with GeoDict software through a geometric analyses and evaluation of the solutions to partial differential equations that describe processes like flow, heat conduction, diffusion, or deformation. GeoDict users can create new composites or new porous media in the computer by trial and error instead of having to rely on the traditional method of production and subsequent experimentation. In January 2013, in addition to the distribution rights, Math2Market acquired all rights to the development of GeoDict from Fraunhofer-Gesellschaft. In other words, besides software sales and consulting projects, now Math2Market can also perform customer-specific development of GeoDict. However, technology based new development will continue to be addressed in close cooperation with Fraunhofer ITWM. In September 2013, Math2Market received an award for its business plan from 1,2,3,Go. This prize is awarded by a consortium of companies in the greater Palatinate/Saarland, Lorraine, Luxembourg, and Belgium region to support innovative entrepreneurial ideas – Math2Market is one of ten winning start-ups.

ThinkParQ

The most recent spin-off from ITWM, ThinkParQ, is mainly involved in the sale and support of FhGFS, a parallel file system in which data is automatically distributed to multiple servers, which makes access much faster. The aim of ThinkParQ is to extend the deployment of FhGFS to other fields, beyond (scientific) high performance computing, for example, to the media industry with the new high definition video formats, etc. where, of course, there is also a growing need for storage systems that can handle such amounts of data. The agreement which gives ThinkParQ exclusive distribution rights to FhGFS – soon to be BeeGFS (Bee Global File System), has been in effect since January 2014. The company currently has three employees.

Dr. Marion Schulz-Reese, Christian Peter, Mirko Spell, Sylvia Gerwalin,
Tino Labudda, Martin Vogt, Claudia Nickel, Dominic Schunk, Eva Schimmele,
Dr. Elmar Gerwalin, Katharina Parusel, Manuela Hoffmann, Anja Nitschky,
Gabi Gramsch, Dominic Daneker, Alexander Basler, Dieter Eubell, Waltraud Dully,
Prof. Dr. Dieter Prätzel-Wolters, Prof. Dr. Axel Klar, Prof. Dr. Ralf Korn,
Martin Braun, Brigitte Williard, Michaela Grimberg-Mang, Erik Schnabel,
Michael Mannweiler, Klaus Linck

FRAUNHOFER ITWM

www.itwm.fraunhofer.de/en/

DR. MARION SCHULZ-REESE
HEAD OF ADMINISTRATION

INSTITUTE PROFILE

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. Mathematical models cut horizontally across a landscape of vertically arranged scientific disciplines and technological applications. This 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 utilise 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.

Of course, we also work together with large companies, especially in the motor vehicle sector, in machine construction, the textile industry, in microelectronics, with banks and the computer industry. Consultation in R&D questions, support in the use of high-performance computer technology and provision of custom-tailored software solutions are integral building blocks of our work.

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 for 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

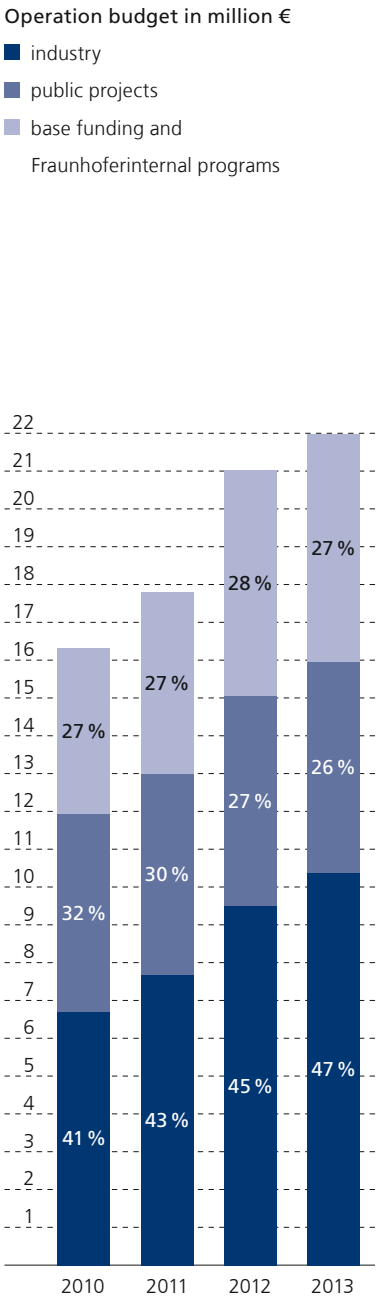
- Processing of data acquired from experiments and observations
- Drafting of mathematical models
- Implementation of mathematical problem-solving in numerical algorithms
- Summarization of data, models and algorithms in simulation programs
- Optimization of solutions in interaction with the simulation
- 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 Structures, Simulation, Traffic and Transportation, Vision (image processing) and Water Systems.

ORGANIZATIONAL CHART

Director	Prof. Dr. Dieter Prätzel-Wolters
Scientific Advisory Board	Prof. Dr.-Ing. Hans Hasse
	Prof. Dr. Axel Klar
	Prof. Dr. Ralf Korn
	Prof. Dr. Helmut Neunzert
	Prof. Dr. Stefan Nickel
Administration	Dr. Marion Schulz-Reese
IT	Dr. Elmar Gerwalin
Public Relations	Dipl.-Math. Steffen Grützner
Competence Center High Performance Computing	Dr. Franz-Josef Pfreundt
Transport Processes	Dr. Raimund Wegener
Flow and Material Simulation	Dr. Konrad Steiner
Image Processing	Dr. Ronald Rösch
System Analysis, Prognosis and Control	Dr. Patrick Lang
Optimization	Prof. Dr. Karl-Heinz Küfer
Financial Mathematics	Prof. Dr. Ralf Korn
Mathematical Methods in Dynamics and Durability	Dr. Klaus Dreßler

BUDGET



The year 2013 was primarily a year of consolidation for ITWM. Following the strong growth of previous years, the operating budget increased by almost 4.5 percent in comparison to the prior year. The extraordinary growth in business income was the real success story: a 47.2 percent share from industry was the highest since 2005 and one of the highest ever reported in the history of ITWM. This represents an increase of 10.4 percent compared to 2012. Total income from industry increased to nearly 10.4 million euros. The share of orders from foreign companies continued to increase contributing revenues of more than 4 million euros. This represents a share of nearly 39 percent of the total income from industry. The largest customers are based abroad, namely Statoil (Norway) and Repsol (USA). More than 70 percent of the orders were placed by "regular" customers and, fortunately in 2013, 45 new customers could be won over. Unfortunately, in the area of public sector contracts, the downward trend of the past two years continued. Federal government funding decreased by more than seven percent, and although the share of state funding in the overall budget increased by eight percent, 20 percent of this flowed into the investment budget. Fortunately, an increase of 46 percent was registered for EU revenues. The support from internal Fraunhofer programs and special allowances remained almost constant. The investment budget, with more than 3.3 million euros, was never before so high. Key strategic investment funds supported the acquisition of a new cluster and a parallel file

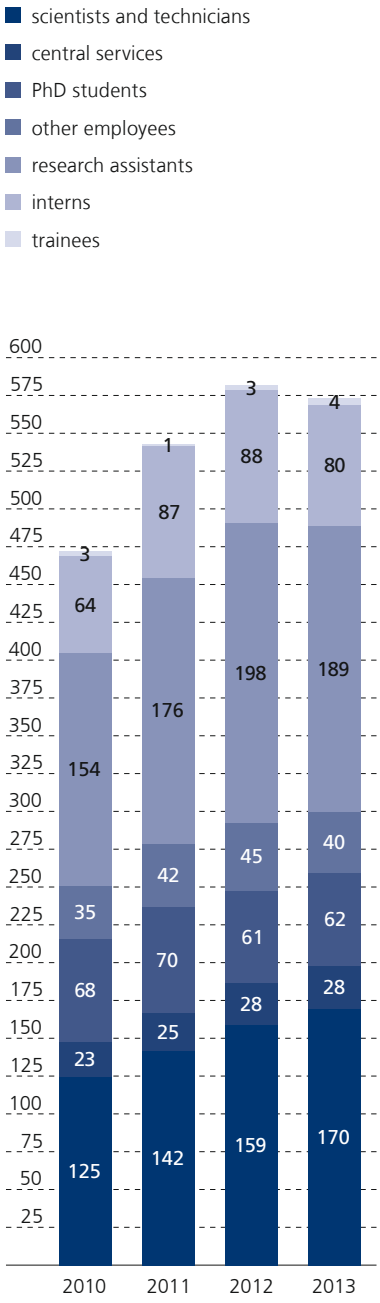
Budget development*	2010	2011	2012	2013
Operating budget	16315	17810	21034	21979
Investments	550	2567	1042	3734
Total	**16865**	**20377**	**22076**	**25713**

*thousand €

system. ITWM looks with optimism towards the future and anticipates a slight increase in reserves in the 2014 operating budget, while other reserves in the investment budget will be drawn down. With additional ERDF funds from the state of Rhineland-Palatinate, investments were made in a special wood analysis and computation lab, a test vehicle for the capture of 3D road and environmental data, as well as the exascale storage and scalability lab.

PERSONNEL DEVELOPMENT

In the research area, 25 new staff members were hired, while 14 departed ITWM. A third of the new hires are not German (Iran, Ukraine, Brazil, Portugal, Spain, Italy, France), which indicates that ITWM is getting to be even more international. One satisfying trend continued: of the new researchers, half were recruited from our own ranks of young talented researchers. This is clear evidence of the fact that the intensive ITWM investment in young researchers is worth every cent, especially, the support provided to the 62 ongoing PhD candidates in 2013. The numerous dissertations funded by ITWM meanwhile, have placed the department of Mathematics at TU Kaiserslautern in the number one spot in national rankings. An important component in ITWM's personnel policy is the support of young talents. Another is certainly the generous distribution of bonuses at ITWM, which the institute uses to reward its dedicated and motivated staff. In 2013, nearly 850,000 euros were paid out for research awards and excellence and IT allowances – that is, nevertheless, still less than 6 percent of the total personnel costs.



CUSTOMERS AND COOPERATION PARTNERS SELECTION 2013

- AbbVie Deutschland GmbH & Co. KG, Ludwigshafen
- Accenture CAS GmbH, Kaiserslautern
- Adam Opel AG, Rüsselsheim, Kaiserslautern
- AixProcess GmbH, Aachen
- Anaesthesio, Dorsten
- Assyst GmbH, Aschheim-Dornach
- AUDI AG, Ingolstadt
- AUTEFA, Linz (A)
- BASF SE, Ludwigshafen
- Bayerisches Staatsministerium der Finanzen, München
- BMW Group, München
- BPW Bergische Achsen Kommanditgesellschaft, Wiehl
- BSN medical GmbH, Hamburg
- ClusterVision, Amsterdam (NL), München
- Continental Automotive Systems AG, Frankfurt/M.
- Cummins, Marktheidenfeld
- DAF Trucks N. V., Eindhoven (NL)
- Daimler AG, Stuttgart, Wörth
- delta h Ingenieurgesellschaft mbH, Witten
- Det Norske Oljeselskap, Oslo (N)
- Deutscher Sparkassen- und Giroverband, Berlin
- Deutsches Krebsforschungszentrum, Heidelberg
- DZ-Bank, Luxemburg (L)
- Eagle Burgmann, Wolfratshausen
- ebm papst, Mulfingen
- EKF diagnostic GmbH, Barleben
- Elsevier Ltd., Kidlington (GB)
- ESI Group, Paris (F)
- FLSmidth Wadgassen GmbH, Wadgassen
- Freudenberg Filtration Technologies, SE & Co. KG, Kaiserslautern, Weinheim
- Görlitz AG, Koblenz
- Heimbach GmbH & Co. KG, Düren
- Hospitals: Dachau, Essen, Frankfurt/Höchst, Heidelberg, Homburg
- Hubert Stüken GmbH & Co. KG, Rinteln
- IBS FILTRAN GmbH, Morsbach-Lichtenberg
- Inergy, Brüssel (B)
- IPConcept, Luxemburg (L)
- John Deere, Mannheim, Kaiserslautern
- Johns Manville Europe GmbH, Bobingen
- K+S Kali, Phillippsthal
- Kreissparkasse Kaiserslautern
- Kronos, Leverkusen
- KTM-Sportmotorcycle AG, Mattighofen (A)
- Landesbank Baden-Württemberg, Stuttgart
- Landgericht Saarbrücken, Saarbrücken
- Liebherr, Kirchdorf, Colmar (F)
- LKC, München
- LONZA Group AG, Basel (CH)
- Lundin, Lysaker (N)
- M+W Process Industries GmbH, Stuttgart
- MAN Truck & Bus Deutschland GmbH, München
- Mann+Hummel GmbH, Ludwigsburg
- Marathon Oil, Houston (USA)

- Math2Market GmbH, Kaiserslautern
- Megware, Chemnitz
- MTU Aero Engines GmbH, München
- MVZ Dres. Englmaier, Waldkraiburg
- NOGRID GmbH, Mainz
- Paul Wild OHG, Kirschweiler
- Pfalzwerke AG, Ludwigshafen
- Porsche AG, Weissach
- proALPHA Software AG, Weilerbach
- Procter & Gamble, Schwalbach, Euskirchen, Cincinnati (USA)
- Progress Rail inspection & information systems, Bad Dürkheim
- R+V Versicherung, Wiesbaden
- RaySearch Laboratories AB, Stockholm (S)
- Repsol, Houston (USA)
- RJL Micro & Analytic GmbH, Karlsdorf-Neuthard
- Robert Bosch GmbH, Stuttgart
- Rock Solid Images, Houston (USA)
- Rolls-Royce Deutschland Ltd & Co KG, Oberursel
- Saft Batterien GmbH, Nürnberg
- Scania CV AB, Södertälje (S)
- Schmitz Cargobull AG, Altenberge
- Schott AG, Mainz
- Seismic City, Houston (USA)
- Seismic Image Processing Ltd, Aberdeen (GB)
- SGL Carbon, Meitingen
- SIEDA GmbH, Kaiserslautern
- Siemens AG, Renewable Energy Division, Nürnberg
- Siemens AG, Oncology Care Systems, Heidelberg
- skytron energy GmbH, Berlin
- StoREgio e.V., Ludwigshafen
- Solvay GmbH, Hannover
- Statoil, Stavanger (N), Trondheim (N), Oslo (N), Houston (USA)
- Stryker GmbH & Co KG, Freiburg
- Superon GmbH, Dernbach
- SWK Stadtwerke Kaiserslautern GmbH, Kaiserslautern
- Teckpro AG, Kaiserslautern
- T-Systems Solutions for Research GmbH, Stuttgart
- Uhde Inventa-Fischer, Berlin
- Universities: Bordeaux (F), Bremen, Erlangen, Freiberg, Freiburg, Heidelberg, Kaiserslautern, Karlsruhe, Kassel, Mainz, Münster, Nancy (F), Saarbrücken, Thuwal (KSA), Ulm, Valenciennes (F)
- Universities of applied sciences: Berlin, Darmstadt, Kaiserslautern, Mainz, Mannheim, Saarbrücken
- Vaillant, Remscheid
- Vesuvius GmbH, Borken
- Voith Hydro, Heidenheim
- Volkswagen AG, Wolfsburg
- Volvo CE, Konz, Göteborg (S)
- VR Automotive Dichtsysteme GmbH, Auengrund
- VW Stiftung, Hannover
- Webasto SE, Stockdorf
- Woltz GmbH, Wertheim
- Xella / Fermacell, Calbe/Saale

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NETWORKING AND COOPERATIONS

ITWM is integrated in a network of national and international partnerships and a member of several associations within the Fraunhofer-Gesellschaft:

- Fraunhofer ICT Group
- Fraunhofer Group for Materials and Components – MATERIALS (as associated member)
- Fraunhofer Automobile Production Alliance
- Fraunhofer Battery Alliance
- Fraunhofer Big Data Alliance
- Fraunhofer Cloud Computing Alliance
- Fraunhofer Lightweight Structures Alliance
- Fraunhofer Simulation Alliance
- Fraunhofer Traffic and Transportation Alliance
- Fraunhofer Vision Alliance (Image Processing)
- Fraunhofer Innovation Cluster "Digital Commercial Vehicle Technology"

Further cooperations

- Innovation Center "Applied System Modeling"
  The Fraunhofer institutes IESE, ITWM, IPM (Department Materials Characterization and Testing) as well as the departments of Computer Science and Mathematics at TU Kaiserslautern work in close cooperation at ASM to bring high tech products to market quickly.
- 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 Math 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 Alliance Kaiserslautern
  Network of academic and research institutes in Kaiserslautern

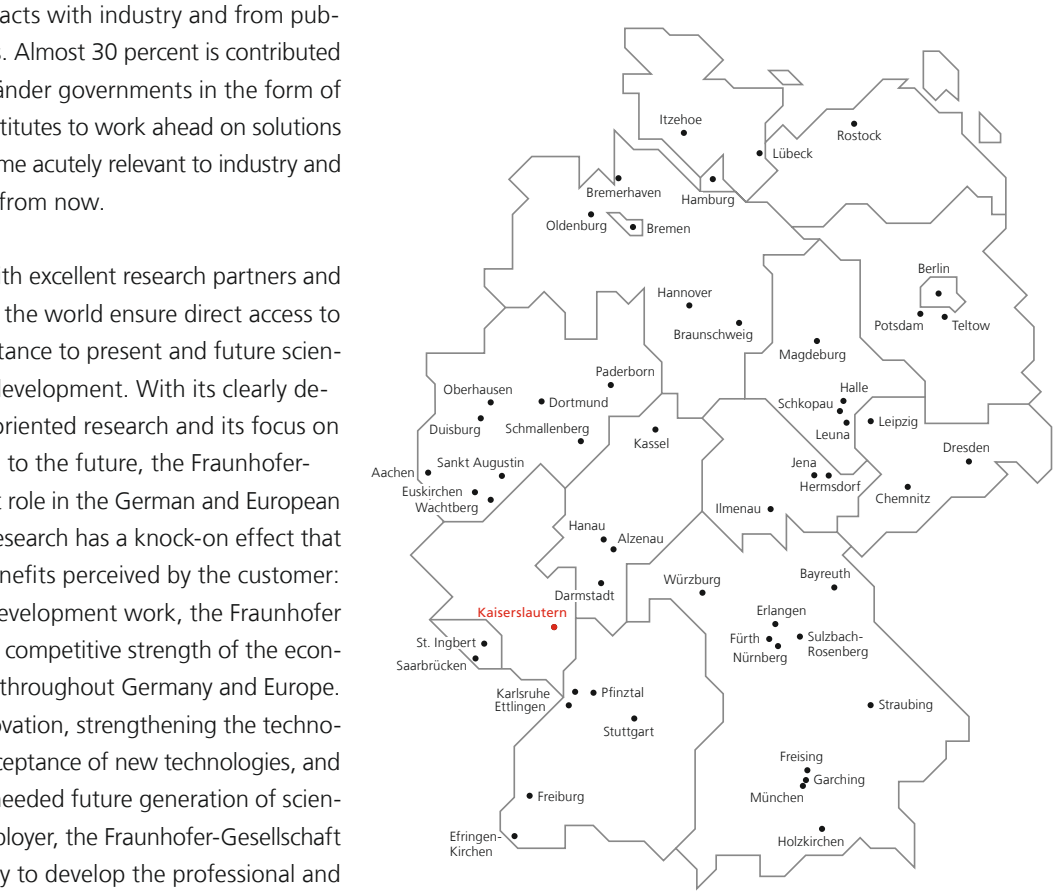
THE FRAUNHOFER-GESELLSCHAFT AT A GLANCE

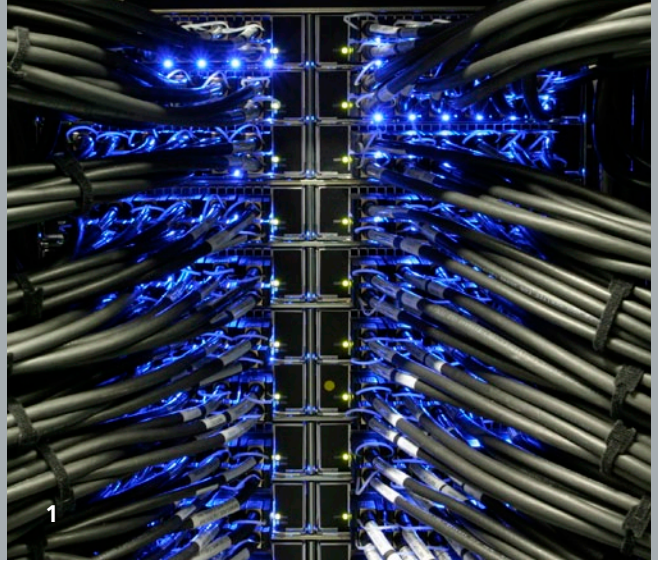
Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual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

At present, the Fraunhofer-Gesellschaft maintains 67 institutes and research units. The majority of the more than 23,000 staff are qualified scientists and engineers, who work with an annual research budget of 2 billion euros. Of this sum, more than 1.7 billion euros is generated through contract research. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder 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.





CENTRAL IT-INFRASTRUCTURE

1 *High-speed network*

2 *Meeting technology*

The innovative project results in the departments are only possible if based on a modern, safe, and reliable central infrastructure that relieves the scientists from routine tasks and provides the tools needed for good project management, creative research, and efficient software development.

These are the reasons why Fraunhofer ITWM continuously invests in a modern IT infrastructure. Currently operating in three server rooms, more than 300 servers and several hundred terabyte data storage devices are networked with 10 to 56 Gigabit/s and are directly available to approximately 400 offices and meeting rooms.

The Linux high performance cluster "Beehive" began operations at year-end 2013/2014, to support the very resource intensive simulation calculations as well as the development and use of parallel software. These 3,200 cores are connected over a high speed network with 200 TB of local disk space, which supports the parallel file system FraunhoferFS – developed in-house at Fraunhofer ITWM and meanwhile, well established in the high performance computing markets of the world.

Besides the numerous other Linux servers for Office applications and smaller computing tasks, there are several dozen Microsoft Windows terminal servers. The co-existence of Linux and Windows architectures has been a major characteristic of ITWM's IT-infrastructure from the beginning. It enables the reproduction of almost any (customer) environment and provides the advantages of both operating systems.

Green offices

In the perfect extension of the server system, users have "thin client" computers in the offices, common areas, and meeting rooms. Consuming only about 15 watts of power, these machines transfer only the graphic display from the server to the work station, which contributes to an overall identical low noise/low heat working environment.

Precisely in cases, where – usually project-specific – the client/server concept reaches its limits, such as for graphics or data intensive requirements, users always have access to well-suited, powerful workstations.

More than 200 advanced and powerful business notebooks complement these stationary installations and provide our scientists with the necessary freedom to run a mobile office and perform programming tasks.

Virtual computer for virtual process and material development

The virtualization of computing systems, i.e., the abstraction of the user's environment from the physical hardware, has become established in recent years as one of the most effective methods for the efficient use of IT resources. The researchers at Fraunhofer ITWM are provided with platforms on which they can independently create and run virtual machines and networks. Increasingly, there are technologies on the market that make it possible to use graphic intensive and CAx applications in virtual environments and also, test setups as well as joint scientific studies in cooperation with TU Kaiserslautern have shown that this 3D remote technology is practical to use. This is why the institute invests in the development of these platforms. In the near future, virtual material design (a major research focus) will also be performed on "virtual machines."

Always safely networked

Whether an internal network connection at Fraunhofer-Gesellschaft, a dedicated line to the partner TU Kaiserslautern, or a highly secure worldwide remote access to and from project partners – Fraunhofer ITWM provides fast and secure networks for connections beyond the institute's borders to exchange information and data. Furthermore, employees on the road or from a home office can access the services within the institute's network via a virtual private network connection.

3 *Workplace*

4 *Virtualization platform and High Performance Linux Cluster*

Timo Wächtler, Dr. Walter Arne, Dr. Raimund Wegener, Dr. Dietmar Hietel, Pratik Suchde, Dr. Isabel Ostermann, Dr. Norbert Siedow, Dr. Simone Gramsch, Dr. Jörg Kuhnert, Andre Schmeißer, Tobias Seifarth, Dr. Jevgenij Jegorov, Jaroslaw Wlazlo, Dr. Christian Leithäuser, Dr. Robert Feßler, Simon Schröder, Dr. Jan Mohring, Thomas Cibis, Dr. Jalo Liljo, Johannes Schnebele

TRANSPORT PROCESSES

▪ FLEXIBLE STRUCTURES

Modeling and numerical simulation of flexible structures in turbulent flows, especially fiber dynamics

▪ FLUID DYNAMICS

Simulation and optimization of flows, fluid-structure coupling

▪ GRID-FREE METHODS

Finite Pointset Method (FPM) for simulation of fluid and continuum mechanical problems

▪ OPTICS, RADIATION, HEAT

Design of freeform lenses, heat transfer, diffusion

▪ MODEL REDUCTION

Transfer of huge finite element models to parametric reduced state space models

www.itwm.fraunhofer.de/en/tv

DR. RAIMUND WEGENER
HEAD OF DEPARTMENT

The core competence of the Transport Process department is the mathematical modeling of complex manufacturing problems and the development of efficient algorithms for their numerical solution (simulation). The problem areas are found in the technical natural sciences (fluid dynamics, radiative transfer, optics, acoustics, structural mechanics, etc.) and, from a mathematical viewpoint, lead themselves to partial differential equations that can be mainly characterized as transport equations. Our industry customers are primarily interested in the optimization of products or the technical design of manufacturing processes. The product spectrum of the department includes collaborative research projects with the R&D divisions of partner companies with a focus on the engineering sciences, studies including design and optimization proposals, concept development, and software solutions from the component to the complete tool.

The year 2013 was a very successful one for the department in the area of contract research. However, the public sector was characterized by a strong trend in which numerous projects came to a successful conclusion. These provide a good basis for contract research in the future. Nevertheless, the department is now facing a major challenge to generate new projects, topics, and follow-on funding in the public sector.

In recent years, the topic of software development has gained in importance to the department. The result is that now specific software tools are available in all subject areas which reflect the range of expertise. In this annual report, we present three such tools: FIDYST (Fiber Dynamics Simulation Tool) simulates filament dynamics in turbulent flows and demonstrates expertise in the areas "fluid dynamics" and "flexible structures". The group also developed the superior "grid-free method" FPM (Finite Pointset Method), a solver for a wide range of problems in the field of continuum mechanics. Advances in the area of "model reduction" are documented in the MATLAB toolbox. Furthermore, as introduced in the last annual report, LODTa (Light Optimal Distribution Tool) is a software tool for the design of free form surfaces based on new algorithmic concepts for beam-shaping.

FIDYST – FIBER DYNAMICS SIMULATION TOOL

1 *Simulation of staple fibers*

FIDYST is a highly efficient simulation software for elastic filaments or fibers in turbulent fluid flows. Based on the theory of Cosserat rods, FIDYST models the dynamics of elastic, line shaped objects in a very general way. There is a broad spectrum of different applications for this tool, although FIDYST has attained a special importance in the field of textile engineering and the production of technical textiles.

Several industry partners in the field of textile engineering have already used FIDYST successfully to design their production machines for nonwoven textiles: typical for this branch are the spunbond and meltblown processes. Industrial partners use the simulation of fiber dynamics to optimize the geometry of the unit in order to achieve better quality. Industrial companies use this, in particular, to analyze the fiber contact with mechanical parts, a new functionality that was first integrated in FIDYST at the start of 2013 as part of an ongoing PhD. The non-wovens segment also benefit greatly by the use of FIDYST software. On the basis of simulation studies with FIDYST they were able to develop a new product that requires fewer raw materials while maintaining the same product quality.

The core of the software is implemented in C++ and the graphic user interface is done with the Qt framework. The software is complemented with libraries for the import of flow data and a viewer that is used to visualize the flow data of the fiber dynamics and the simulation results. The flow data can be imported in EnSight Gold Case format, so that FIDYST can be used independently of the flow solver in use. In the process, the geometric parts are detected and automatically processed for the simulation of the filament/wall contact. FIDYST can also process transient flow data, so the filament contacts with moving machine parts can be simulated. To enter the material data of the filaments, FIDYST provides a user interface with a context sensitive help function, through which additional model parameters can be controlled. Because the EnSight Gold Case format is also used for the export of the filament dynamics, the simulation results can be subsequently processed further in standard tools for visualization or data analysis.

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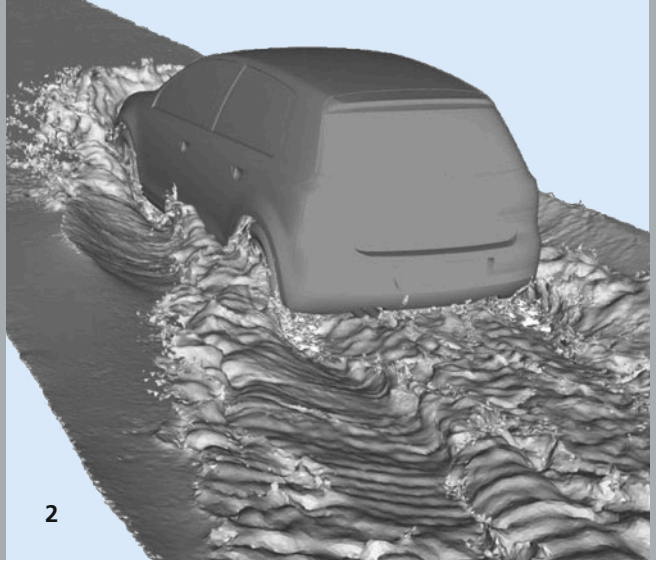


2

FPM – FINITE POINTSET METHOD

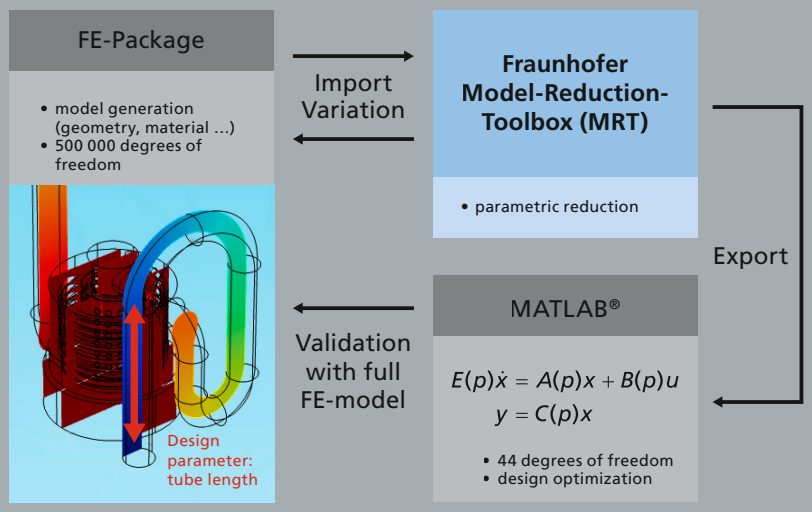
1 *Experimental water crossing*

2 *FPM-simulated water crossing*

FPM is an original development of Fraunhofer ITWM. It is a grid-free, numerical approach to model problems in the area of flow and continuum mechanics. The geometric basis is a cloud of numerical points that carry relevant physical and geometric data. For each individual point the conservation equation for mass, momentum, and energy are solved, while FPM makes use of differential operators that approximate the partial derivatives of the differential equations. These operators are generated by a least-squares method or linear programming. In contrast to Finite Element or Finite Volume methods, this method is not based on a weak formulation. FPM can be thought of as a generalized, finite-difference approach. This offers far reaching benefits when incorporating new material laws or new physical modeling concepts. The particles in the point cloud move at the speed of the continuum (Lagrangian character). Simple transport problems are easily mapped through the point movements. The Lagrangian approach enables a very simple handling of phase boundaries, free surfaces, or moving parts of the geometry.

Since 2000, ITWM has been developing FPM for industrial applications. The first application was a gas dynamic solver for airbag deployment in a crash simulation. Here, there is still an active cooperation with ESI Group, one of the leading suppliers of crash software. At the same time, development continues on an incompressible or weakly compressible FPM flow solver. Another early application was in the area of filling and sloshing for fuel tank systems in the automotive sector. A traditional cooperation in this area is in effect with Volkswagen. There are also applications in glass forming (ventures with Schott, Nogrid) that attained an industrial scale, even at this early stage of FPM development.

Today, FPM covers a very wide range of physical processes. In addition to applications from traditional fluid mechanics, we focus on non-traditional aspects, for example, elastoplastic processes (chip formation in metal processing), or visco-elastic phenomena (spin process of fibers). In the area of soil mechanics, we try to incorporate new, highly non-linear, material models into the solution methodology. By modeling population balances, we can cover the range of disperse phases and couple these with classic continuous phases.



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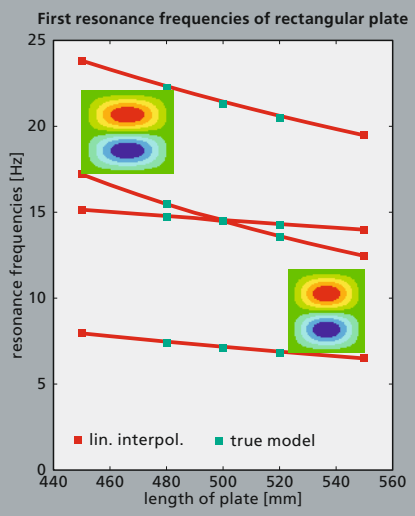


2

PARAMETRIC MODEL REDUCTION WITH MRT

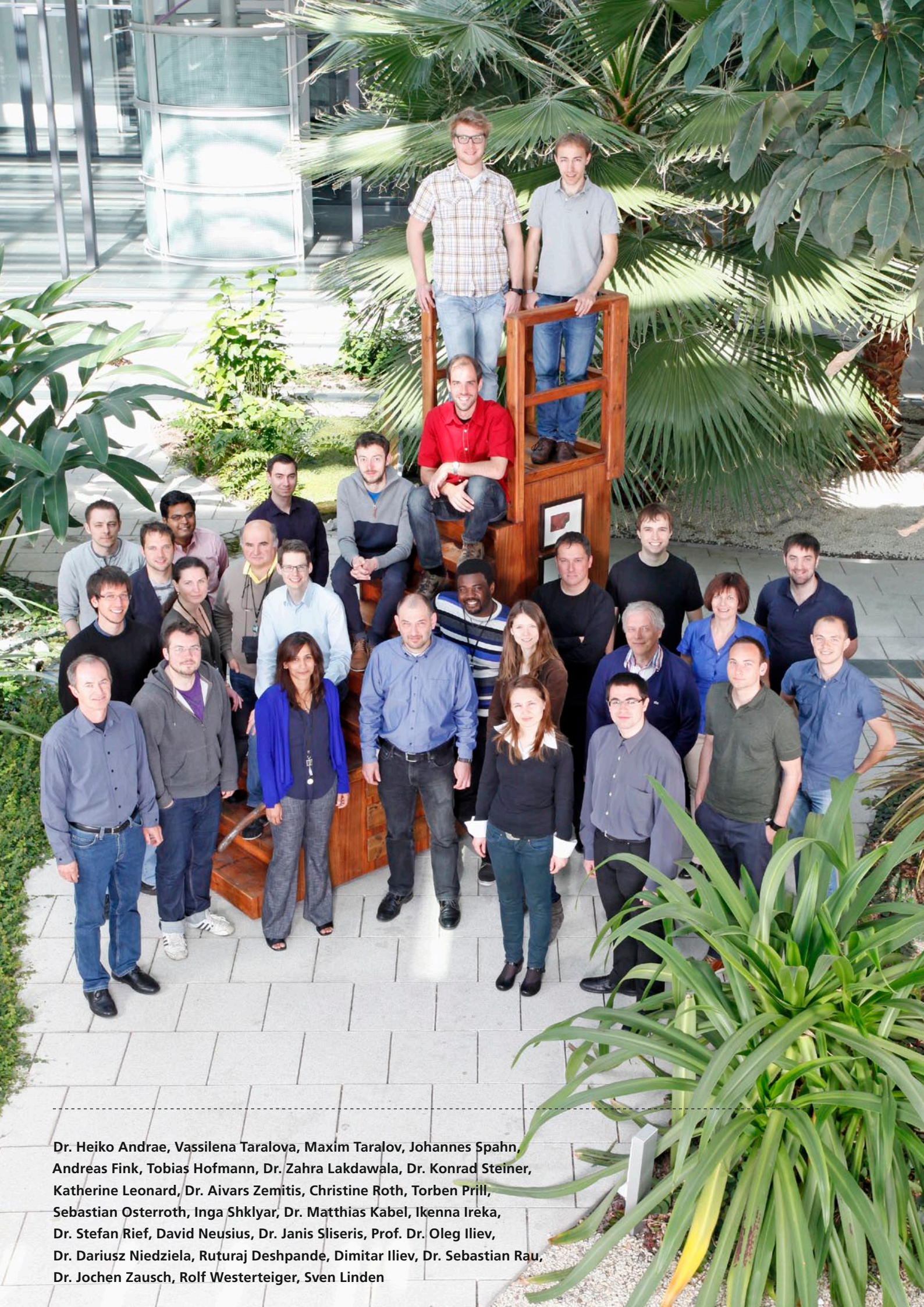
Designing machines or processes requires both an integrated, interactive simulation of all components at a system level as well as a detailed analysis, on which the macroscopic structural properties of the geometry or material parameters depend. The first kind of simulation is usually based on a description that uses a system of differential algebraic equations, in which individual components are represented by less than one hundred degrees of freedom. Software such as MATLAB-Simulink® or Dymola are used for this. The detailed analysis, however, solves discretized partial differential equations often with more than a hundred thousand degrees of freedom per component, typically with FE packages like ANSYS® or COMSOL®. Model reduction connects both worlds by converting large FE models into compact system models with sufficiently equivalent input-output behavior.

The Fraunhofer Model Reduction Toolbox (MRT) is a tool that allows linear FE models to be transferred from ANSYS to MATLAB and then reduced, assembled, and simulated so that results may be displayed. It features, in particular, the possibility to create parametrically reduced models. If a design is to be optimized, the user wants to play through the various combinations of geometries or material parameters in rapid succession. If it was necessary to derive the modified reduced model from the full FE model from the bottom up every time, the user would quickly be lost. The preferred alternative is to generate a reduced model, during an offline phase, based on an automatic selection of points in the parameter range and then, online, very quickly interpolate the matrices for new parameter sets. There is no longer any need to use the FE tool in this phase. The challenges of this approach relate to the fact that the state-space representation of a dynamic system is only unique up a change of basics. When matrices corresponding to non-fitting bases are interpolated, the result can be wrong in many ways. The solution strategy is based on normal forms and eigenvalue tracking in the parameter space. This, of course, is all invisible to the user. The user only writes an ordinary APDL script and, from the user interface, selects the load and design parameters, the input and output variables as well as the level of reduction, and finally, starts the otherwise fully automatic reduction process.

The Model Reduction Toolbox has been under development for over eight years in public sector projects and, again and again, expanded for the special requirements of industry customers. In principle, any linear FE model that allows a harmonic analysis can be reduced.

1 *Usage of the model reduction toolbox*

2 *The phenomenon of eigenvalue-crossing illustrated for a plate with variable length*



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FLOW AND MATERIAL SIMULATION

▪ MICROSTRUCTURE SIMULATION AND VIRTUAL MATERIAL DESIGN

Structure-property-relationship and design of porous media and composites

▪ HYDRO DYNAMCS AND CFD

Numerical simulation of flow through porous media on multiple scales

▪ COMPLEX FLUIDS

Computational fluid dynamics of complex fluids: fluid and bulk material handling in process technology

▪ MECHANICS OF MATERIALS

Multi-scale simulation of composites: Calculation and optimization of deformation, stiffness, compressibility and resilience

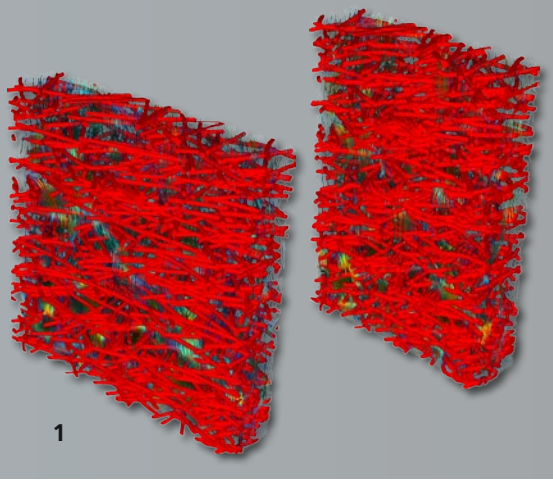
www.itwm.fraunhofer.de/en/sms

DR. KONRAD STEINER
HEAD OF DEPARTMENT

The department is oriented on multi-scale modeling and the development of efficient and robust simulation methods and software tools for the integration of virtual material design in product development and process technology. Modeling and simulation of the production processes (mixing, dispersing, injecting, filtering, and coating) of complex composites or hybrid materials are increasingly integrated in the virtual design process. The typical challenge for many simulation-based applications lies in representing the interrelated influences on complete components under dynamic loads in the production processes and the constraints of the local material properties. Current customer inquiries relate to the production and functionalization of filter materials and technical filter systems, batteries or fuel cells, or fiber and particle reinforced lightweight components. What makes this department unique is the resident expertise in company-specific software solutions and the development, supply, and specific use of multi-scale and multi-physics methods suitable for industrial application.

The year 2013, after major personnel upheavals in the department, was perceived as a new beginning with many risks. Fortunately, the necessary changes and development of long term, stable customer and partner relationships were realized much faster than expected. Consequently, the year could be closed out more successfully than ever before in terms of the industry revenue ratio and the positive results. The perspectives for the future are very good based on the high order backlog and the long term project plans.

The upheaval was also used to extend or expand our complementary scientific and economic cooperation with selected partners. Examples of this are the close cooperation in education and research with the Chair of Mechanical Engineering at TU Kaiserslautern, the cooperation in the area of simulations of hybrid composites with the leading edge cluster MERGE at TU Chemnitz, the cooperation with the Helmholtz-Institute in Ulm for modeling and simulation of batteries, and of course, the productive division of labor with our spin-off Math2Market in the marketing and advance development of the GeoDict software as a virtual materials lab. The extensive international contact, in particular, through the co-founded Interpore Society and also, the close collaborative research with the Department of Mathematics at the TU Kaiserslautern were intensified by means of personnel exchanges.



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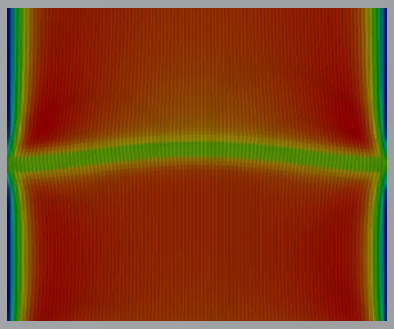

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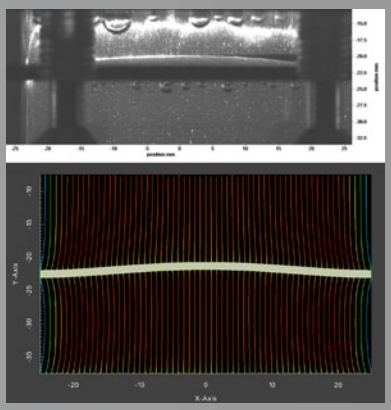


3

DEFORMATION OF FILTERING MEDIA AND FLUID-POROUS-STRUCTURE INTERACTION (FPSI)

Previous research and corresponding developments in the field of modeling and simulation of filtration processes have proven that the use of specialized CFD software can significantly shorten the design period of filtration devices. In the past, manufacturers and developers of filter elements and/or media could base their computer-aided designs on the assumption that the filtering material is a "rigid" structure. In more and more application scenarios however, one has to take into account elastic behavior of the filtering medium. Reasons for this are, amongst others: new fields of application for existing filter elements and filtering media, very different or more dynamic operating conditions (higher flow rates or pressures, use of different fluids), strong effects caused by relatively small deformations, in particular in the case of pleated filtering media, innovation in the areas of filtering media or their manufacturing.

This does not only mean that the developing engineers are facing great challenges. The mathematical modeling and numerical simulation is confronted with demanding questions, too. The mathematical treatment of these so-called poroelastic effects is very different when considering the filtering medium as a micro-structure compared to describing it as a continuum on the macroscopic level of the filter element scale.

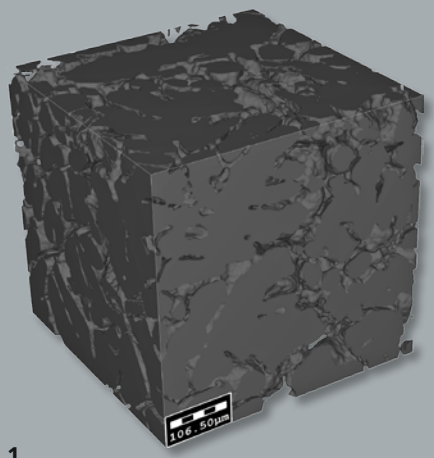
On the micro-scale, the elasticity properties of the fiber material have to be used properly in order to compute the deformation of the porous under mechanical load (i. e., including the pore spaces) as a whole. This step succeeded with the software FeelMath: For a given microstructure and known elasticity parameters of the fiber material, the deformations, stresses and effective elastic properties of the porous can be simulated for several load case scenarios. Using flow solvers from GeoDict, it is possible to compute the corresponding permeability of the deformed medium. This knowledge is of special importance on the macroscopic level in order to treat the interaction between the filtering medium and the fluid flow. The pressure distribution induces a deformation of the porous and this changed shape in turn influences the flow field etc.

The mathematical modeling, algorithmic treatment and experimental study of this Fluid-Porous-Structure interaction (FPSI) is subject of the German-French Fraunhofer-Carnot project "FPSI_Filt". Similar to solid mechanics, it is possible to derive poroelastic plate and shell models such that the dimensionality of the elasticity problem is reduced. By coupling the flow solvers with the elasticity model, the FPSI can be simulated. Comparison with corresponding experimental studies has shown that this approach is very promising and there is ongoing further development and validation in close collaboration with industrial partners.

1 *Comparison between undeformed (left) and compressed (right) porous microstructure and the corresponding flow fields (stream line visualization).*

2 *Fluid-porous-structure interaction: Simulated flow velocity for a originally flat filtering medium deformed due to the pressure distribution*

3 *Comparison between the experimental observation of the deformation of a flat porous probe in a flow channel (top) and the corresponding numerical simulation (bottom). (Experiment: LFMA, Lyon)*



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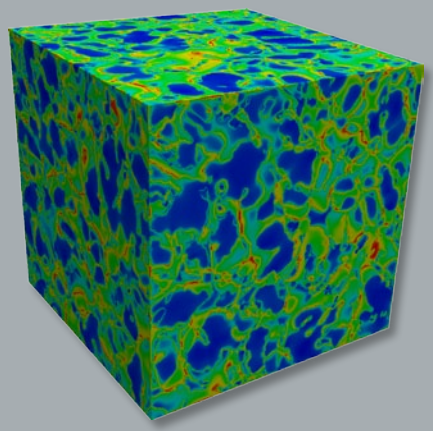

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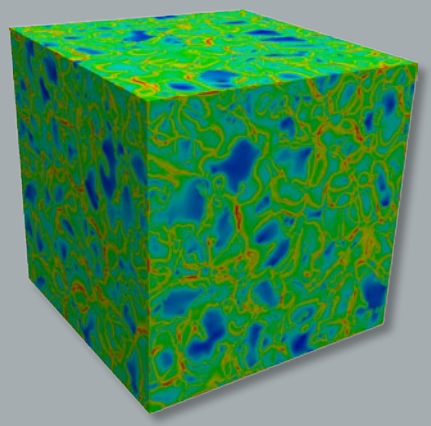

3

RESIDUAL STRESSES IN ALUMINUM-SILICON CAST ALLOYS

1 *Primary dentritic α phase in aluminum-silicon alloy*

2 *Type 2 residual stress in a volume element of the alloy (red: high stress, blue: low stress)*

3 *Type 2 residual strains (red: large strain, blue: small strain)*

Al-alloys have a higher strength compared to pure aluminum. This is why the Al-alloys are used in many areas of light weight construction. In the project presented here, Al-Si casting alloys are examined, for example, for use in cylinder heads and crankcases. Since the aluminum and silicon have different coefficients of thermal expansion as the molten mass solidifies during cooling, besides the usual macroscopic residual stress, additional residual stress develops at the microscopic level, the so called type 2 residual stress. These residual stresses, which previously could not be measured, represent high material strain on microscopically small areas and play a major role in crack formation in the castings. Together with partners at the Chair of Metal Forming and Casting (utg) and the Forschungsneutronenquelle Heinz Meier-Leibnitz (FRM II)at TU Munich, BMW, and RWP as well as colleagues at Fraunhofer IIS (EZRT), these type 2 residual stresses were measured by means of neutron diffraction separately in each phase of the Al-Si structure and are taken into account, for the first time, in the microstructure simulation developed at ITWM, which enables mechanical properties such as stiffness, plastic flow, and strength to be predicted much more accurately than before. These results can be used to calculate the fatigue of the component.

As the Al-Si molten mass solidifies, the Al-based a phase first form that have a dendritic structure. Figure 1 shows an example of such a dendritic structure that was reconstructed from a computer tomography scan taken at the synchrotron in Grenoble. As the temperature decreases, the solubility of the silicon in the molten mass quickly diminishes, so that tiny platelets or needle shaped Si crystals start to form in the so-called eutectic phase. Very high compressive stresses were measured in these small Si crystals by means of neutron diffraction. The FeelMath software developed at ITWM enables, with the help of these measured values, the residual stresses (Figure 2) and associated intrinsic elasticity (Figure 3) in the entire structure to be determined and any loads to be simulated. In the example shown here, there is high type 2 residual stress in the eutectic phase, so that it is likely to be subjected to a sufficiently high mechanical load to cause micro-cracking and harmful effects. In this way, a cause of experimental observations could be clarified. The aim of the project, however, is not only a deeper understanding of structural properties, but also a deliberate assessment of the sensitivity of the process parameters, such as the cooling rate and the alloy composition, on the strength of the Al-alloys.

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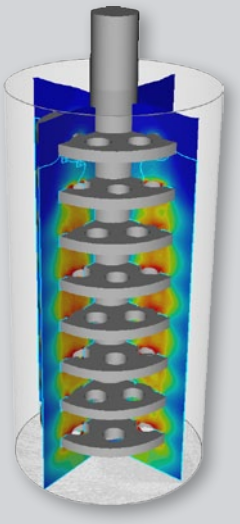

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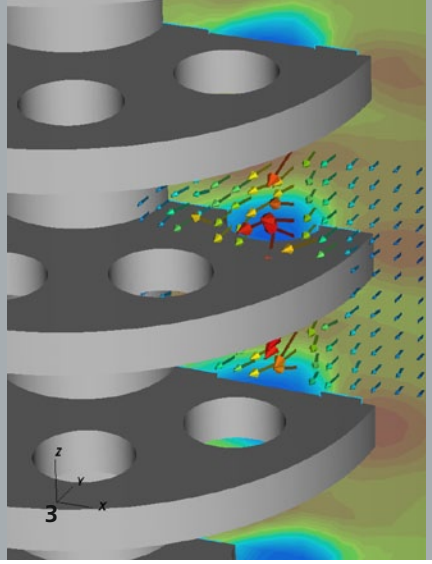


3

THE DESIGN OF BEAD MILLS THROUGH NON-NEWTONIAN MULTI-PHASE SIMULATION

Mills play a critical role in the manufacturing processes of granular materials. The tremendous economic relevance of these processes in the manufacturing sector – in the chemical sector alone, approximately 60 % of the products are granulates, another 20 % contain powdered ingredients – indicates that even a small improvement in efficiency will have a great impact, for example on the total energy consumption of the processes.

After several years of joint research in the simulation of granular media single phase granular flow processes – or those that can be considered as a simplified single phase – are now manageable as a simulation. The next challenge is the simulation of multi-phase flows with at least one granular or powdery phase. Of these, the simulation of the flow in bead mills presents a special challenge. The calculation of complex flows within a simulation links several areas of current research: Two-phase suspension flows of powder and water, modeled as a non-Newtonian fluid, a third phase modeled as granular beads, fast moving components, and a fourth phase of the surrounding air.

The modeling and numerical difficulties that this presents are huge. The interaction of four, full resolution, spatial and temporal phases must be modeled, not only among themselves but also with the fast moving components. The resulting phase-specific requirements for the numerical simulation process are met with an extended time-step control. The FLUID component, a multi-phase, non-Newtonian model together with a third Newtonian phase, was combined here for the first time with the GRAIN component – for the simulation of the mixing beads in such a complex problem. In collaboration with the project partners, subsequent simulation results were successfully compared with available measurements.

The resulting flow fields for suspension, air, and mixing beads provide detailed information about the density distributions, velocity fields, and pressure distributions as well as shear forces and energy state of the involved phases. This allows a virtual performance analysis and the design of the mills relative to the local and global forces, stresses, and energy losses. In addition, from the local shear forces, it is possible to make inferences about the expected abrasive wear, which in turn enables performance optimization of the mill, i. e., energy consumption at a constant grinding capacity.

1 *KRONOS bead mill*

2 *The real mill is fully resolved both in space and time. The plots allow a view and evaluation of the flow behavior of all phases in the whole mill and locally.*

3 *The arrows show the flow of TiO_2 suspension, while the pseudocolor plots shows the density of beads simulated as a granular material.*

FLUID

GRAIN

Project partner:

KRONOS®

Andreas Fink, Dascha Dobrovolskij, Dr. Ronald Rösch, Torben Prill, Markus Rauhut, Sebastian Hubel, Björn Wagner, Rebekka Malten, Dr. Katja Schladitz, Sonja Föhst, Easwaran Prakash, Alexander Dillhöfer, Thomas Weibel, Dr. Oliver Wirjadi, Dr. Ali Moghiseh, Thomas Redenbach, Dr. Martin Spies, Franz Schreiber, Hans Rieder, Andreas Jablonski, Christine Roth

IMAGE PROCESSING

▪ SURFACE INSPECTION

Online-evaluation of the optical appearance of industrial products

▪ ULTRASONIC IMAGING

Nondestructive testing and visualization of industrial materials and components

▪ MICROSTRUCTURE ANALYSIS

Characterization and stochastic modeling of micro-structures based on 3D image data

www.itwm.fraunhofer.de/en/bv

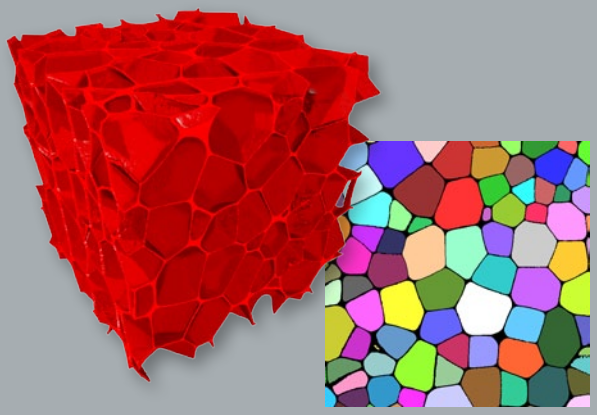
DR. RONALD RÖSCH
HEAD OF DEPARTMENT

In 2013, the department continued the close cooperation with partners in industry and research to develop and implement custom solutions in the fields of image/signal processing and ultrasonic imaging. The worldwide economic recovery has had a positive effect on growth in the sector. Surface inspections, i. e., the examination of the optical characteristics of a product, have become one of the key quality management methods in industrial production. The errors detected may be of the functional or aesthetic kind. It is particularly difficult to represent subjective findings for an aesthetic error as a mathematical model. The department specializes on the development of complex surface inspection systems that have a high proportion of algorithms.

The field of ultrasonic imaging develops another type of imaging technology and presents new possibilities for inspection and visualization of industrially relevant materials and components. The aims include: fault recognition and classification in complex components, analysis of material properties as well as simulation and optimization of ultrasonic sensors.

Micro- and nanostructures largely determine the macroscopic material properties of advanced materials. The department develops algorithms for the characterization and stochastic modeling of such structures using three-dimensional image data. The analysis of spatial geometry and structural property relationships in materials creates new possibilities such as the optimization of material properties through virtual material design. In 2013, this focus area received special recognition in the form of a nomination for the Bauma Innovation Prize and a prize at the Young Researcher Symposium.

Meanwhile, two image processing software packages have become well established: MAVI and ToolIP. MAVI is a software system for the analysis of volume images of complex microstructures, for example, foams or fiber reinforced composites. It provides local analytical methods, for example, for porosity, consistency, or orientation. The local fiber orientation tensors can be determined for fiber reinforced composites. Furthermore, there is a special software option for the analysis of particles. ToolIP is a development environment that enables the graphic programming of complex image processing solutions. The underlying image processing library contains approximately 300 different algorithms for image enhancement, edge detection, object recognition, registration, segmentation, feature calculation, and classification as well as matrix operations, basis operations, and image transformation. Both images from the visible and the invisible ranges can be processed (e. g. X-ray, ultrasonic, infrared).



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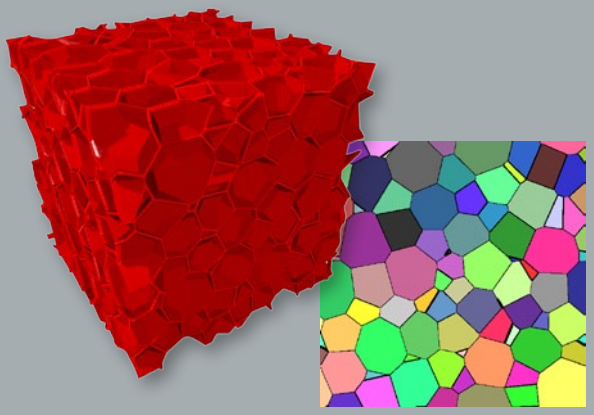


2

AN INTEGRATED METHOD FOR ANALYSIS AND SIMULATION OF CLOSED-CELL RIGID POLYMER FOAMS

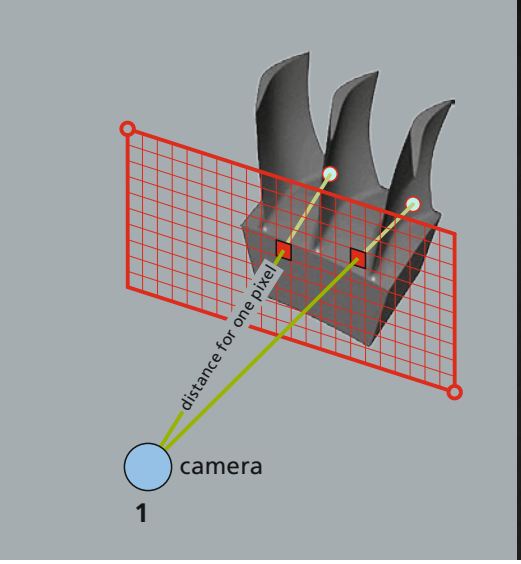
Rigid polymer foams are used as core material of high loadable light weight sandwich structures for example in wind turbine blades and primary aircraft structures. In particular compared to honeycomb core materials, closed cell rigid polymer foams are easier to produce and to proceed. Their extended use requires extensive knowledge about their mechanical behavior. In high loadable structures, the foam core not only acts as a spacer between the two stiff face sheets but also has to sustain mechanical and thermic loads during production and operation of the part. These high requirements call for complex methods for characterization of the rigid polymer foams.

Therefore image analysis of data acquired by micro-computed tomography (µCT), fitting of stochastic geometry models, and finite element simulation of mechanical properties were combined into one closed analysis chain in this AiF project. This way, the relation between microstructure and mechanical properties of closed-cell rigid polymer foams can be analyzed in detail for the first time. The key progress made in this project is the automation of all necessary steps starting with segmentation and analysis of the 3D images of the micro-structure, via modeling of the cell structure up to simulation, to a degree that enables structure optimization in the above mentioned fields of application by non-experts.

To this end, the segmentation of the foam structure in the gray value images, the image analytic reconstruction of the cell structure and the choice of the geometry model that resembles best the real structure, had to be automated. Based on more than 20 µCT images, methods were developed for directly deriving the parameters for segmentation and the crucial smoothing step during cell reconstruction from the image data. Laguerre tessellations generated by random close sphere packings were identified as a particularly suitable class of models since the rigid polymer foams feature polyhedral cells. That is, the cell walls are planar. If the sphere radia are gamma distributed, then the generated cell structure is determined by sphere packing density and variation coefficient of the radia distribution. These model parameters can not be deduced directly from the image of the real structure. Instead, a distance measure including eight measurable geometric characteristics is minimized based on simulated model realizations. For the chosen special case, the dependence of these characteristics from the variation coefficient can be approximated by polynomials. Thus the extensive simulation has to be performed only once. For a new structure, the optimal model parameters can be read off directly.

1 *Volume rendering of a sample of the PMI rigid foam Evonik ROHACELL® WIND-F RC100, the edge length of the visualized cube is 600 pixels corresponding to 16 mm at pixel edge length 2.7 µm. Superimposed: slice through image analytically reconstructed cell system*

2 *Volume rendering of a realization of the best fitting stochastic geometry model. Superimposed: slice through the cell system*



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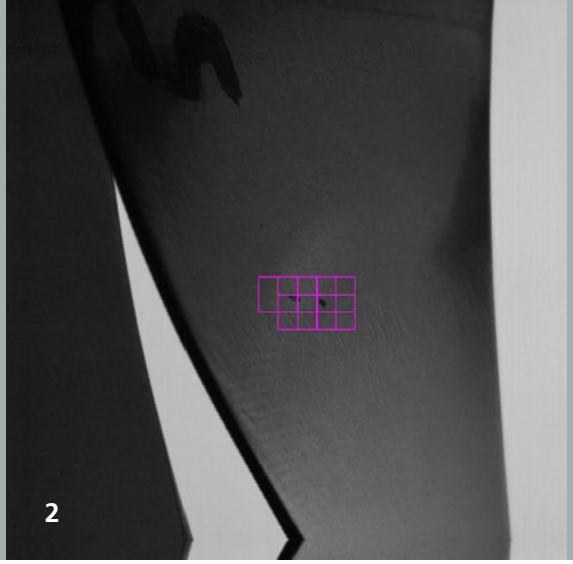
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3

INSPECTION AND MEASUREMENT OF BLADED INTEGRATED DISKS (BLISK)

1 *A challenge for image processing is the precise position determination of defects in 3D coordinates*

2 *A typical defect on the air foil of a BLISK*

3 *Prototypical inspection of the surface of a BLISK with two cameras and lighting*

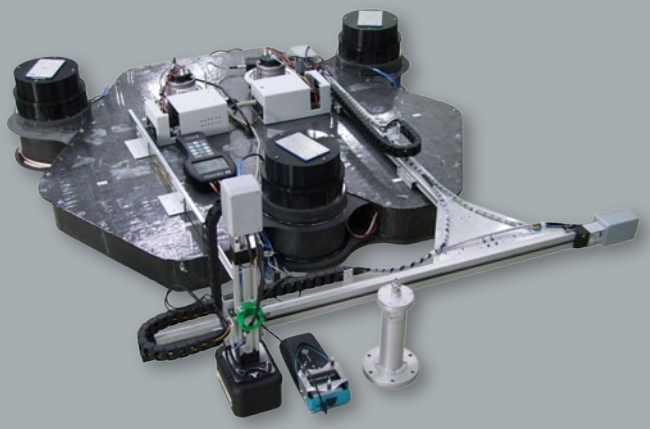
A major component in today's aircraft engines are the so called BLISKs. Due to the strict quality requirements, BLISKs are now examined for defects for several hours by well-trained specialists, who then measure the defects to obtain a quantitative description of the defects. Fraunhofer ITWM, in collaboration with partners Hexagon Metrology and Hexagon Technology Center is developing an integrated, fully automated solution for the surface inspection and measurement of BLISKs. The effort is part of "Clean Sky", an EU Framework Program for research and innovation.

The first work step accomplishes the geometric measurement of the components using a coordinate measurement machine (CMM). In combination with a CAD model of a BLISK, this step provides all information about the form and geometry of a BLISK and any deviations from defined set values. The task of Fraunhofer ITWM is to develop a solution for the second work step. Several cameras are used to perform a 100 % scan of the BLISK and examine it for surface defects. The data for the location and type (e. g., cracks, impact points, etc.) of potential surface errors is stored. The task contains a number of challenges: One of these is the development of a lighting system that effectively shows all types of defect on the BLISK. Based on the variety of defect types, multiple lighting methods are needed. Also, because the geometry of the component is so complex, it is difficult to position the camera and the lighting in such a way that the entire surface can be gradually scanned. Additionally, the cameras and parts of the lighting system have to be so small and lightweight that they can be moved through the CMM. Lastly, complex algorithms for surface inspection have to be developed that are able to automatically identify all potential defects without the benefit of having much sample data.

A third work step will perform a precise classification of the defects and determine the correct measurements. This requires the development of a new sensor for the defect measurement and classification. The basis for this is the defect position data determined in the second step. Using the results from the previous step, a second CMM automatically generates a measurement program for all defects. These measurements then result in a quantitative description of the possible defects. In cases, where a defect is questionable, the inspection has to be reviewed by an expert.

The overall aim of the project is to provide a safer and more efficient quality management of BLISKs.

CLEANSKY



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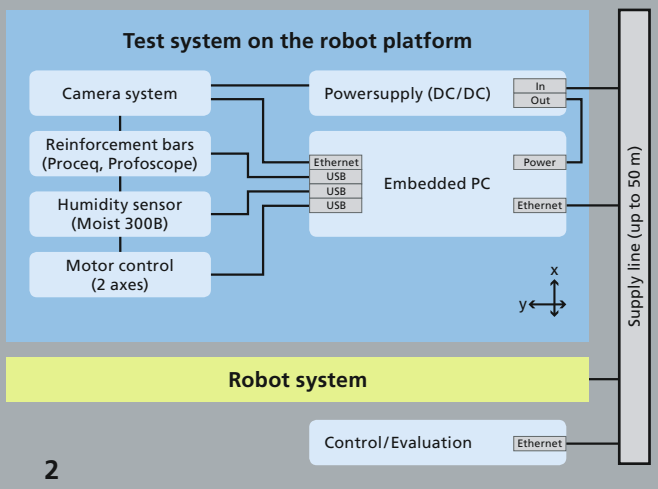


2

ROBOT SYSTEMS FOR THE INSPECTION AND ASSESSMENT OF LARGE CONCRETE COMPONENTS

Engineered structures such as bridges, dams, locks, and cooling towers often have poorly accessible surfaces that require regular inspection. In collaboration with four different medium sized companies in a ZIM project (Zentrales Innovationsprogramm Mittelstand), Fraunhofer ITWM and the robotic systems working group at the Computer Science department of the TU Kaiserslautern is investigating innovative concepts in structural maintenance. An inspection system, held on the surface by a partial vacuum, was developed especially for the inspection of vertical and steep surfaces. It can deploy various measuring sensors (to record humidity, the condition of the rebar, optical recognition of surface defects) directly to the inspected site.

Various partners contributed innovative research studies on the topics: development and construction of density and friction wheel systems, robotic design and construction, user and object oriented inspection methodology, including the development of test and analysis processes for the inspection of large concrete structures as well as robot controls. The Fraunhofer ITWM contribution includes the test engineering based on various measuring methods, the mechanized testing on the structure as well as the data captures and test evaluation.

The integrated system consists of a flexible, deployable, climbing robot, the test engineering as well as the associated analysis electronics and software. The various measuring sensors are moved across the building surface with the aid of a light manipulator mounted on a robot-platform (Figure 1). The test area is currently one half of a square meter. The control and measuring computer is for programming the sensor system and conducting the testing. The concept envisions a user operating the system from an industrial grade laptop, while the inspection software runs on the robot-platform. The control is achieved via remote desktop, which ensures a certain independence from the operating system. A report is generated at the end of the test which shows a graphic analysis and summarizes the relevant results. The inspection software features various presentations for each sensor. In this way, for example, the ultrasonic testing provides a three dimensional data array while the humidity measurements and the rebar search are recorded as two dimensional data sets. The parametrizations of the sensor system as well as the settings related to the sensor positioning module are sensor dependent. Currently, the various components are being integrated on the robot-platform. In conclusion, the activities of the Test and Evaluation phase are carried out jointly with the project partners.

1 *Integration scanner on robot-platform: The integrated ultrasonic converter and both sensors for the rebar detection using Foucault (or Eddy) current and the measurement of the humidity (microwaves)*

2 *Block diagram of the control and measuring computer (embedded PC) on the robot-platform*

Dr. Patrick Lang, Anastasia Migunova, Dr. Andreas Wirsen, Vladimir Shiryaev, Dr. Alex Sarishvili, Hans Trinkaus, Thanh Hung Nguyen, Dr. Christian Salzig, Dr. Jan Hauth, Tjorben Groß, Andreas Barthlen

SYSTEM ANALYSIS, PROGNOSIS AND CONTROL

▪ SYSTEM ANALYSIS AND CONTROL

Development of model based monitoring systems and control strategies as well as their hardware integration

▪ DATA MINING AND DECISION SUPPORT

Development of data based prognosis tools and technology for visual analytics

▪ MULTISCALE STRUCTURE MECHANICS

Numerical algorithms for computing the effective mechanical properties of multiscale materials

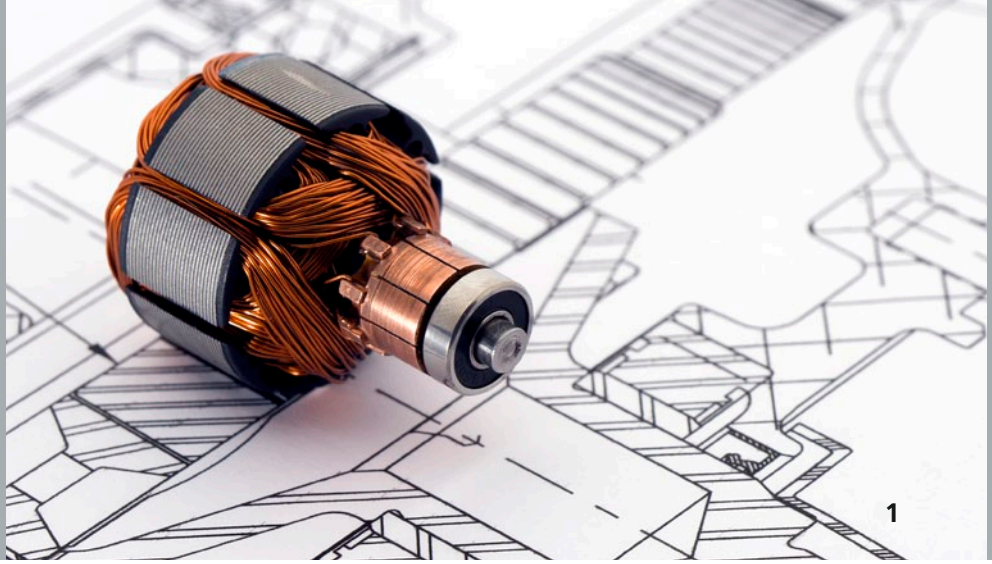
www.itwm.fraunhofer.de/en/sys

DR. PATRICK LANG
HEAD OF DEPARTMENT

The department's core competencies are mathematical system and control theory, data mining, and multivariate statistics in addition to multiscale analysis methods. These competencies are used in modeling, analysis, prognosis, and control of complex system behavior in various key application areas.

Problems in the area of energy systems are monitoring of power turbine generators, stabilization of energy transmission networks and the improvement of energy efficiency in industrial production processes. The increasing integration density of electronic and mechatronic components, associated with a variety of sensors and actuators often results in complex and very sensitive overall system behavior. Multi-domain models from systems theory form the basis for an analytical or simulative (SIL / HIL) behavior verification. The abundance of available omics data is bringing the vision of personalized medicine based on suitable biomarkers ever closer. Mathematical models in combination with simulation and optimization tools are improving the biotechnological processes and assisting in the development of highly effective and highly specific drugs; powerful data analysis tools support the diagnosis and decision making; interactive software facilitates the implementation of individual counseling sessions. In the area of Materials and Product Design, models are developed for the prognosis, classification, and simulation of product and material behavior, which then serve as the basis for appropriate design decisions. In order to minimize the need for costly experiments in data collection, design of experiment (DOE) approaches are used. A special focus is technical textiles where, by means of the mathematical homogenization method, effective material properties can be calculated. Manufacturing and business processes, in many cases, are characterized by the high complexity resulting from the linkage and interaction of many components. The systematic analysis of these processes enables their optimization in terms of quality or energy efficiency, identifies weaknesses, and results in new product designs. Tailored for human visual comprehension, representations of data and analysis results promote their use.

The department provides consulting services and customer-specific software development in all these application areas in addition to its own products.



QUALITY MANAGEMENT IN THE PRODUCTION OF ELECTRIC MOTORS FOR THE AUTOMOTIVE INDUSTRY

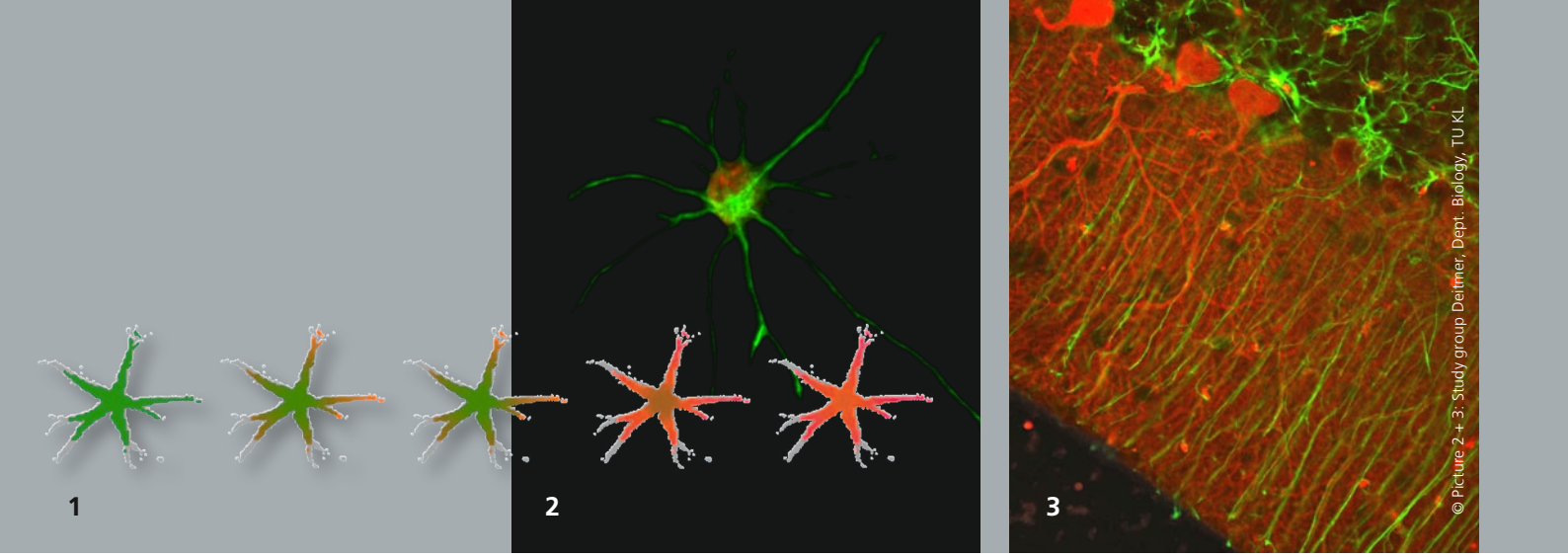
1 *Armature of a small electric motor*

Small electric motors are required in the automotive industry, for example, to run the window regulators, windshield wipers, pumps or fans. To ensure that these engines satisfy specifications in terms of functionality and durability, they undergo post production testing. Fault prone components are discarded so as not to be used for sale.

Fraunhofer ITWM performs orders for industrial partners in this environment, in which the planned quality assurance methods are tested for functionality and expanded for product variants. In the process, a better understanding is achieved of how the separate components of the motor armature influence the signal during the measurement and conclusions may be drawn regarding production accuracy.

To solve this challenge, ITWM develops the in-house software tool Analog Insydes, which can be used to model, simulate, analyze, and optimize the analog circuits. In effect, it models the motor armature as well as the connection of the measurement system as an equivalent circuit diagram consisting of electrically analogous components to determine the applied currents and voltages. In this way, the automatically generated circuit equations for the armature measurement implicitly include the dependencies of the applied current and voltage signals from the armature parameters. Furthermore, the power of Analog Insydes is used to derive a clear approximation of the symbolic transfer function of the armature. This facilitates simple analysis of system behavior.

If several measurements are taken with different configurations of the same armature, using the generated equation system, conclusions can be made about the variants of the individual armature parameters. These are then used to check whether the produced component satisfies the functionality and durability requirements. Additionally, other characteristics of the armature produced can now be determined with the help of the motor parameters, eliminating the need for explicit measurements. This significantly decreases the time of the testing cycle required for the quality control of an individual component.



FAST SIMULATION OF REACTION-DIFFUSION PROCESSES IN BRAIN CELLS

1 *Simulation of a reaction-diffusion process in a virtual three-dimensional astrocyte (image plane cut)*

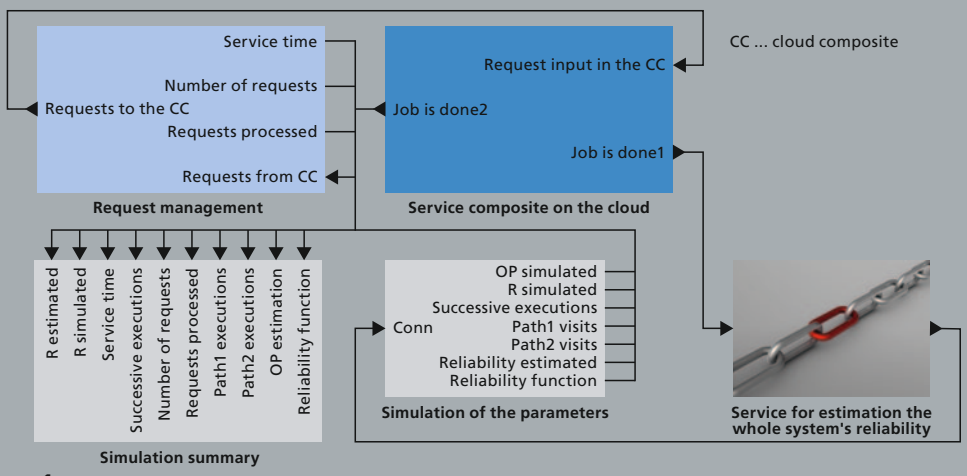
2 *Cultured astrocyte of a rat brain*

3 *Purkinje neuron and Bergmann glia of a rat*

Brain cells typically exhibit a complex three-dimensional geometry: depending on cell type, one or several branches which are more or less ramified by themselves (dendrites, axons) grow out of the cell soma. They build manifold connections to the neighboring cells and, in this way, establish large-scale networks. Commonly known are the neural networks, which are considered to fulfil fundamental functions in the brain. Nevertheless, another kind of brain cell contributes essentially to the functioning of the brain: the glial cells. While it was commonly assumed in the past that the glial cells serve as a kind of glue to the neurons, recent research has shown that they do not only feed the neurons with nutrients, but they also play an essential role in processes directly connected to learning. The interconnections between the cells serve to the exchange of information and matter. These interactions are based on electrochemical processes and are highly complex. Some examples are: active and passive transport of ions over the cell membranes, transport of substances inside the cell by diffusion processes, and chemical buffering of ions.

Since neurons and glial cells are quite small, direct measurements with a sufficient temporal and spatial resolution are nearly impossible. For this reason, one tries to understand the processes based on model cells (e. g. frog oocytes) which are easier to observe, and then to transfer the results to the more complex cells. Mathematical modeling and computer-based simulations support this goal. From a mathematical point of view, the task is to obtain numerical solutions of a certain kind of partial differential equations (especially reaction-diffusion equations) in complex three-dimensional geometries. Common software solvers work on discrete grids and require the inversion of very large sparse matrices. The complex spatial structures of cells and cell networks have to be modelled by extremely fine grids, which enormously increases the computational power needed to solve the resulting equation systems. Accordingly, simulations have to run on high-performance computer clusters. In a joint work of the department "System Analysis, Prognosis and Control" at ITWM and the Division of General Zoology at the University of Kaiserslautern headed by Prof. Deitmer, a fast numerical solver has been developed. This solver is based on a stochastic approach and therefore requires no grid and no inversion of large matrices. The solver allows the simulation of complex three-dimensional cells on a PC or notebook in real time.

The method has also been tested on an implementation of the Hodgkin-Huxley model. This model describes the propagation of action potentials in neurons and heart tissue. Other possible applications of the method could be found in the real-time control of technical systems where thermal conductivity plays a major role (e. g. melting or annealing processes).



1

INNOVATIVE SERVICES IN THE INTERNET OF THE FUTURE – IndiNet

The "Innovative services in the future Internet" project is one of four scientific research projects of the leading edge cluster "Software innovation for the digital enterprise". The aim of the project is to develop a plat form that will assist the suppliers of emergent software components in developing new business models with proven procedures, directives, and templates so they can position their offer in the open market. The technical implementation and operation of the associated services are supported by appropriate tools and services. In this context, ITWM develops a service for estimating the reliability of composite services, how they can be created and offered by users of the platform.

1 *Demonstrator platform for estimating reliability and simulation of failure behavior of a composite of cloud services*

The reliability estimation uses stochastic methods and is based on component service reliability information, where the quality of the reliability data may vary considerably. The typical user of such services would be a service provider, who produces custom platform services for businesses that already use existing services. In some cases, perhaps in the context of a service level agreement (SLA), the service provider has to make performance information available to his customers about the composite services offered. This may include information about availability, throughput, response times, and reliability. A standard component of SLA is Mean Time Between Failures (MTBF), an objective criterion in the analysis of failure data of a software product during testing. If the MTBF is available for all components of a composite service, the information can be used directly to assess the reliability of the total composite. For the service provider, it makes sense to mainly use those services to produce the composite that, in terms of reliability data, possess detailed SLAs. If there is no reliability information for the individual component services available, it can be estimated by means of inhomogeneous Poisson processes or by heuristic methods.

A demonstrator platform for estimating the reliability of a newly developed composite service in the cloud was created as part of the project. The platform enables the designer to make informed statements about the sensitivity of the overall reliability of the composite with respect to arbitrary variations in the reliability of the individual services and the operational profile of the composite. The demonstrator allows the design of query input frequencies, the modeling of request processing times, the identification of bottlenecks in the execution process, and also the visualization of the relevant variables during the simulation.

Prof. Dr. Karl-Heinz Küfer, Dr. Sebastian Velten, Dr. Neele Leithäuser, Jasmin Kirchner, Dr. Michael Bortz, Dr. Heiner Ackermann, Grete Kaffenberger, Chhitiz Buchasia, Neil Jami, Alexander Belyaev, Sandra Keth, Dr. Veronika Dick, Dr. Alexander Scherrer, Katrin Stöbener, Bastian Bludau, Dr. Richard Welke, Anna Hoffmann, Dr. Philipp Süss, Tabea Grebe, Dr. Johannes Leitner, Andreas Dinges, Dr. Volker Maag, Dr. Peter Klein, Dr. Kai Plociennik, Dr. Jan Schwientek, Jens Leoff, Dr. Rico Walter, Dimitri Nowak, Dr. Maksym Berezhnyi, Dr. Jonas Haehnle, Dr. Ingmar Schüle

OPTIMIZATION

▪ MEDICAL THERAPY PLANNING

Development of new methods for clinical therapy planning based on multicriteria optimization

▪ OPTIMIZATION IN VIRTUAL ENGINEERING

Physically and technically based models and their simulation in algorithmic software (virtual engineering)

▪ OPTIMIZATION OF ENTERPRISE STRUCTURES AND PROCESSES

Modeling of planning systems for logistics and organizational tasks and development of specialized software applications

www.itwm.fraunhofer.de/en/opt

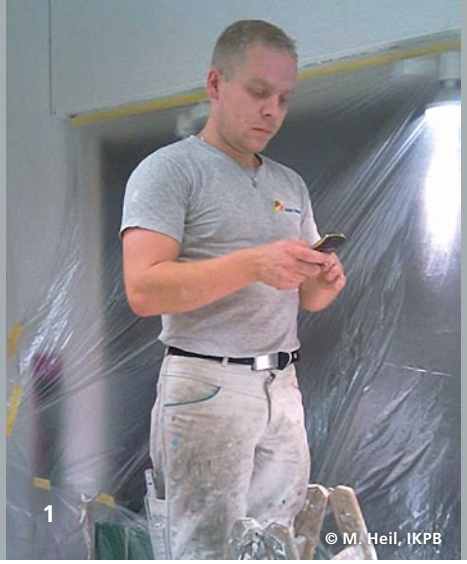
PROF. DR. KARL-HEINZ KÜFER
HEAD OF DEPARTMENT

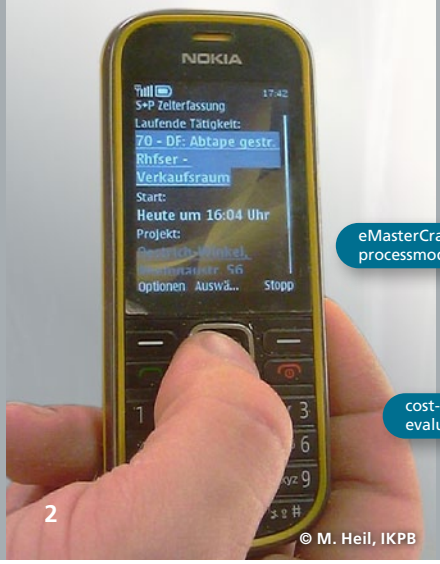
The major aim of the Optimization Department is to develop custom solutions for planning and decision making problems encountered in the logistic, engineering, and life sciences and to work in close cooperation with partners in research and industry. The work is characterized by a methodical approach with tight integration of simulation, optimization, and decision support. Simulation in this context refers to the construction of mathematical models by taking into account the design parameters and constraints while optimizing quality and costs. The department's core competencies include the development and implementation of application and customer-specific methods of optimization to calculate the best possible solutions for designing processes and products. A unique feature is the close integration of simulation and optimization algorithms that consider multiple criteria approaches as well as the development and implementation of interactive decision support tools. Generally, optimization can be viewed not so much as a mathematical problem to be solved, but rather as a continuous process that the department supports through the development of suitable tools.

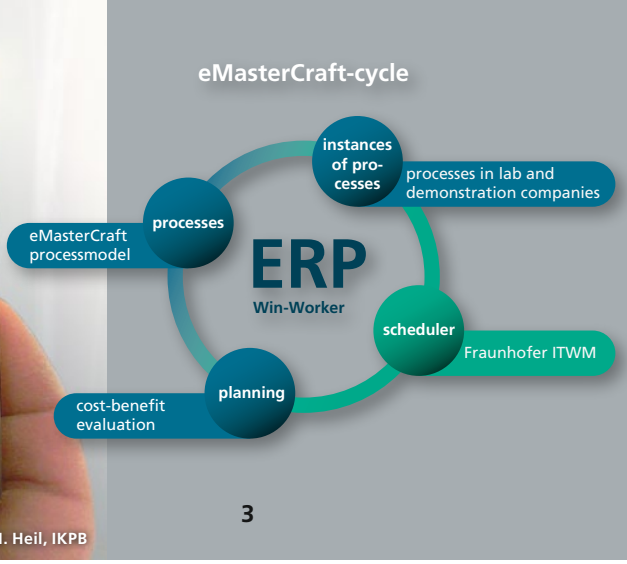
The year 2013 is characterized in the department as one of growth and outstanding commercial success, in particular:

- The start of the INES research and development project, commissioned by BASF for stationing detection, data reconciliation, and for the sensitivity analysis of process data
- The start of a large collaborative project called SPARTA for the planning of adaptive radiotherapy, sponsored by BMBF
- Presentation of "Patient-Navi" for the planning of clinical ambulance services at GirlsDay 2013 in the Office of the German Chancellor
- Simulation of a bulk port for managing the stadium construction in the Emirate of Qatar for the Soccer World Cup 2022, commissioned by FLSmidth & Co

In the scientific area, in addition to three completed PhDs, we have approvals from BMBF and BMWi for the projects ViLoMa, SPARTA, and SkaSIM. Also, we have funding recommendations at BMBF and AiF for the H2OPT and PARA-OPT and an international workshop on "Projection Methods" with renowned scientists from the USA and Israel.







eMasterCraft – eBUSINESS AND STANDARDIZED MASTER DATA IN THE BUILDING AND FINISHINGCRAFTS

Compared to manufacturing, the construction industry lags significantly behind in the usage of electronic processes. This creates competitive disadvantages, high costs, inefficient processes, and leads to poor planning. The "eMasterCraft" project is sponsored by the Federal Ministry of Economics in the context of the "Mittelstand-Digital" initiative. It is a multi-disciplinary research project that aims to increase the penetration of the building sector with electronic data exchange and computer aided processes in the skilled trades, but more importantly, for the communication among themselves as well as with architects and planning offices.

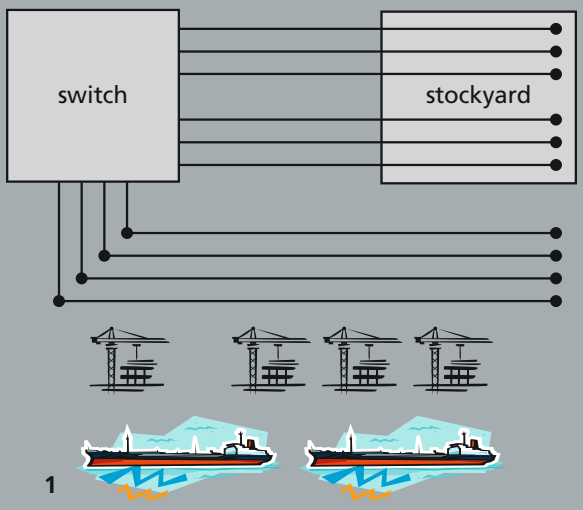
The first step, above all, is to implement standards: for master data, data exchange formats, and processes. The small enterprises are not able to develop or maintain this on their own, but must rely on industry standards. The skilled trades will only be moved to a stronger focus on EDP processes if it does not hurt their bottom line.

This is why ITWM develops in eMasterCraft a cost-benefit analysis tool that enables a comparison of the costs of electronic processes with the company-specific benefits of their use. It generates a comparison of the actual company processes to target processes in a simulation. The basis of the simulation is "Scheduler", an optimization component, which plans realistic time schedules for scarce resources. The ability to calculate realistic deadlines based on existing resources and contracts is a huge advantage for a trade enterprise. The cost-benefit tool provides these advantages in a monetary evaluation context.

Launched in 2012 with a term of three years, eMasterCraft is a consortium of nine partners from research, trade, and business associations. The lead manager is IKPB (Institut für kybernetisches Planen und Bauen) in Kassel, which established an eMasterCraft project office in the vicinity of ITWM in Kaiserslautern.

1 + 2 *Already reality at innovative skilled trade enterprises: A painter enters his work progress in a mobile telephone app; The information is available in just a moment at the company for further planning.*

3 *The development cycle in eMasterCraft: key component of the cost benefit tool is the ITWM automatic scheduler.*



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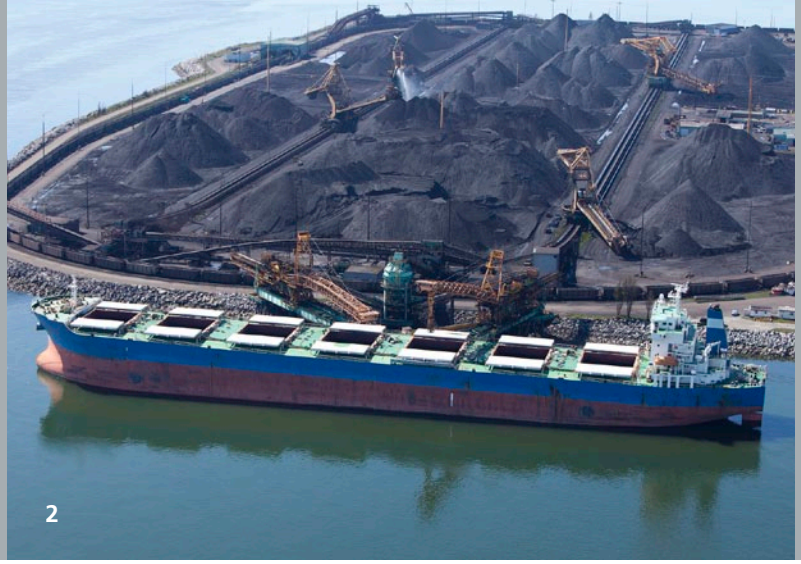


2

SIMULATION BASED THROUGHPUT OPTIMIZATION FOR AN EXTENSION OF A PORT HANDLING BULK MATERIALS

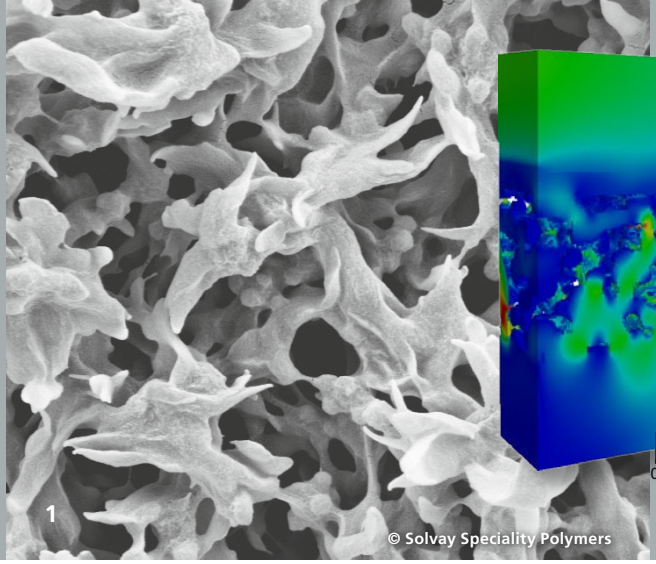
1 *Schematic diagram of the simulated harbor*

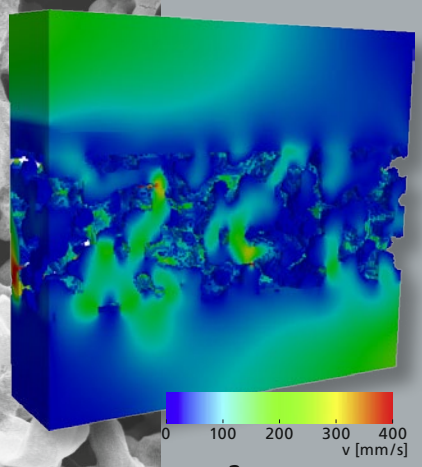
2 *Bulk carrier and intermediate stockyard*

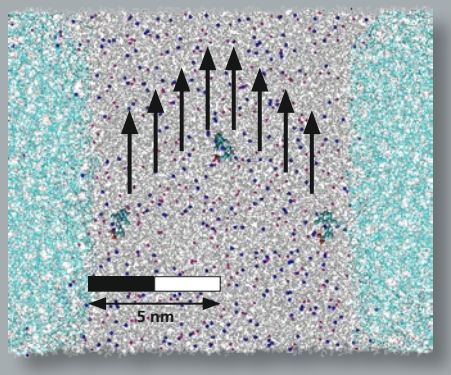
Increasing globalization leads to a steady rise of the quantity of goods to be transported. The main mode of transportation for bulk materials (like coal or sand, but also grain) is transportation via ship. This is especially true if large quantities have to be transported over long distances. As central hubs, ports handling bulk materials play a crucial role in the underlying logistic networks. Well-balanced unload, transportation and stockyard capacities are essential for the economic success of these terminals. In addition, strategic decisions which have to be taken in this context involve high investments and therefore have to be well prepared.

To support such a strategic decision a study has been conducted by the optimization department in which the throughput of an extension of a terminal handling bulk materials has been approximated. The customer for this study is FLSmidths, a company which develops and builds individual transportation and storage systems for bulk materials. The terminal under consideration currently contains several berths and cranes for unloading bulk materials. This infrastructure is to be extended by a system of conveyer belts and a temporary stockyard. The main purpose of this extension is to decouple ship unloading from onward transport in order to increase throughput, decrease idle times and balance stochastic arrival times. Within this study a specialized simulation model has been developed and implemented. In a first step, due to complexity reasons, the simulation of the ship unloading and the simulation of the temporary stockyard have been considered separately. The ship unloading has been analyzed using a Constraint Programming approach. In this approach the goal is the minimization of the total unloading time for single ships subject to balance, stability and sequence constraints as well as speeds (cranes and belts). To simulate the occupation of the temporary stockyard a Discrete Event Simulation has been implemented. This simulation can be parameterized so that, for example, different layout strategies (e. g. all storage areas have the same size vs. the size of the storage areas can be adjusted dynamically) can be compared. To integrate the simulations for the unloading and the stockyard aspect and to obtain results for the overall system, the simulation of the temporary stockyard has been run using optimal unloading plans.

Based on the integrated simulation model various degrees of freedom concerning the design of the system and having an impact on the throughput became apparent. Alternatives have been discussed and recommendations have been given. Furthermore, important observations about the operation of the extended terminal have been made. These findings help FLSmidths in the development and implementation of an operational control system.







1 2 3

NANOPUR – NANO-MEMBRANE FOR THE EFFICIENT FILTRATION OF DRINKING WATER

NANOPUR, a project of the 7th Framework Programme of the EU, develops an active ultra filtration membrane for the efficient filtration of drinking water. 12 partners from seven countries collaborate in the development of nano-structured membranes that combine high permeability and high filter selectivity. The overall objective is to improve energy efficiency, long term stability, and filter performance in membrane filter processes. Innovative concepts of water filtration based on nano-functionalized membranes are integrated in a bottom-up approach. Building on recent developments in the field of polymer-based membranes, surface treatments, and bio-functionalization, a new membrane with improved permeability and greater selectivity is being developed for the production of drinking water. The filter, in particular, separates virus and drug residues, for example, Diclofenac.

ITWM has started to model the membrane characteristics on a nano-scale. Molecular modeling can identify structure-property relationships for Zeta potentials and flow potentials; both attributes are experimentally difficult to access, but are needed to define the filtration properties of the membranes. By taking advantage of appropriate molecular correlations, wall rheology models are developed that can be used as boundary conditions in the mesoscale models of fluids transport and particle deposit simulations. On the basis of these meso models, the Flow and Material Simulation Department at ITWM calculates on the macro level, the component level, the Key Performance Indicators (KPI) for the water filtration. From a technological perspective, these are the energy consumption, fouling, and filter efficiency (selectivity). To support the commercialization of the developed membranes, the KPIs are extended by empirical cost and risk assessments. Since all quality and cost dimensions cannot be simultaneously optimized, the concept of Pareto optimality (best possible compromise) is used and a comprehensive decision support tool will be developed.

1 + 2 *Membrane (left) and flow simulation with atomistic characterized limiting conditions on the membrane surface (right)*

3 *Water flow at atomic resolution through the membrane pores with 3 Diclofenac molecules*

Stefanie Grimm, Dr. Jörg Wenzel, Dr. Gerald Kroisandt, Prof. Dr. Ralf Korn, Dr. Johannes Leitner, Dr. Peter Ruckdeschel, Dr. Christina Erlwein-Sayer, Dr. Bernhard Kübler, Dr. Sascha Desmettre, Dr. Roman Horsky, Dr. Tilman Sayer

FINANCIAL MATHEMATICS

▪ OPTION PRICING

Valuation formulae and pricing algorithms

▪ CREDIT RISK AND STATISTICS

Validation and enhancement of rating procedures

▪ PORTFOLIO OPTIMIZATION

Calculation of risk measures and risk management of large portfolios

▪ INTEREST RATE MODELS

Development of interest rate models with particular emphasis
to low interest rate periods

▪ ACTUARIAL MATHEMATICS

Simulation and optimization of ALM strategies

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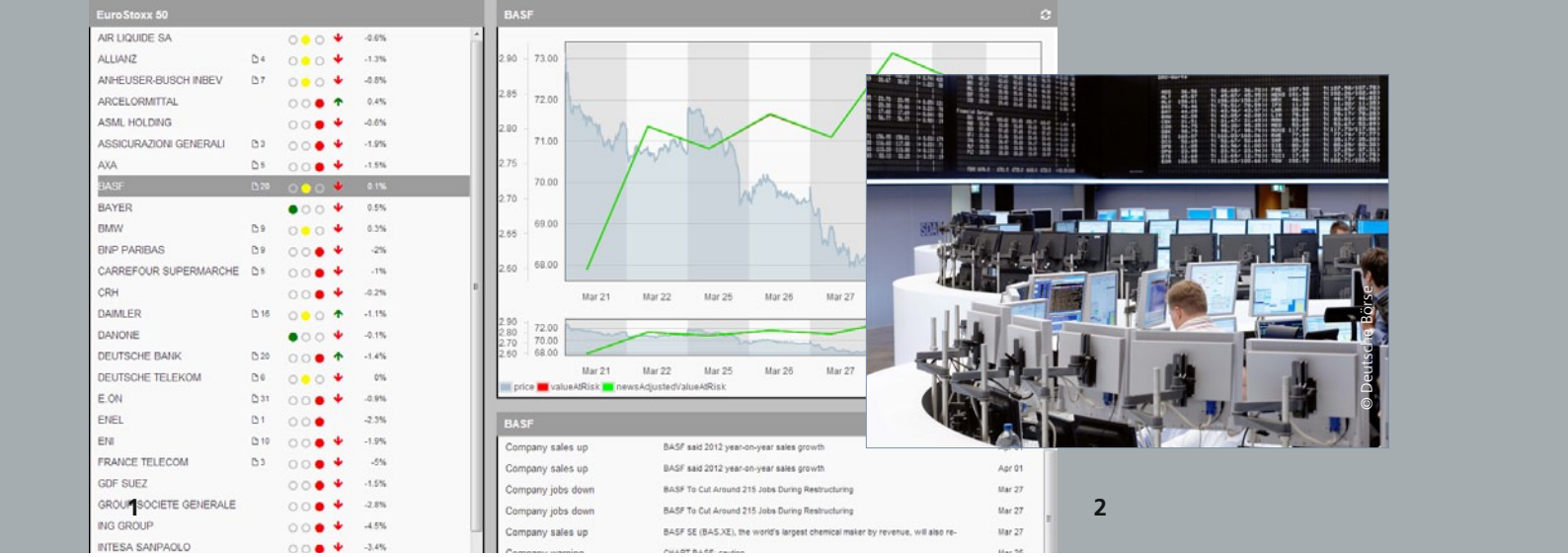
PROF. DR. RALF KORN
HEAD OF DEPARTMENT

The Financial Mathematics department offers modern solutions to all problems in development, analysis and numerical implementation of mathematical models for the finance and insurance industry. Our approach is based on most recent research in finance and statistics to develop concepts, algorithms, models and software platforms for finance and insurance. As in previous years new challenges in our field increasingly arose in risk management. Here, in 2013 we focused on the two research projects "News Optimized Risk Management" (NORM) and "Robust Risk Estimation". The NORM project was completed in 2013. One of the results of it is a web-based demonstration tool which is now available online, see the detailed section on the NORM project. Moreover, we could also complete a large industry project for the risk management of UCITS funds.

Acquiring new projects turned out to be difficult in 2013. This may partially be due to increased risk aversion in banking and finance but also to a decreased appetite for new and even more refined equity or interest rate models. On the other hand new regulatory requirements result in new business areas for our department. In particular, this concerns topics such as measuring liquidity risk, managing of risk of companies' complete portfolios as well as examination of suspicious cases and irregularities in accounting. Also, the current extremely low level of interest rates yields new tasks in the area of asset liability management for life insurers. Therefore, we emphasized our acquisition activities in this area and could successfully solicit a WISA "Stochastic Modeling and numerical Simulation for the risk management of insurance companies" jointly with Fraunhofer SCAI.

We continued the cooperation with our trusted partners such as e. g. R+V Versicherung, teckpro AG, and Landesbank Baden-Württemberg. Also, we could carry out a project with the local savings bank Kreissparkasse Kaiserslautern, which showed potential for further cooperation. Multiple publicly sponsored projects were continued as planned. This concerns in particular the BMWi project "Quantifizierung des geothermischen Fündigkeitsrisikos" (GEOFÜND) in geothermal drilling as well as the BMBF project "Energieeffiziente Simulationsbeschleunigung für Risikomessung und -management" (ESR) on energy efficient simulation speed-up. Together with TU Kaiserslautern the DFG project "Regime-Switching Models in Finance: Statistics and Optimization" was started.

Last but not least we are happy to report two successful PhD completions in our department this year.



NEWS OPTIMIZED RISK MANAGEMENT (NORM)

News move markets. The EU-supported project NORM aims at developing and implementing a dynamic approach for measuring market price risk by integrating the effects of financial news. Dutch software specialist SemLab and British consultancy OptiRisk serve as our project partners.

News-based approaches are particularly eligible for short term risk assessment. In turbulent market phases, the strong impact of news on asset returns becomes apparent. Most standard tools for market price risk assessment make use of historical price data only. They neglect information stemming from other sources like news streams. This retrospective risk assessment thus does not mirror current and future risk properly. NORM starts from the observation of significant correlations between news occurrence and volatility of asset returns. The standard risk measure Value at Risk (VaR) directly depends on the volatility.

The NORM approach combines historic price data and information coming from some news stream and builds a model for the evolution of the conditional volatility. More precisely, the data are used to calibrate a GJR-GARCHX(1,1) model which exhibits the following features:

- Integration of news
- Distinction between positive and negative news
- Volatility clustering
- Volatility asymmetry
- Fat tails
- Backtesting

There is a web tool which serves as POC (proof of concept) application. It is accessible via www.semlab.nl/portfolio-item/news-based-var. The user may select one of the shares of the EURO STOXX 50 index. Its 1-day-VaR is calculated using a traditional method as well as the news-adjusted NORM approach.

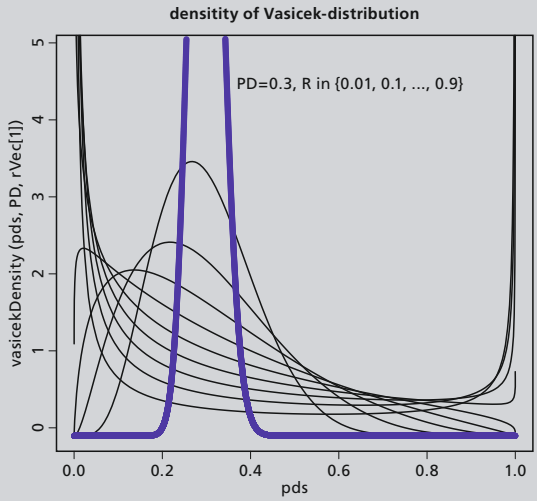
1 *Webtool*

2 *Stockbroker at Deutsche Börse*

The Eurostars Programme is powered by EUREKA and the European Community

GEFÖRDERT VOM

Bundesministerium für Bildung und Forschung



1

EVALUATION OF RISK WEIGHTS

1 *One way to model default-correlations is based on the Vasicek-distribution.*

Changes in banking regulation, especially Basel II since 2007 and Basel III starting in 2014/2015, force banks and other financial institutions to improve their risk management dramatically. This process ranges from the collection of data over the modeling of risk and statistical analysis to accounting aspects and risk reporting.

The approach in the German capital adequacy regulation (SolvV) aims at not only taking default risk of a stand-alone asset (e.g. expected loss) into account but also the risk resulting from correlated defaults within a credit portfolio. Correlated defaults can e.g. cause observed total portfolio losses to fluctuate much more over different years than would be expected under an independence assumption. This fact makes it quite difficult to valuate a credit portfolio and to determine the adequate risk capital and provisions. Since neither default probabilities are known (they can only be estimated using rating methods), nor default correlations are available – for their accurate estimation much data are required and it is questionable if it is at all possible to project in a dynamically changing economic setting future risks using historical data – risk management is not a science but an art, requiring high competence, good judgement and integrity.

Applied in the right spirit, risk weights provide an important improvement over other approaches based on an independence assumption of the stand-alone risks in a portfolio. Our task was to present the mathematical background of the regulation as well as the evaluation of these risk weights for some components of a credit portfolio.

1

REGIME SWITCHING IN FINANCIAL MARKET MODELS: STATISTICS AND MODEL SELECTION

In present day modeling of financial markets, accounting for possible regime switches is gaining importance. One assumes that model parameters, instead of being constant over time, may switch between different states/regimes. These regime switches are driven by a Markov chain which can be modeled in discrete or in continuous time.

In Hidden Markov Models (HMM) or Markov Switching Models this Markov chain is unobservable. The current state, respectively the corresponding transition probabilities must be recovered/filtered from the observable time series. Based on these filters the respective model parameters can be estimated.

In a financial market context, these states can be interpreted as representing a good or a bad market situation with consequences for the parameter estimation. E. g., modeling stock returns by an HMM, one can imagine turbulent states in which the general volatility level is high, whereas calmer market situations with lower volatility often coincide with higher average returns. In the discussed HMMs, these parameter changes can be captured by the Markov chain in a flexible and effective way.

In this field, the Department of Financial Mathematics at ITWM is working together with the department of Mathematics at the Kaiserslautern university on a joint research project "Regime-Switching in continuous time financial market models: Statistics and problem specific model selection"; this project has been funded by the Deutsche Forschungsgemeinschaft DFG from 2011 to 2013.

In this framework, the two departments organized an international workshop "Regime-switching models in Finance: Statistics and Optimization", at ITWM in November 2013, featuring presentations on filtering, algorithms for parameter estimation and their robustification, model selection and clustering, change point analysis, and modeling of asset allocation and portfolio optimization. This event provided a good opportunity to the scientific community for exchange, to present new ideas and to initiate further reaching approaches. Attendees from industry got updated on the current state of the art in research and could present their own applications and problems to the research community.

1 *Simulated data from a Hidden Markov Model as discussed at the workshop, with two-dimensional observations (upper/lower panel) and three states (red, green, blue).*

Dr. Klaus Dreßler, Dr. Nikolaus Ruf, Steffen Polanski, Dr. Sascha Feth, Sonja Baumann, Christine Rauch, Dr. Peter Cesarek, Dr. Michael Burger, Michael Roller, Michael Kleer, Dr. Michael Speckert, Dr. Eder Santana Annibale, Thorsten Weyh, Thomas Halfmann, Martin Obermayr, Alexander Lemken, Christoph Mühlbach, Dr. Andrey Gizatullin, Fabio Schneider, Axel Gallrein, Thomas Stephan, Dr. Sebastian Seifen, Ekaterina Kruglova, Dr. Clément Zémerli, Eduardo Pena Vina, Tim Rothmann, Michael Horcicka, Dr. Stefan Steidel

MATHEMATICAL METHODS IN DYNAMICS AND DURABILITY

▪ MODELING AND SIMULATION OF USAGE VARIABILITY AND RELIABILITY

Design targets for durability and optimization of highly variable design attributes like reliability and energy efficiency

▪ SYSTEM SIMULATION IN VEHICLE ENGINEERING

Tire, soil, and driver models

▪ NON-LINEAR STRUCTURAL MECHANICS

Simulation of highly deformable components and structures such as tires, rubber bushings, hydro-bushings, air-springs, hoses and wiring harnesses

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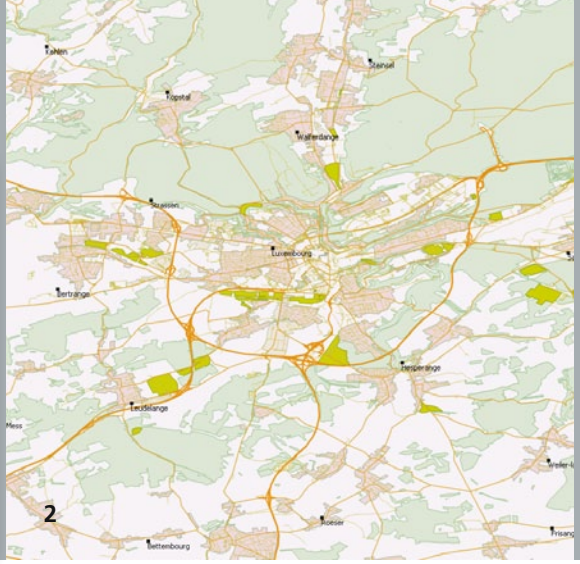
DR. KLAUS DRESSLER
HEAD OF DEPARTMENT

The expertise of this department is in the area of modeling and simulation of usage variability, dynamic loading, and energy efficiency for vehicles and machines. Consequently, we deal with statistical methods for modeling diverse use cases and variants, as well as multibody system simulation (MBS) and Finite Element Methods (FEM) for system and component analysis. In our industrial projects, we examine reliability and durability, as well as structural and system dynamics primarily with regard to the motor vehicle industry.

At the Fraunhofer Innovation Cluster "Digital Commercial Vehicle Systems/Vehicle-Human-Environment" (www.nutzfahrzeugcluster.de), the department MDF has overall responsibility for coordination and works with industry partners Bosch, BPW, Daimler, GoodYear, John Deere, Liebherr, and Volvo on sub-projects for usage variability, energy efficiency, on-board simulation, tire and soil simulation, as well as structural mechanics. Our geo-referenced information and analysis system VMC (Virtual Measurement Campaign®) enables systematic analysis of the usage variability of vehicles based on geo-referenced data. This provides measurement parameters for reliability and for the optimization of other quantities like energy efficiency and fuel consumption. Statistical methods also play a major role in reliability engineering and operational release of components. The department is developing the software system JUROJIN for statistically validated proof of component fatigue life. In system and vehicle development, simulation is important for calculating the physical system characteristics at an early stage and in different phases of the development process in order to evaluate, improve, and validate the design. Of growing importance are the hybrid and interactive simulations, which enable electronic control devices and the driver to be included in the calculations with realistic results. We are working on the development and application of advanced methods for multibody simulation and the simulation of coupled physical systems. We also develop processes for invariant system excitation, for tire simulation (CDTire), for soil and material simulation, as well as for simulation of highly deformable structures like rubber bushings, cables, and hoses (IPS Cable Simulation). A special highlight in 2013 was the launch of our interactive driving simulator RODOS®. The system is designed on the basis of an industrial robot with a 1000 kg payload. Interactive visual scenes are generated and seamlessly projected within a spherical dome having a diameter of 10 meters. The active stereo projection synchronizes and adapts the images from 18 projectors to ensure that a very realistic perception is achieved. The system is used in projects to develop driver models for the improvement of human-machine interfaces, as well as for the development and validation of assistance systems.



LORRY – DEVELOPMENT OF TRUCK TIRES WITH LOW ROLLING RESISTANCE

Since the end of 2012, ITWM is working on the European FP7-funded project LORRY (project number 314463, website: www.lorryproject.eu). The project is coordinated by Goodyear and the consortium consists of ten further partners from seven EU countries. The aim of the project is to reduce the CO_2 footprint of trucks by developing new tires with 20 % less rolling resistance, which corresponds to a reduction of 5 % fuel consumption and CO_2 emissions. The CO_2 footprint is a measure of the total amount of carbon dioxide emissions that occur during the different stages of the life cycle of a product.

In addition to tire development, the proof of tire quality using real measurements is another major component of the project proposal. This is carried out via vehicle fleet measurements by an involved logistics company and a provider of telematics solutions. ITWM is responsible for the planning of the fleet measurements, as well as the implementation of the statistical analysis of the measured data. In addition, the existing methodology of the VMC software is extended such that a prediction of rolling resistance for certain customers in certain markets will be possible.

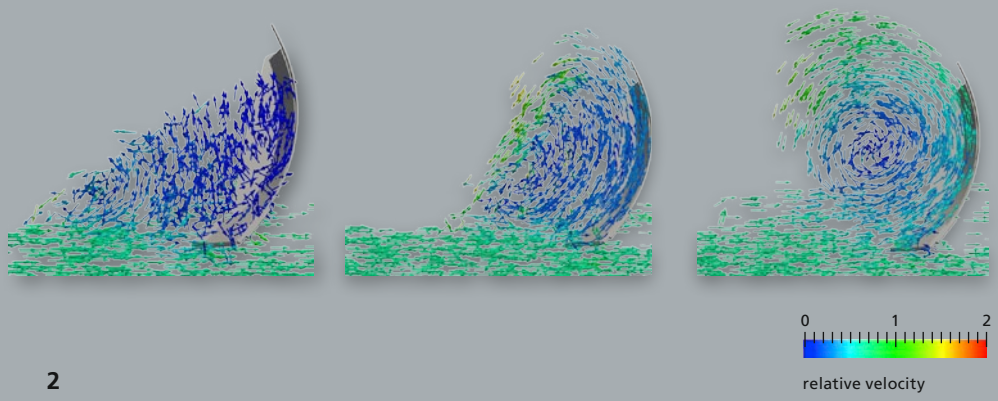
There is a strong relation to the contents of the ITWM software VMC® (virtual measurement campaign, www.itwm.fraunhofer.de/en/departments/mdf/statistical-methods/virtual-measurement-campaign) which is implemented amongst others in collaboration with the truck companies DAF, Daimler, MAN, Volvo and Scania. VMC allows systematic analysis of the usage variability of vehicles based on geo-referenced data. In combination with vehicle and driver models, it is possible to simulate measurement runs of any length in the computer. The goal is also to improve planning of real measurement campaigns and to transfer existing data from one region to another, so as to make existing data available for other markets.

In addition to the expertise in the field of modeling usage variability, the subject tire modeling plays a central role in the LORRY activities. Within this work area, ITWM is constantly developing the software CDTire (www.itwm.fraunhofer.de/en/departments/mdf/services-and-products/cdtire). It is a family of structural mechanics tire models with different modeling detail of belt, sidewall and tread to provide an appropriate optimal combination of accuracy and computational effort for several applications. Currently, in a joint project with Goodyear an MBS tire model is extended based on CDTire technology in terms of handling rolling resistance and wear.

1 *Virtual measurement depending on driver and vehicle models*

2 *Visualization of geo-referenced data*

1



2

DETERMINATION OF FORCES IN SOIL-TOOL INTERACTION

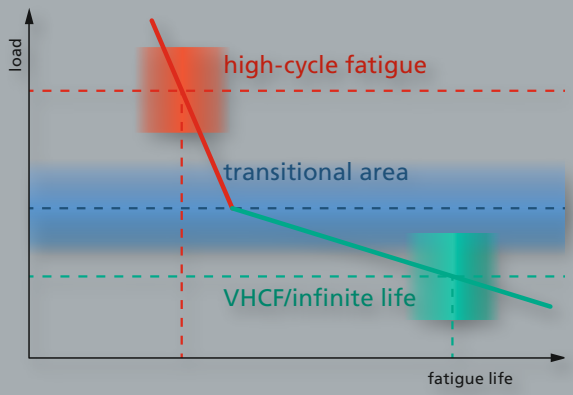
1 *Material flow ahead of the leveling shield in field trials*

2 *Material flow in the simulation with*
a) no cohesion
b) adaptive-cohesive and
c) constant-cohesive material

For several years, the discrete element method (DEM) of particle simulation has been used successfully at ITWM in the prediction of forces in soil-tool interaction. In effect, this takes a simulation method actually designed for micro-mechanical material properties and uses it to simulate macroscopic effects. The particles no longer represent individual grains of the real material; instead, the macro-mechanical attributes are adjusted to correspond to the real material.

In practical applications, cohesive materials play a major role. The forces of soil-tool interaction may increase up to three times in cohesive material compared to noncohesive material. A recent extension of the simulation model serves to illustrate these effects. Macroscopic cohesion in granulates and natural soil is caused by various micro-mechanical effects, for example, capillary cohesion. The impact of these effects on the behavior of loose material depends, among other things, on the size of the grains. Independent of origin, soil cohesion leads to greater shear strength, especially at low pressures. Consequently, modeling cohesion in particle simulations does not focus on its (microscopic) origin but rather on the macroscopic effects. In large scale experiments on the shield of a bull dozer, evaluation of the emerging cohesion revealed a dependence on the stress curve. In areas with a high pressure, greater cohesion was built up than in areas of lower pressure. The model implemented for cohesion is the extension of a model already used for noncohesive materials. Large scale experiments on construction equipment have demonstrated the suitability of the method for determining the forces. The model also reproduces the dependency of cohesion on the stress curve.

Applications for particle simulation can be found in the area of usage variability. One simulation study, for example, examined a series of trajectories for filling the bucket of an earth mover with respect to the complexity for the operator and the time and energy requirements. This study served in the development of an assistance system and as a first step towards autonomous operation of the equipment. A major limitation for the use of particle simulation in an industrial environment is the relatively high computation time. For this reason, during the past two years, we have been part of a cooperative effort with the HPC department to improve the efficient implementation of particle simulation. A simplified implementation of particle models will be developed in the future such that even real-time applications like the RODOS® simulator will be supported.



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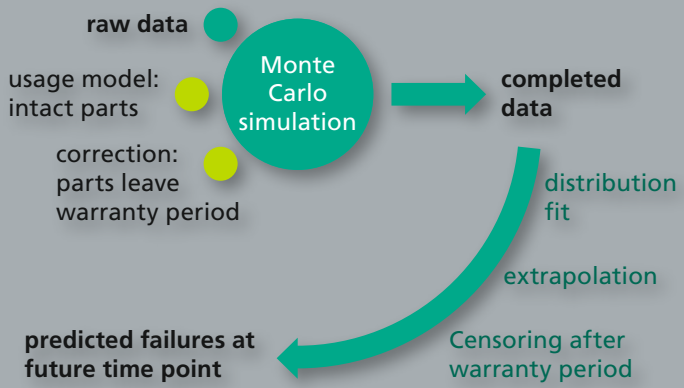


2

JUROJIN – STATISTICAL EVALUATION OF FATIGUE TESTS

The statistics program JUROJIN was developed at our department for the planning and evaluation of fatigue tests. The methodology and program structure are based on practical application cases, so that several passenger and commercial vehicle manufacturers have already used it to solve typical tasks quickly and efficiently. Test plans can be prepared that ensure maximum information yield despite small sample sizes. Often, conducted tests do not conform to the initial plan but include deviations, for example, unplanned premature shut-downs. In such cases, to compensate, JUROJIN adaptively generates extended test plans. The software was greatly expanded in the context of bilateral industry projects in 2013.

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. At lower amplitudes, a nearly horizontal curve is frequently observed. In this range of fatigue strength, loads may theoretically be applied "infinitely often" (more than 106 repetitions). Traditionally, regression in load direction is performed based on the information [component fails/component is durable] to identify the infinite strength regime. The fact that the fatigue strength for components that do fail is not considered leads to information loss – high-cycle fatigue and infinite life behavior are evaluated using separate tests. Motivated by inquiries from Robert Bosch Co., a new stochastic model was developed that allows joint identification of high-cycle fatigue and infinite life or very-high-cycle fatigue behavior. Random variables describe the transition region and the scattering of the fatigue life. JUROJIN efficiently incorporates all information in a simultaneous parameter estimate, including an automated selection of the optimal model complexity. In addition to evaluating components under development, JUROJIN can also analyze warranty data for parts already in production. The available input data for such an analysis only refers to failed components and provides no information on the fatigue life of intact components. Forecasting on this basis would be too pessimistic. Also, as soon as the first components are no longer covered by the warranty period, defects are no longer fully reported to the manufacturer. In this case, the forecasts would be too optimistic. In a project with the company Liebherr, this fragmentary (missing data) was considered and a corrected likelihood-function developed. Combined with a usage model of the intact units, JUROJIN applies Monte-Carlo simulation to calculate a statistically complete data as a basis for extrapolation. Reliable failure forecasts for future time points are thus possible even in the early phases of the warranty period.

1 *Combined S-N-curve*

2 *Missing data situation for warranty data*

Dr. Franz-Josef Pfreundt, Sabine Müller, Dr. Rui Màrio da Silva Machado, Dr. Dominik Michel, Frauke Santacruz, Kathrin Fuchss Portela, Dr. Norman Ettrich, Matthias Klein, Ely Wagner Aguiar de Oliveira, Dr. Abel Amirbekyan, Dr. Mirko Rahn, Matthias Deller, Alexander Petry, Dr. Leo Nesemann, Dr. Javier Lechuga Garcia, Egor Derevenetc, Bernd Lietzow, Dr. Matthias Balzer, Kai Krüger, Dr. Tiberiu Rotaru, Dr. Pawan Kumar, Sven Breuner, Dr. Dimitar Stoyanov, Bernd Schubert, Lena Oden, Dr. Martin Kühn, Dr. Valeria Bartsch, Clemens Koch, Christian Mohrbacher, Bernd Lörwald

COMPETENCE CENTER HIGH PERFORMANCE COMPUTING

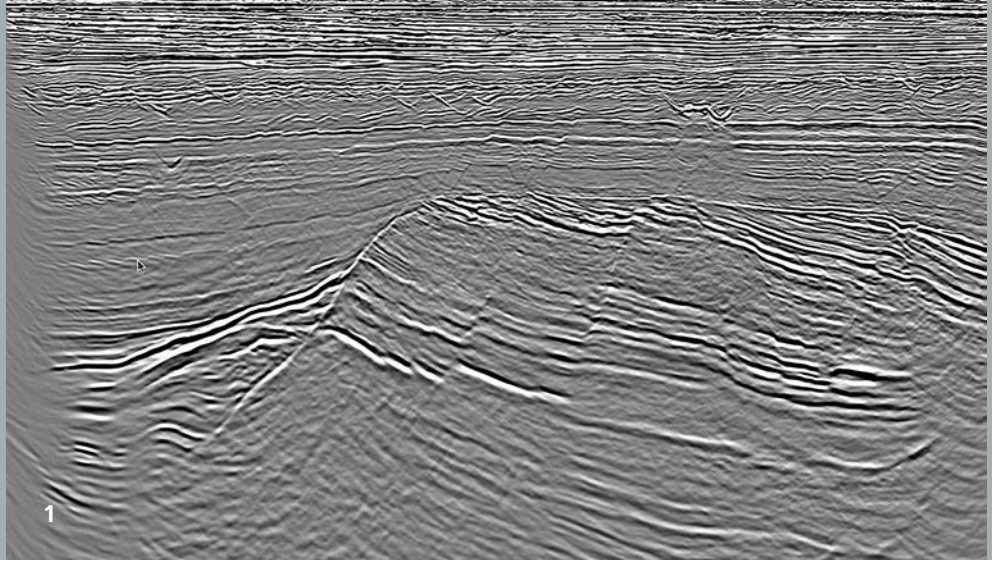
- BIG DATA – FhGFS, GPI, GPI-Space
- HPC TOOLS
- SEISMIC IMAGING
- BIG DATA VISUALIZATION
- PERFORMANCE OPTIMIZATION
- E-ENERGY, SMART GRIDS

www.itwm.fraunhofer.de/en/hpc

DR. FRANZ-JOSEF PFREUNDT
HEAD OF DEPARTMENT

It is more and more evident that the productivity and competitiveness of German and European industries depends on the ability to efficiently perform ever more detailed simulation calculations. The design of new functional materials, the optimization of machines and processes, the control of complex systems or the identification of structures in large networks: virtually no branch of industry can survive without the use of powerful computers and the requirements are constantly increasing. More accurate models require more comprehensive calculations and more accurate sensors generate more data. The Competence Center for High Performance Computing, in close cooperation with various industrial and academic partners, explores the question of how increasingly complex processors and parallel computers can be used efficiently. In addition to supplying the tools to manage the super computers, it also develops integrated software solutions.

The Global Address Space Programming Interface (GPI) follows a programming model that is very well-suited for programming scalable parallel software, i. e. software that actually solves problems faster by providing more resources. Critical parts of large relevant applications in various sectors of industry benefit remarkably by switching to the model of global storage and asynchronous communication proposed by GPI. Based on GPI and taking into account the advanced development of paradigms from the cloud environment, CC HPC has created the development platform and runtime environment GPI-Space. It is a tool that considerably simplifies the development and fault tolerant execution of parallel software programs and is perfect for working with Big Data applications. Both seismic applications and GPI-Space are preferably used with, for their data storage needs, the parallel file system, BeeGFS, formerly known as FhGFS, similarly developed at CC HPC. It features user friendly operation, superior performance and scalability. The user base continues to grow and over the past year both the scope and the speed were continuously improved. Last but not least CC HPC is involved in the transformation of energy systems towards renewable sources of energy. The principle goal is to manage the fluctuating production of renewable sources of energy. The projects mySmartGrid and myPowerGrid focus on issues like the temporal decoupling of the energy production and energy consumption, demand forecasting and relocation, optimization of the self-consumption as well as the management of distributed battery systems appropriate for the grid. Much knowledge of the design and control of complex IT systems flows into the quest for an environmentally safe and economic energy supply. Green by IT is becoming a new growth business for the department.

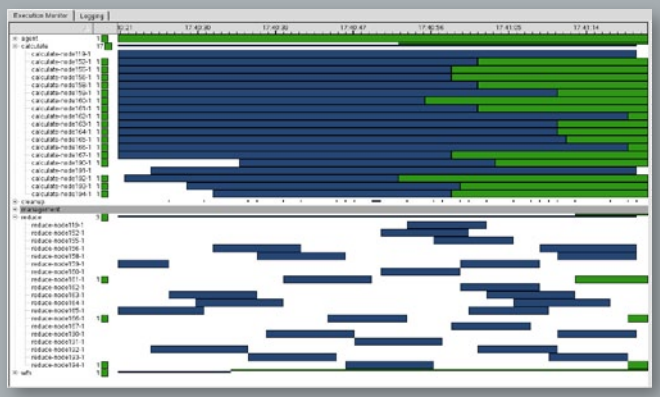


SEISMIC DEPTH MIGRATION IN USE

Prestack depth migration has been the main research topic of the HPC department in the field of seismic exploration for the last years. Seismic migration is one of the most important methods of the processing sequence of seismic data since it maps recorded seismic signals to their original subsurface location and, thus, generates images of Earth's structures and formations that are used for detecting oil and gas reservoirs. Applied to industry-standard data sets, depth migration in the prestack domain is an extremely compute-intensive process with the challenging requirement to image thousands km³ large parts of the subsurface with extreme accuracy in some (small but a-priori unknown) areas of interest. Developing successful tools, thus, requires a combined research effort in the disciplines geophysics, mathematics, and high performance computing. Nowadays, migration methods must provide high imaging quality in structurally more and more complicated regimes and in large depths of up to 15 km since reservoirs in simple geological settings are widely already found. In addition, migration results must be amplitude-controlled so that quantitative material parameters can be derived from the migration results.

1 *GRT-migration result of a real data set with improved signal-to-noise ratio*

The HPC department is offering two methods that fulfill these requirements. Our SF-GRT-migration (based on Generalized Radon Transform) is worldwide one of the few methods that compute densely sampled so-called angle gathers that can directly be interpreted in terms of material contrasts and pore fluids. In 2013, a breakthrough was achieved by developing a stable focusing analysis for identifying the signal content of the seismic data. The signal-to-noise ratio of the final images is greatly improved now. The software is widely in use by our cooperation partner Statoil, who has been funding the development of SF-GRT for several years. We are offering services with SF-GRT and thus guarantee to finally adapt the tool to practical usage. The second production-ready software in our portfolio for seismic migration is RTM (reverse time migration). RTM is a wave equation-based migration method that is particularly suited for imaging complicated subsurface structure. Our version of this method, FRTM, was developed under the particular constraints of ultimate robustness for large output volumes, high frequencies, and large compute-node numbers and perfect scalability. Best imaging quality is achieved by the careful design of all geophysical details like imaging condition, treatment of boundaries, and stacking the shot results. FRTM is integrated into a dynamic resource management system and meets all the requirements of daily usage inside a tough processing environment. Service projects to clients' marine surface seismic data sets demonstrate the competitiveness of FRTM and confirm the expandability of FRTM towards elastic modeling and computation of angle gathers.



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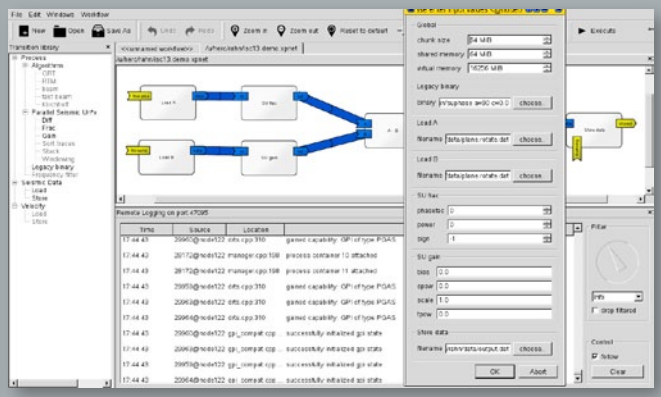


2

GPI-SPACE: THE NEXT STEP IN BIG DATA ANALYSES

1 *Momentary application state as an interactive Gantt diagram*

2 *Integrated graphic interface for development and execution*

Absolute performance and throughput play an ever greater role in data processing for numerous enterprises in a variety of sectors. The analysis of extremely large volumes of data enables not just new business models for industry, but also new discoveries in R&D based on advanced technology. The key words are: personalized industries, identification of disease markers, genome analyses for all, or process monitoring for individual components.

GPI-Space is the CC HPC approach to solving two of the most important and still open issues in the processing of extremely large data volumes: a programming model for the respective applications and the execution environment. The GPI-Space system was developed in close cooperation with our customers in the oil and gas industry and that is where it is deployed. The fundamental concepts, however, are independent of the specific application and may, in particular provide the field of Big Data analysis with a source of new motivation. The virtual storage device used in GPI-Space is based on the fast, internal main memory and not on slower external disk storage as in other like Big Data solutions. By this alone, the response times are significantly reduced, especially, if the same data is used by multiple resources. The virtual memory is also independent of specific applications and enables their simple and direct connection. The GPI-Space operating environment is not only fault tolerant, but also fully interactive and allows you to change the size and structure of the machine used during the runtime of an algorithm, or to use the optimal topology for the different phases. That is another big advantage over existing solutions like Hadoop, which usually have to keep as many resources at the ready during the entire run time as required by the hungriest part of the application. Of course, there are latencies hidden in the operating environment and the operating environment permits any (existing) programs and modules to join together to form a new application. The operating system is driven by graphic workflows which are independent of the specific hardware and specific basic modules. GPI-Space separates the coordination of the data from the data computation and ensures efficient execution of the applications even on future hardware. The GPI-Space Workflow Interpreter automatically extracts all activities that could be currently executed and transfers these to the operating environment from which they get distributed to the existing resources for (parallel) execution. The three main components of GPI-Space – virtual storage, distributed operating environments and Workflow Interpreter – are seamlessly integrated, yet, can also be used separately.

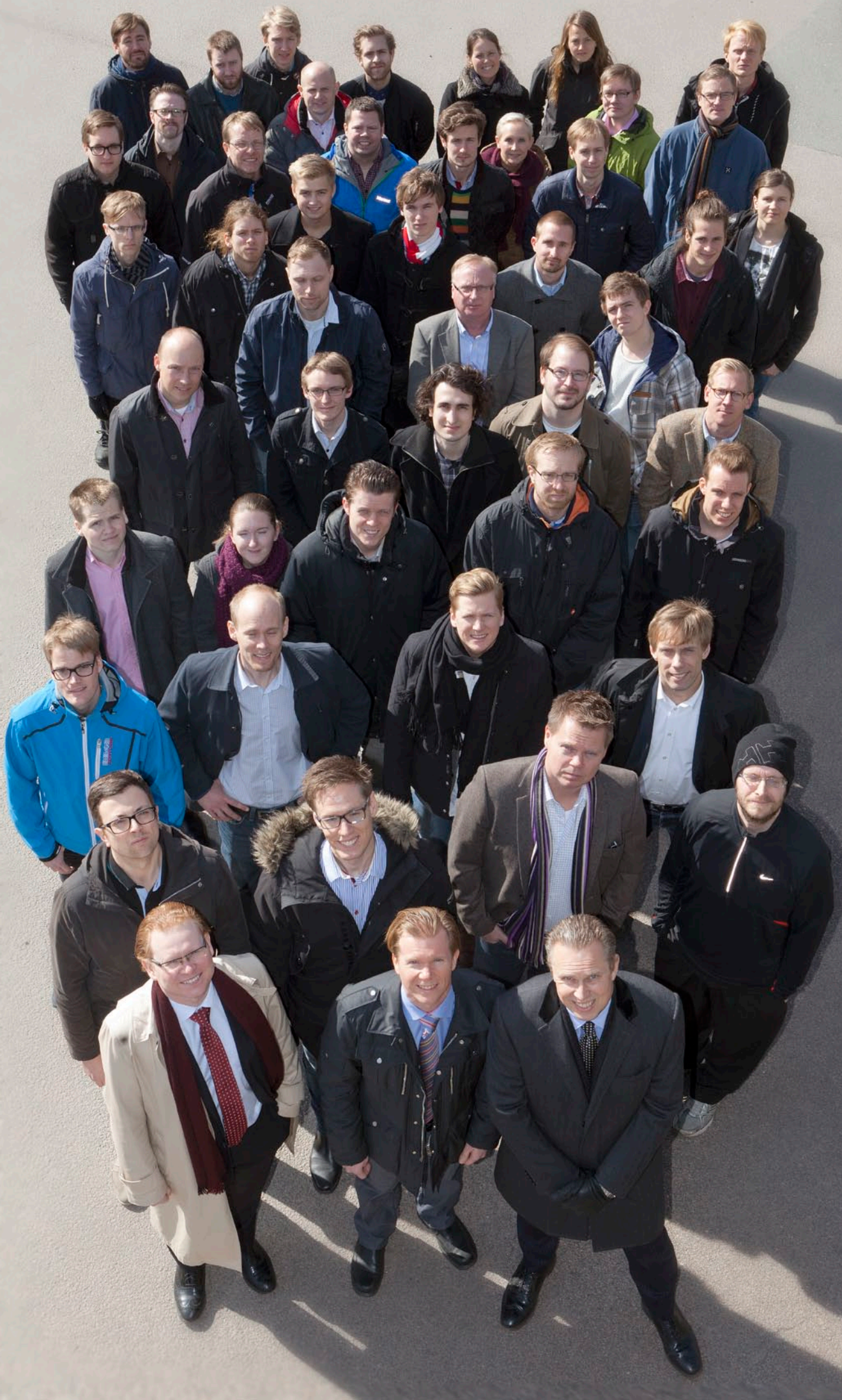
COORDINATED DISTRIBUTED ENERGY STORAGE

The volatile character of wind power and PV is at odds with the necessity of keeping the balance between generation and consumption within the power grid. With respect to grid stability and uninterrupted service, this poses serious challenges for the management of energy generation. One option for balancing the inevitably increasing fluctuations is the short-term storage of electricity. Even today, electric energy is already stored by means of pumped hydro. A new development, however, is the adaption of electrochemical storages, such as lithium-ion batteries. Even today batteries are being installed in private homes to increase self-sufficiency. Use of energy storage systems only in consideration of the individual home, however – such as exclusively to increase the self-sufficiency through locally generated PV power – does not fully exploit the possibilities of the storage systems and may even run counter to the stability of the grid, such as when wind turbines have to be shut down or conventional power plants have to be placed in operation. The storage potential of these batteries can be better exploited with coordinated control appropriate to the current state of the grid instead of exclusively increasing self-sufficiency.

1 *Test setup of the myPowerGrid battery storage system with energy meters, battery inverter/charger (upper right), local energy management system (EMS) and 4 kWh lithium-ion battery storage (lower right)*

With myPowerGrid, we are in the process of developing a web platform taking the first steps down the road towards coordinated, distributed electricity storage. Combining both public and private interest, an optimal management of the storages is ensured, in order to guarantee supply preferably wholly from renewable energy sources. The aggregated operation of storages enables a safe, ecologically sensible and at the same time economically optimized management by provision of many different services for utilities, transmission system operators, and virtual power plant managers. Among these are reduction of load and generation spikes (“peak shaving”), adaptation of energy yield forecasts, inclusion of the virtual storage in combined, regenerative plants in order to provide reserve power, and participation in energy and reserve power markets.

The myPowerGrid project installed one of the first battery storage systems in order to develop the required software components. With the state of the art today, it is possible to control the battery very accurately – for example, to increase the self-sufficiency of locally generated PV energy, but also to accommodate excess flow and reduce peak power feeds. Furthermore, the local energy management system communicates with the central myPowerGrid platform and exchanges status information and schedules for contracted energy services. In the next step of the project, battery storage devices will be installed with the project partners. An evaluation of the software components and the provision of energy services will subsequently be performed.



FRAUNHOFER-CHALMERS RESEARCH CENTRE FOR INDUSTRIAL MATHEMATICS FCC

▪ GEOMETRY AND MOTION PLANNING

Software development for robot motion planning and simulation of flexible cables

▪ COMPUTATIONAL ENGINEERING AND DESIGN

Numerical methods and simulation tools for hydrodynamics, structural dynamics, and electromagnetism

▪ SYSTEMS AND DATA ANALYSIS

Software development for dynamical systems, prognosis and control, image and video analysis, statistics, and quality engineering

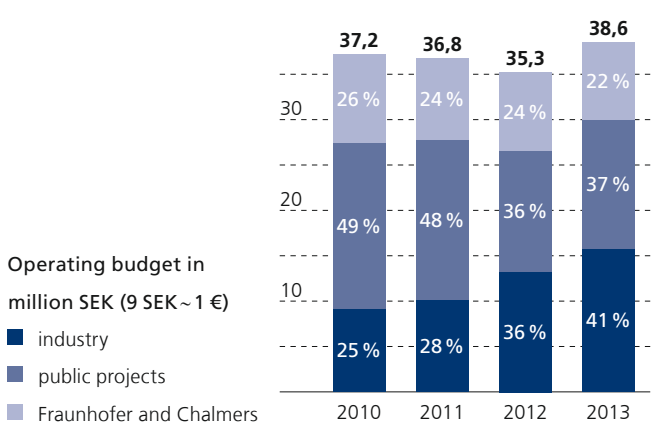
www.fcc.chalmers.se

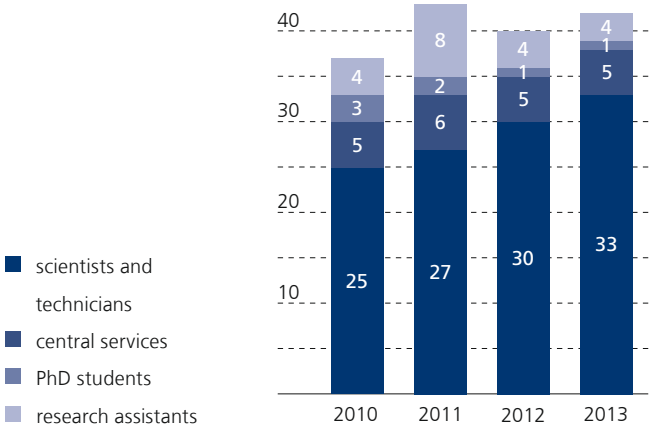
DR. JOHAN CARLSON
HEAD OF DEPARTMENT

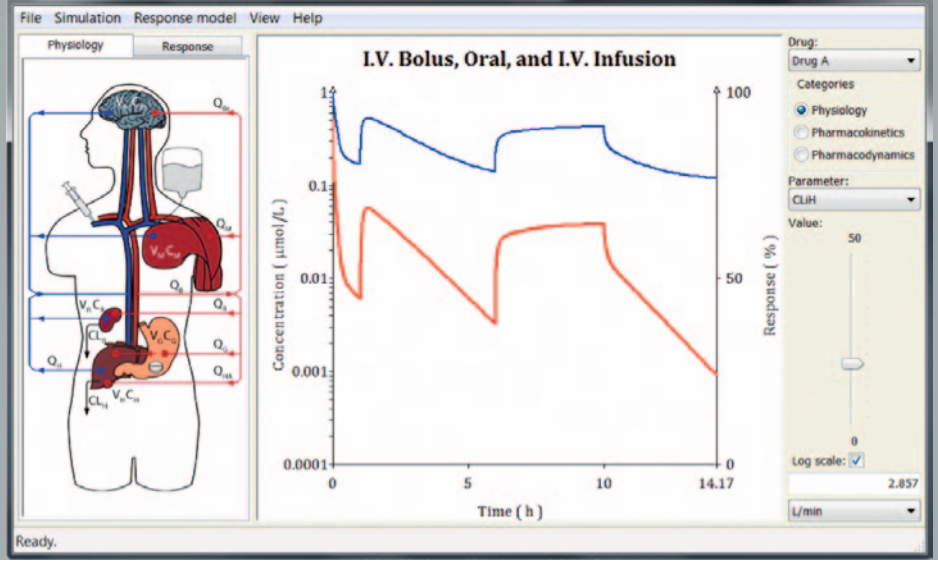
Modeling, Simulation and Optimization provide a significant leading edge in industrial innovation of products and production systems. In 2013, we have successfully proved this together with clients from the automotive and vehicle, pharmaceutical, wood and paper, and electronics industries. Examples include the simulation of electrostatic spray painting, the optimization of robot stations and lines, the modeling and simulation of drug compound distribution and effect, and the edge wicking of paper boards. During 2013, we have performed over fifty projects for our industrial clients and twenty public projects financed by public research agencies such as SSF, VINNOVA and the EU. The revenue shows a satisfying growth of almost 10 percent since last year, an industrial income of 41 percent and a positive net result. Our work and technologies have helped clients mainly in Sweden, but also in Germany, US, Finland, Denmark, Japan and Great Britain. However, the full potential of using advanced mathematics in industry is far from reached and new technologies together with increased efforts in marketing and sales will hopefully continue our growth in 2014 and beyond.

A great advantage for FCC is the possibility of long term collaborations with Fraunhofer and Chalmers. The cooperation and exchange of projects with ITWM during 2013 have involved a variety of subjects such as metrology, biomechanics, the simulation of flexibles, position tracking systems, product configuration optimization, the simulation of ultra-fast electronics, and genome analytics such as next generation sequencing. We have also grown our cooperation with several other Fraunhofer units. The well-established collaboration with Chalmers centres and departments includes in 2013, projects, grant applications, guest lectures, PhDs and master students with Wingquist Laboratory, Product and Production Development, Systems and Synthetic Biology, Fluid Dynamics, Biomedical Engineering, Chalmers e-Science Centre CheSC, Signals and Systems, and Mathematical Sciences.

Dr. Johan Carlson
Director of FCC







INTERACTIVE PHARMACOKINETICS AND PHARMACO-DYNAMICS

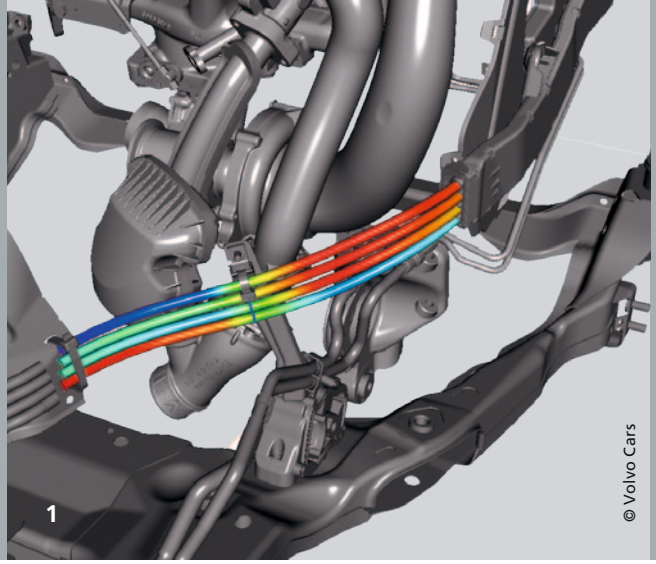
Mathematical modeling and simulation of what the body does to a drug after administration, such as its absorption, distribution, metabolism, and excretion, also known as pharmacokinetics, or models of what the drug does to the body, i. e., how the drug concentration is translated into a medical effect, also known as pharmacodynamics, are of increasing importance in drug development. The explanation is to be found in the promise of reduced costs and accelerated drug development due to better experimental design, improved understanding of results, and models of stronger predictive power. The aim of the Maxsim2 project is to develop a software platform for simulation of the temporal behavior in pharmacological, pharmacodynamic, and pharmacokinetic processes.

Pharmacokinetic models considered are so called compartment models as well as physiological flow models. Compartment models ranges from simple one compartment models with linear or nonlinear elimination to highly nonlinear target mediated drug disposition models whose qualitative behavior dramatically changes with dosage.

The resulting software, developed within the Maxsim2 project is an easy to use, intuitive, and interactive application for pharmacokinetic and pharmacodynamic simulation. A gallery of common pharmacokinetic and pharmacodynamic models is provided by which one interacts with the model and runs simulations using sliders, check boxes, and number fields. Parameters such as volumes, clearance, partition coefficients, pharmacodynamic parameters, and parameters related to absorption and dosage regimens can be changed, which in real time is mirrored by changes of concentration-time or response-time profiles. This interactivity and direct feedback of what-if scenarios give a good understanding of both the qualitative and quantitative impact of different parameters; an understanding which has a large impact both from a therapeutic perspective as well as health economics perspective.

We envision Maxsim2 as an ideal application for both educational and commercial use where thorough understanding of pharmacodynamic and pharmacokinetic interplay is important. The targeted audience is professionals having working knowledge in pharmacokinetics and pharmacodynamics but limited or no experience in simulating such processes as well as students who want to gain experience in pharmacology from a systems perspective. For more information please visit www.maxsim2.com.

1 *The graphical user interface of Maxsim2 showing a simulation of plasma drug concentration (red) and drug effect (blue) after three consecutive dose administrations: intravenous bolus, oral, and intravenous infusion, respectively. The slider, in this example, controls hepatic clearance, i. e., how fast the liver is able to remove the drug from the blood. Changes in this parameter are reflected in real time in the corresponding changes of the curves in the time-concentration/effect diagram.*



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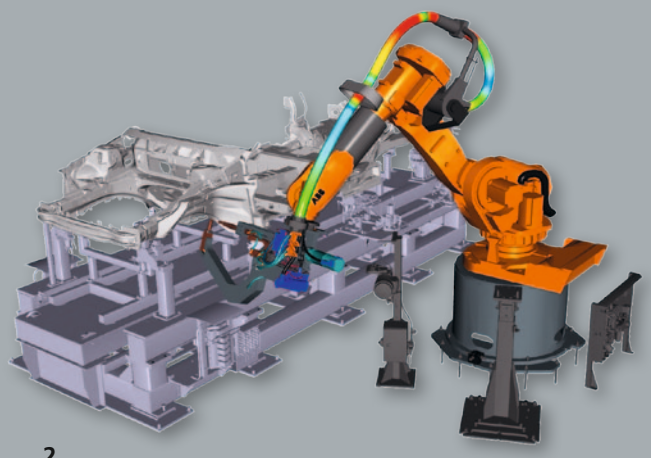

2

DESIGN AND ASSEMBLY ANALYSIS OF FLEXIBLES

1 *Volvo V60 D6 AWD Plugin-Hybrid High voltage cable simulation*

2 *A Robot and its cable dress pack*

Environmental friendly propulsion systems based on electricity and battery technology has resulted in a dramatically increased usage of complex cables and hoses in vehicles. For virtual product realization this means new and fundamental demands on simulations to support design, assembly and maintenance activities. FCC has within the VINNOVAs FFI program together with AB Volvo, Delphi, Volvo Cars, Opel, GM, Saab Automobile, and Wingquist Laboratory at Chalmers developed methods and algorithms packaged in the IPS software tool for accurate real time simulation of cables and hoses. An extensive collaboration with the dynamics and durability department at Fraunhofer ITWM, and the related spin-offs IPS Sweden AB and FlexStructure GmbH are also important parts of the success.

Today, many assembly problems that are detected too late in the product and production realization, involve cables, hoses and wiring harnesses. Studies in the automotive industry shows approximately 25 percent of all quality problems are related to flexible parts and connecting tasks. For example, the assembly of high voltages cables and harnesses are tricky due to its concealed routing, connections, weight and awkward ergonomic postures. Many of the working related injuries are caused by this type of assembly tasks. Furthermore the product quality output is to a large extent dependent on the design for assembly. One major reason for these problems has been the lack of virtual manufacturing tools supporting real time simulation of flexible parts and motions.

IPS Cable Simulation is a user-friendly, innovative tool for virtual assembly design as well as the verification and visualization of flexible parts. Its main capability is the real time calculation of the deformations of cables, hoses and wires of various material types and a variety of cross-section profiles. Forces and moments can be analyzed, the cable length can be optimized, clips can be attached, and motions can be evaluated. The material properties include stretching stiffness, stiffness for bending around different axis, torsion stiffness, length density. The core cable simulation technology is based on 8 years of validated research at the geometry and motion planning group at FCC and the dynamics and durability group at Fraunhofer ITWM.

Four important application areas for real time simulation of flexible parts are: Engine packing and design, assembly planning, wiring harness design and manufacturing, robot cable dress packs. Investigations by Opel, GM, Ford and Delphi point out this technology as a global very competitive solution.

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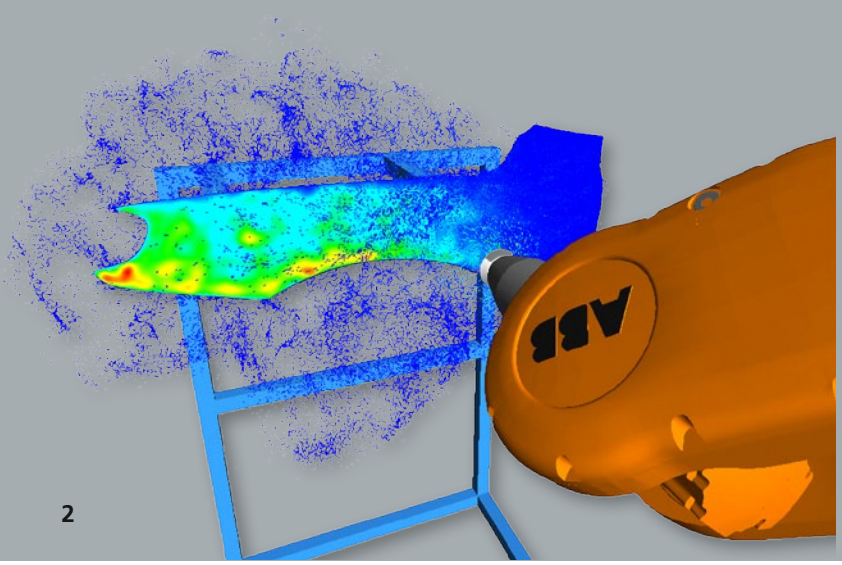

2

VIRTUAL PAINT SHOP: SPRAY PAINTING

The goal of this ongoing project is to help the automotive industry reduce the costs and the environmental impact of their paint and surface treatment processes. Using advanced mathematics it is now possible to improve these processes by computer simulations without using a single drop of paint. The project is part of Vinnova's FFI program for Sustainable Production Technology that supports the Swedish automotive industry and our research partners are Volvo Cars, Scania CV, AB Volvo, General Motors and Swerea IVF.

The surface treatment is the process in an automotive factory that consumes most energy, water and chemicals, and produces most waste and pollution. Approximately 40 percent of the energy for OEM operations in automotive manufacturing is consumed in the paint shops. In the paint shop the product preparation relies to a large extent on individual experience and physical testing on a large number of prototypes. Therefore, the paint shop not only has a large environmental impact it is also a bottleneck in production.

The spray painting and surface treatment processes pose great challenges for mathematical modeling and simulation, and are characterized by multi-phase and free surface flows, multi-physics, multi-scale phenomena, and large moving geometries. We have shown that it is possible to simulate the spray painting of a car in just a few hours on a standard computer. This is an extreme improvement compared to earlier approaches that require weeks of simulation time. Unique algorithms for two-way coupled simulations of air flows, electrostatic fields and charged paint droplets have made this possible.

The paint simulation algorithms have been integrated in a virtual paint module in the in-house package for automatic path planning, IPS. In the software, an arbitrary geometry can be painted using a robot and the user sets the process conditions like paint flow, air flow, electrostatic droplet charge and atomizer bell rotation speed. During 2013 we have performed deployment projects in Germany together with Fraunhofer ITWM and its spin-off company fleXstructures. The first commercial release of the IPS Virtual Paint software is available from the spring 2014 and our industrial partners predict that positive effects will include a reduced time required for introduction of new car models, a reduced environmental impact and an increased product quality.

1 *An electrostatic coating process with speed rotary atomizers*

2 *A robot is painting a Volvo V60 car fender in IPS Virtual Paint.*

TALKS

Andrä, Heiko; Kabel, Matthias; Spahn, Johannes
Ein alternatives präzises Verfahren für die Schädigungs- und Versagensvorhersage von FVK in der Prozesskettensimulation
VDI-Konferenz »Simvec-Spezial«, Baden-Baden, December

Arnold, Michael
Automated Learning of Self-Similarity and Informative Structures in Architecture
Scientific Computing and Cultural Heritage Heidelberg, November

Balzer, Matthias; Kleinert, Jan; Obermayr, Martin
Parallel implementation of the non-smooth contact dynamics method for large particle systems
Particles 2013, Stuttgart, September

Bardin-Monnier, Nathalie; Cheng, Liping; Kirsch, Ralf; Thomas, Dominique; Wiegmann, Andreas
PleatLab: A flexible interface for pleat scale simulations
GeoDict User Conference 2013, Kaiserslautern, September

Bare, Zoufine; Orlik, Julia
An asymptotic second order 1D approximation of a 3D contact problem for a beam with friction
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Bare, Zoufine; Orlik, Julia; Panasenko, Grigory
Asymptotic approximations of a thin elastic beam with Robin condition
ISAAC 9, Krakow (PL), August

Bortz, Michael
Grey Box Modeling and decision support in Medical Therapy Planning
ITWM Research Days »Grey-Box Models and Model Reduction«, Kaiserslautern, December

Bortz, Michael
Some Elements of Chemical Process Design
Workshop Projection Methods – Theory and Practice, Kaiserslautern, June

Bortz, Michael
Mit MINT zum Beruf
BIT, Kusel, June

Breuner, Sven
FhGFS – A flexible parallel file system for performance-critical applications
International Supercomputing Conference, Leipzig, June

Breuner, Sven
FhGFS - Status and Roadmap
12th HLRS Workshop on Scalable Global Parallel File Systems, Stuttgart, March

Burger, Michael
Integration eines detaillierten, flexiblen Reifenmodells in den Fraunhofer-Fahrsimulator
VDI-Tagung, Hannover, October

Cesarek, Peter; Zupan, Dejan
Velocity-based approach in non-linear dynamics of three-dimensional beams
4th Canadian Conference on Nonlinear Solid Mechanics, Montreal (CDN), July

Cheng,nLiping; Rief, Stefan; Wiegmann, Andreas;
SIMPLE-FFT for flow computations in low porosity µCT images
The 5th Interpore, Prag (CZ), May

Dalheimer, Mathias
Messen Steuern Regeln mit IPv6
IPv6 Kongress, Frankfurt, June

Dedering, Michael; Iliev, Dimitar; Iliev, Oleg; Kirsch, Ralf; Lakdawala, Zahra; Lance, Michel; Michard, Marc; Mikelić, Andro
Modeling and Simulation of Fluid-Porous-Structure Interaction (FPSI) on the Filter Element Scale
FILTECH 2013 Conference, Wiesbaden, October

Dieringer, Rolf; Hebel, Jochen; Becker, Wilfried
Determination of singularity orders at notches and cracks in composites using a new formulation of the scaled boundary finite element method
17th International Conference on Composite Structures, Porto (P), June

Dillhöfer, Alexander; Rieder, Hans; Spies, Martin
Ein Vergleich verschiedener Ultraschallverfahren für die Prüfung reparaturgeschweißter CuNiAl-Bronzen
DGZfP-Jahrestagung 2013, Dresden, May

Dillhöfer, Alexander; Rieder, Hans; Spies, Martin
Entwicklung eines Webservice zur Bereitstellung von rechenintensiven Algorithmen auf einem Hochleistungsrechner über das Internet
DGZfP-Jahrestagung 2013, Dresden, May

Dobrovolskij, Dascha; Spies, Martin; Dillhöfer, Alexander; Rieder, Hans
3D-Schallfeldsimulation in Echtzeit am Beispiel von Prüfköpfen für die hochauflösende Ultraschallprüfung
DGZfP-Jahrestagung 2013, Dresden, May

Dreßler, Klaus
Simulation based design, assembly and validation of cables, hoses and wiring harness
Daimler CAE-Forum Stuttgart, July

Dreßler, Klaus
Simulation in vehicle engineering
Kolloquiumsvortrag University Lund (S), September

Escoda, Julie; Wirjadi, Oliver; Schladitz, Katja
Random Modeling Of Woven Textile Composites
EUROMAT, Sevilla (E), September

Föhst, Sonja; Wagner, Willi; Wirjadi, Oliver; Houdek, Jan; Schladitz, Katja; Ackermann, Maximilian; Konerding, Moritz
Geometric analysis of post-pneumonectomy lung regeneration in mice
BAMEK, Kaiserslautern, June and 11th ECS Kaiserslautern, July

Foss, S.-K.; Karlsen, E. S.; Osen, A.; Rhodes, M.; Mispel, J.; Michel, Dominik; Kotava,N.; Merten, Dirk; Lehnertz, B.; Ettrich, Norman
Interactive, Geological Scenario Migration
EAGE, London (GB), June

Gallrein, Axel
CDTire: State-of-the-art tire models for vehicle simulation
Science meets Tires – Visionen für die Reifentechnik, Aachen, September

Gallrein, Axel; Bäcker, Manfred
Structural MBD Tire Models: Evolving from Spindle Load to Deformation Measurements
Multibody Dynamics 2013, ECCOMAS Thematic Conference, Zagreb (HR), July

Gallrein, Axel; Bäcker, Manfred; Gizatullin, Andrey
Structural MBD tire models: Closing the gap to structural analysis – history and future of parameter identification
SAE 2013 World Congress & Exhibition, Detroit (USA), April

Gerwalin, Elmar
Remote Visualisation with PC-over-IP
Arbeitstagung der IT-Manager der Fraunhofer-Gesellschaft, Kassel, November

Gizatullin, Andrey
CDTire/Real-time: a comfort and durability tire model on Fraunhofer driving simulator
LMS European Vehicle Conference: Smart simulation and testing for optimized mechatronic system's design, München, October

Grünewald, Daniel
GASPI – The next generation communication API
Gauß-Allianz: 3. HPC Statuskonferenz, Dresden, September

Grünewald, Daniel
GASPI/GPI
ISC13, Leipzig, June

Hauser, Matthias
Hierarchical Model Order Reduction of Systems under Parameter Variations
ITWM Research Days "Grey-Box Models and Model Reduction", Kaiserslautern, December and Model Reduction of Complex Dynamical Systems 2013, Magdeburg, December

Hebel, Jochen; Gruttmann, Friedrich; Wagner, Werner
Computational homogenisation of composite shell structures
17th International Conference on Composite Structures, Porto (P), June

Hermanns, Oliver; Tegen, Thomas
Kabelauslegung und Absicherung Radarsystem AESA
Cassidian Radarforum, Ulm, July

Hubel, Sebastian; Dillhöfer, Alexander; Rieder, Hans; Spies, Martin; Bamberg, Joachim; Hessert, Roland; Preikszas, Christina
Einsatz von Rayleigh-Wellen zur Untersuchung von Eigenspannungen in randzonenverfestigten Triebwerkswerkstoffen
DGZfP-Jahrestagung 2013, Dresden, May

Iliev, Dimitar; Iliev, Oleg; Kirsch, Ralf; Lakdawala, Zahra; Zemitis, Aivars
Modeling and Numerical Simulation on the Filter Element Scale
AFS Spring Conference, Minneapolis (USA), May

Iliev, Oleg; Giles, Mike; Nagapetyan, Tigran; Ritter, Klaus
Monte Carlo methods for CDF approximation
Mini-Workshop: Numerical upscaling for Media with deterministic and stochastic heterogeneity, Oberwolfach, February

Iliev, Oleg; Giles, Mike; Nagapetyan, Tigran; Ritter, Klaus
Multilevel Monte Carlo method for CDF approximation on a compact interval
Ninth IMACS seminar on Monte Carlo methods, Annecy-le-Vieux (F), July

Iliev, Oleg; Kirsch, Ralf; Lakdawala, Zahra; Zemitis, Aivars
Methoden und Strategien zur effizienteren Simulation von Filterelementen
NAFEMS Seminar: »Innovative Anwendungen der Strömungssimulation in der Produktentwicklung«, Wiesbaden, March

Iliev, Oleg; Printsypar, Galina; Rief, Stefan
A Two-dimensional model of the pressing section of a paper machine
Interpore, Prag (CZ), May

Iliev, Oleg; Printsypar, Galina; Rief, Stefan
FFT accelerated SIMPLE algorithm for flow computations in low porosity materials
Interpore, Prag (CZ), May

Kabel, Matthias; Andrä, Heiko
Fast Numerical Computation of Precise Bounds of Effective Elastic Moduli
19. Symposium Verbundwerkstoffe und Werkstoffverbunde, Karlsruhe, July

Kabel, Matthias; Andrä, Heiko; Hahn, Friedemann; Lehmann, Martin J.
Simulating the Compression of Filter Material
GeoDict User Conference 2013, Kaiserslautern, September and Filtech 2013, Wiesbaden, October

Kabel, Matthias; Andrä, Heiko; Krzikalla, Fabian
Fast Numerical Computation of Effective Elastic Moduli of Porous Materials
The 5th BIOT Conference on Poromechanics (BIOT-5), Wien (A), July

Karlsen, E. S.; Foss, S.-K.; Osen, A.; Rhodes, M.; Mispel, J.; Michel, Dominik; Kotava, N.; Merten, Dirk; Lehnertz, B.; Ettrich, Norman
Interactive and Integrated Salt Model Building
EAGE, London (GB), June

Kleer, Michael
The Fraunhofer robot-based driving simulator: details of the multibody real-time module simulation
VI-grade 5th Users Conference, Marburg, April

Kleer, Michael; Gizatullin, Andrey; Dreßler, Klaus; Müller, Sabine
Real-time human in the loop MBS simulation in the Fraunhofer Robot-Based Driving Simulator
Multibody Dynamics 2013, ECCOMAS Conference, Zagreb (HR), July

Klein, Matthias
Black box system identification of photovoltaic power plants
ITWM Research Days »Grey-Box Models and Model Reduction«, Kaiserslautern, December

Klein, Matthias
myPowerGrid – Wirtschaftlichkeit von Photovoltaik-Stromspeichern
ZUKUNFTSENERGIE JOHANNISKREUZ, Johanniskreuz, February

Kleinert, Jan; Obermayr, Martin
On Forces and Accelerations in the Non-smooth Contact Dynamics Method
Congress on Numerical Method in Engineering 2013, Bilbao (E), June

Kleinert, Jan; Obermayr, Martin; Balzer, Matthias
Modeling of Large Scale Granular Systems using the Discrete Element Method and the Non-Smooth Contact Dynamics Method: A Comparison
Multibody Dynamics 2013, ECCOMAS Conference, Zagreb (HR), July

Kochendörfer, Alexandra
Quantifizierung des Fündigkeitsrisikos
Geofünd Tagung, Traunreut, March

Korn, Ralf
Aspects of Interest Rate Modelling
METU Ankara, IAM Seminar, April

Korn, Ralf
Aspects of stochastic modelling, statistics and insurance in predicting success in hydrogeothermal explorations: a financial mathematicians point of view
Geomathematics in Honor of W. Freeden's 65th birthday, St. Martin, April

Korn, Ralf
Besser länger leben durch Mathematik
Nikolaus-Kopernicus-Planetarium Nürnberg, March

Korn, Ralf
Guarantees: Past, Present, Future?
»The Future of Life Insurance«, Hannover, May

Korn, Ralf
Mathematik an der Börse – Muss das sein? Einführung in Prinzipien und Methoden der modernen Finanzmathematik
Workshop der Cusanus-Stiftung, Uder, May

Korn, Ralf
Modeling, Valuing and Managing Economic Risks
DMV/ÖMG-Tagung Innsbruck, Mathematics for the Planet Earth 2013, Innsbruck (A), September

Korn, Ralf
Monte Carlo Methods in Finance: Basic Methods and Recent Advances
IAM Workshop, METU Ankara (5 talks), April and ITWM Kaiserslautern (4 talks), October

Korn, Ralf
Save for the bad time or consume as long as you have?
Wissenschaftstag der DGVFM, Berlin, April; Imperial College London (UK), May; Building Bridges, Conference in honor of Claudia Klüppelberg, University Braunschweig, August and Nomura seminar, University of Oxford (UK), December

Korn, Ralf
Some Recent Mathematical Developments in Risk Management
TU München »Risk Management Reloaded«, September

Kuhnert, Jörg
Finite Pointset Method: Optimized Meshfree Solver for Industrial Filling and Sloshing Applications
Advances in Computational Mechanics, San Diego (USA), February

Kuhnert, Jörg; Jefferies, Anthony
Finite Pointset Method: Meshfree Solver for Water Crossing Applications
7th Int. Conference on meshfree methods, Bonn, September

Labudda, Tino
Fernwartung beim Fraunhofer ITWM
VDMA-Anwenderforum Teleservice, Frankfurt/M., March

Lang, Holger; Leyendecker, Sigrid; Linn, Joachim
Numerical experiments for viscoelastic Cosserat rods with Kelvin-Voigt damping
Multibody Dynamics 2013, ECCOMAS Conference, Zagreb (HR), July

Latz, Arnulf; Zausch, Jochen
Thermodynamic theory and simulation of transport and intercalation of solvated ions in Li-Ion batteries
224th ECS Meeting, San Francisco (USA), October

Leithäuser, Christian
Modeling and simulation along the process chain for filaments and nonwovens
Young Researcher Symposium 2013, Kaiserslautern, November

Leithäuser, Neele
Models and algorithms for considering vehicle scheduling constraints in timetable synchronization problems
GOR Workshop, Karlsruhe, April

Lemken, Alexander
Classification on arbitrary graphs using Conditional Random Fields with a global template
Statistische Woche Berlin, September

Linden, Sven; Wiegmann, Andreas
The LIR space partitioning system
Young Researcher Symposium 2013, Kaiserslautern, November

Linn, Joachim
Generalized Maxwell type viscoelasticity for geometrically exact Cosserat rod and shell models
Multibody Dynamics 2013, ECCOMAS Conference, Zagreb (HR), July

Losch, Katharina; Schladitz, Katja; Ballaschk, Uta; Berek, Harry; Aneziris, Christos G.
Interrupted in situ compressive deformation experiments on MMC foams in an XCT: Experiments and estimation of displacement fields
11th ECS Kaiserslautern, July

Maag, Volker; Grebe, Tabea; Nowak, Uwe
Properties and benefit of the linear efficient frontier approximation in the objective space
22nd International Conference on Multiple Criteria Decision Making, Málaga (S), June

Maas, Ramona; Leyendecker, Sigrid
Muscle paths in biomechanical multibody simulations
Multibody Dynamics 2013, ECCOMAS Conference, Zagreb (HR), July

Machado, Rui
On the scalability of constraint programming on hierarchical multiprocessor systems
42nd International Conference on Parallel Processing (ICPP), Lyon (F), October

Malten, Rebekka
Blick über den Tellerrand der klassischen Oberflächeninspektion
Oberflächenseminar, Karlsruhe, December

Moghiseh, Ali; Ohser, Joachim
A reliable method for approximating the PPI value of foams
FILTECH 2013, Wiesbaden, October

Mohrbacher, Christian
An introduction to the Fraunhofer Parallel Filesystem (FhGFS)
Parallel Computing in Photon and Neutron Science Applications Workshop, Hamburg, March

Mohrbacher, Christian
FhGFS–A parallel filesystem for performance critical applications
SC13, Denver (USA), November

Mohrbacher, Christian
FhGFS File system checking
FhGFS User Meeting, Kaiserslautern, May

Mohrbacher, Christian
FhGFS on demand
FhGFS User Meeting, Kaiserslautern, May

Mohring, Jan
Parametric Model Reduction – Pitfall Met in Practice
ITWM Research Days »Grey-Box Models and Model Reduction«, Kaiserslautern, December

Müller, Lilli
Generating speed profiles: essential input for virtual measurements
Marburg, April

Nagapetyan, Tigran
Multi-level Monte Carlo method for approximation of distribution functions and an application to asymmetric flow field flow fractionation
Young Researcher Symposium 2013, Kaiserslautern, November

Neunzert, Helmut
Ein besonderes Fraunhofer-Projekt: Kann man Synagogen-Orgeln, die 1939 zerstört wurden, wieder zum Klingen bringen?
Rotary-Club, Kaiserslautern, November

Neunzert, Helmut
In der Engl Ordnungen – Zum 60. Geburtstag von Prof. Heinz Engl
Linz (A), March

Neunzert, Helmut
Keep Swinging
Vernissage »e.Motion – Arts meets Science«, München, April

Neunzert, Helmut
Why mathematics?
18th International Conference Mathematical Modelling and Analysis (MMA2013), Tartu (EW), May

Nguyen, Thanh Hung
Improving Gröbner-based Clause Learning for SAT Solving Industrial-sized Boolean Problems
Young Researcher Symposium 2013, Kaiserslautern, November

Niedziela, Dariusz; Schmidt, Sebastian; Steiner, Konrad; Zausch, Jochen
Multi-phase-simulation of suspension flow through granular beads in a rotating disk mill
13th European Symposium on Comminution and Classification, Braunschweig, September

Nowak, Dimitri
Global Optimization of Uniform Coverage Problems with Modified Remez Algorithm
59th Workshop Nonlinear Optimization: a Bridge from Theory to Applications, Enrice (I), June

Obermayr, Martin
A discrete element model for cohesive soil
Particles 2013, Stuttgart, September

Obermayr, Martin
Application of the discrete element method for the prediction of draft forces in different types of soil
38. Kolloquium des SFB 716, University Stuttgart, January

Obermayr, Martin; Vrettos, C.; Kleinert, Jan; Eberhard, P.
A discrete element method for assessing reaction forces in excavation tools
Bilbao (E), June

Oden, Lena
GGAS: Global GPU Address Spaces for Efficient Communication in Heterogeneous Clusters
IEEE Cluster 13 Conference, Indianopolis (USA), September

Oden, Lena
GPI für Akzeleratoren – Schnelle Kommunikation in Hybriden Clustern
German Heterogeneous Computing Usergroup (GHCG) Treffen, Aachen, May

Oden, Lena
GPI2 for GPUS: A PGAS framework for efficient communication in hybrid clusters
ParCo2013: Internat. Conf. on Parallel Computing, München, September

Oden, Lena
GPI2 for GPUs: A PGAS-API for efficient communication in Hybrid Clusters
NVIDIA Application Lab, 1st Annual Workshop, Jülich, July

Ohser, Joachim; Redenbach, Claudia; Moghiseh, Ali
The Estimation of PPI Value of Foams from Second-order characteristics estimated from dark field images of planar sections
11th ECS Kaiserslautern, July

Ohser, Joachim; Lehmann, Martin; Eisengräber-Pabst, J.; Moghiseh, Ali
Chart Cloudiness Induced by Uniformly Random Scattering of Fiber
11th ECS Kaiserslautern, July

Orlik, Julia; Damlamian, Alain; Cioranescu, D.; Shiryaev, Vladimir
Homogenization for multi-scale contact problems with friction
Third International Workshop on Multiscale Modeling and Methods, St. Etienne (F), October

Orlik, Julia; Shiryaev, Vladimir
Evolutional contact with friction on periodic microstructures
3rd workshop on thin structures, Naples (I), September

Orlik, Julia; Shiryaev, Vladimir
Evolutional contact with Tresca friction on a periodic microstructure in the framework of the energetic formulation
12th GAMM-Seminar on Microstructures, Berlin, February and 84th annual meeting of GAMM, Novi Sad (SRB), March

Orth, Thomas; Graff, A.; Schmitte, Till; Spies, Martin; Kersting, Thomas
Betriebstaugliche Ultraschall-Querfehlerprüfung an SAWL-Pipeline-Rohren mit Phased-Array Technik
DGZfP-Jahrestagung 2013, Dresden, May

Pfreundt, Franz-Josef
Fraunhofer FhGFS paralleles Filesystem
SORT – Storage Round Table 2013, München

Pfreundt, Franz-Josef
HPC and Big Data Storage and Parallel File Systems - The Fraunhofer Parallel Filesystem
HP Cast 20, Leipzig, June

Pfreundt, Franz-Josef
Interaktive fotorealistische Produkt-Visualisierung am Beispiel eines Automobilherstellers
HP Workstation Evolution, Frankfurt, March

Pfreundt, Franz-Josef
The Fraunhofer Parallel File System
HP Cast 21, Denver (USA), November

Prill, Torben; Jeulin, Dominique; Schladitz, Katja
Simulation of the FIB-SEM Imaging Process and Segmentation of FIB-SEM Data Sets
Microscopy Conference 2013, Regensburg, August

Prill, Torben; Jeulin, Dominique; Schladitz, Katja; Faessel, Matthieu
Characterization and Optimization of Nanoporous Carbon Structures Based on FIB-SEM Nanotomography
5th International Conference on Porous Media and Annual Meeting of the International Society for Porous Media, Prag, May and EUROMAT 2013, Sevilla (E), September

Prill, Torben; Jeulin, Dominique; Schladitz, Katja
Characterization of Nanoporous Media by FIB-SEM Nanotomography
Young Researcher Symposium, Kaiserslautern, November

Prill, Torben; Jeulin, Dominique; Schladitz, Katja; Faessel, Matthieu
Characterization of Nanoporous Carbon Structures Based on FIB-SEM Nanotomography
11th ECS Kaiserslautern, July

Prill, Torben; Shafaei, Behrang; Schladitz, Katja; Wirjadi, Oliver
Simulation of the FIB-SEM Images for Segmentation of Porous Microstructures
FILTECH 2013, Wiesbaden, October

Rahn, Mirko
GASPI und GPI-2
RRZE, Erlangen, December

Rieder, Hans; Dillhöfer, Alexander; Spies, Martin; Rauhut, Markus; Taeubner, Kai; Kreier, Peter
Ein Multi-Sensor-Verfahren zur umfassenden zerstörungsfreien Prüfung gegossener Großbauteile am Beispiel von Schiffsantriebskomponenten
DGZfP-Jahrestagung 2013, Dresden, May

Rieder, Hans; Dillhöfer, Alexander; Spies, Martin; Rieder, Isabell
Vorstellung eines E-Learning Kurses zum Thema Ultraschallabbildung mittels SAFT
DGZfP-Jahrestagung 2013, Dresden, May

Rief, Stefan
Analysis and Optimization of Paper Machine Clothings by Multi-Scale Simulation
11th European Congress of Stereology and Image Analysis 2013, Kaiserslautern, July

Roller, Michael; Betsch, P.; Gallrein, Axel; Linn, Joachim
On the use of geometrically exact shells for dynamic tire simulation
Multibody Dynamics 2013, ECCOMAS Conference, Zagreb (HR), July

Rotaru, Tiberiu; Rahn, Mirko; Pfreundt, Franz-Josef
MapReduce in GPI-Space
BigDataCloud 2013, 2nd Workshop on Big Data Management in Clouds (in conjunction with Euro-Par 2013), Aachen, August

Ruckdeschel, Peter
Autokorrelationen im Marktpreisrisikomanagement
DSGV-Arbeitskreis Treasury, Berlin, February

Ruckdeschel, Peter; Erlwein-Sayer Christina
Robustness Aspects of Elliott's Algorithm
Workshop zu DFG-Projekt »Regime-switching in zeitstetigen Finanzmarktmodellen: Statistik und problemspezifische Modellwahl«, Kaiserslautern, June

Ruckdeschel, Peter; Horbenko, Nataliya; Kohl, Matthias
‚RobExtremes' – Robust Extreme Value Statistics – a new member in the RobASt-Family of packages
Status-Symposium »Extreme Events«, Volkswagenstiftung, Hannover, February

Sarishvili, Alex
Software Reliability prediction via two different implementations of Bayesian model averaging
ECML/PKDD 2013, European conference on machine learning and principles and practice of knowledge discovery in databases, Prag (CZ), September

Sarishvili, Alex
Workflow eines Data Mining-Projektes in der Produktion
Workshop Data Mining in Produktion und Fertigung, Kaiserslautern, May

Scherrer, Alexander
Software-assisted decision making in breast cancer therapy planning
ORAHS 2013, Stanbul (TR), July

Schladitz, Katja
Bildanalyse und automatische Anpassung stochastischer Geometriemodelle
MAFoaM-Abschlussworkshop, Fraunhofer IWM, Halle, September

Schladitz, Katja
Biscuits roses im Champagner - sind Krümel Zufall?
WiMa-Kongress, University Ulm, November

Schladitz, Katja
Genormte Charakterisierung zellularer Werkstoffe mittels Computertomografie
DGZFP Unterausschuss Computertomografie, Wittingen, June

Schladitz, Katja
Quantitative 3D analysis of microstructures
TOPICAL DAY Imaging and image analysis, EMPA, Dübendorf, April

Schlimper, Ralf; Heidenreich, Rene; Schladitz, Katja; Vecchio, Irene
Mikro-CT-Bildanalyse, Mikrostrukturmodellierung und Eigenschaftssimulation von Werkstoffen am Beispiel geschlossenzelliger Polymerhartschäume
3D-NordOst, Berlin, December

Schmidt, Sebastian; Niedziela, Dariusz; Steiner, Konrad
Numerical simulations of granular flow (with applications) in mixers
Jahrestreffen der Fachgruppen Agglomerations- und Schüttguttechnik und CFD, Weimar, March

Schmidt, Sebastian; Steiner, Konrad
CoRheoS : Multiphysics solver framework and simulation infrastructure for complex rheologies
NAFEMS World Congress 2013, Salzburg (A), June

Schmidt, Sebastian
POD-DEIM based model order reduction for a three-dimensional microscopic Li-Ion battery model
ITWM Research Days: Greybox-models and Modelreduction, Kaiserslautern, December

Schmidt, Sebastian; Steiner, Konrad; Niedziela, Dariusz; Zausch, Jochen
Multiphysics Solver Framework and Simulation Infrastructure for Complex Fluid Dynamics
NAFEMS World Congress 2013, Salzburg (A), June

Schröder, Michael
Logistik im Krankenhaus – Anforderungen, Konzepte und IT-Systeme
University of Applied Sciences, Pirmasens, April

Schröder, Michael
Planungsprobleme lösen – Reichen ein gutes Modell und ein effizienter Algorithmus?
University Göttingen, May

Schröder, Michael
TeamScheduler – Intelligente Assistenz für das Projektmanagement
Jahrestagung des ikbp, Kassel, November

Schröder, Michael
TeamScheduler – Kreatives Zeitmanagement
Fraunhofer-Netzwert-Symposium, München, December

Schröder, Michael; Berger, Martin
Dispatching of mobile breast cancer screening units by optimization methods
OR 2013, Rotterdam (NL), September

Schubert, Bernd
A dedicated cache for metadata?
Linux Plumbers Conference, New Orleans (USA), September

Schulz, Volker; Gottfried, M.; Craß, F.; Zausch, Jochen; Schmidt, Sebastian; Steiner, Konrad; Steiner, T.; Breihof, S.; Burgard, K.; Latz, Arnulf
Simulation of Lithium-Ion batteries and its application to the testing of EVs and hybrid cars
Kraftwerk Batterie, Aachen, February

Schwientek, Jan
Semi-infinite optimization applied to gemstone cutting - with links to projection methods
Workshop Projection Methods – Theory and Practice, Kaiserslautern, June

Shafei, Behrang
Segmentation of fibers in filter media based on 2D (SEM) and 3D (CT) image data
11th ECS, Kaiserslautern, July

Shafei, Behrang
Supervised multi-class segmentation with p-Laplacians and RKHS methods
84th Annual Meeting of the International Association of Applied Mathematics and Mechanics (GAMM), Novi-Sad (SRB), March

Shiryaev, Vladimir; Bare, Zoufine; Orlik, Julia
Computational model for periodic hyperelastic string structures under Coulomb friction
HSTAM, Chania (GR), May

Siedow, Norbert; Feßler, Robert; Jegorov, Jevgenij
Fast design of freeform optics
3rd EOS Conference on Manufacturing of Optical Components, München, May

Siedow, Norbert; Lochegnies, Dominique; Bechet, Fabien; Moreau, Philippe
Radiation impact on the two-dimensional modeling of glass sheet sagging and tempering
74th Conference on Glass Problems, Columbus, Ohio (USA), October

Sliseris, Janis
Numerical Prediction for the Modulus of Elasticity of L-MDF Plates
Young Researcher Symposium, Kaiserslautern, November

Spahn, Johannes
A multiscale approach for modeling progressive damage of composite materials using fast Fourier transforms
Young Researcher Symposium, Kaiserslautern, November

Spahn, Johannes
FFT-based multiscale modeling of nonlinear microstructured materials
Young Researcher Symposium, Kaiserslautern, November

Spahn, Johannes; Staub, Sarah; Kabel, Matthias; Müller, Ralf
Simulation of nonlinear microstructured materials and determination of effective macroscopic quantities
11th European Congress of Stereology and Image Analysis, Kaiserslautern, July

Spahn, Johannes; Andrä, Heiko; Kabel, Matthias; Müller, Ralf
A multiscale damage model for composite materials using a FFT-based method
V International Conference on Coupled Problems, 2013, Ibiza (E), June

Spies, Martin; Hubel, Sebastian; Dillhöfer, Alexander; Rieder, Hans; Bamberg, Joachim; Hessert, Roland; Götze, Joshua
Ultrasonic evaluation of residual stresses in aero engine materials using bulk and Rayleigh surface waves
40th Review of Progress in QNDE, Baltimore (USA), July

Spies, Martin; Rieder, Hans; Dillhöfer, Alexander
Experimentelle und modellbasierte POD-Bestimmung für Volumenfehler in gegossenen Bronze-Bauteilen unterschiedlicher Gefügestruktur
DGZfP-Jahrestagung 2013, Dresden, May

Spies, Martin; Rieder, Hans; Dillhöfer, Alexander; Hubel, Sebastian; Dobrovolskij, Dascha
ProRepaSII – Entwicklung und Validierung von Methoden zur zerstörungsfreien Prüfung von Propellerwerkstoffen mit Ultraschall
Statustagung »Maritime Technologien« des Bundesministeriums für Wirtschaft und Technologie, Berlin, December

Spies, Martin; Rieder, Hans; Dillhöfer, Alexander; Müller, Wolfgang; Schmitz, Volker
SAFT, TOFD, Phased Array – Klassische Anwendungen und neuere Entwicklungen der Ultraschall-Bildgebung
Seminar des DGZfP-FA Ultraschallprüfung »Bildgebende Verfahren für die Ultraschallprüftechnik«, Berlin, November

Spies, Martin; Rieder, Hans; Dillhöfer, Alexander; Rauhut, Markus; Taeubner, Kai; Kreier, Peter
Recent progress in the NDE of cast ship propulsion components
40th Review of Progress in QNDE, Baltimore (USA), July

Spies, Martin; Rieder, Hans; Dillhöfer, Alexander; Rauhut, Markus; Taeubner, Kai
Ultrasonic inspection, defect reconstruction and POD issues for complex materials and components
14th Asia Pacific Conference on Non-Destructive Testing, Mumbai (IND), November

Steiner, Konrad
Microstructure and multiscale simulation of thin, multilayered porous media
Industrial workshop on "Thin porous media" at 5th Interpore Conference, Prag (CZ), May

Stephani, Henrike
Typischer Aufbau eine Oberflächeninspektionssystems
Oberflächenseminar, Karlsruhe, December

Sun, Yang; Lu, Jin-jun; Cheng, Liping
The applicability investigation on two models for porous air-filters
Filtech 2013, Wiesbaden, October

Süss, Philipp
Interactive radiotherapy treatment planning
Workshop Projection Methods – Theory and Practice, Kaiserslautern, June

TEACHING ACTIVITIES

Süss, Philipp
Fully interactive radiotherapy planning Multicriteria decision support and beyond
Oncoray, Dresden, September

Süss, Philipp
Optimierung und interaktive Planung in der IMRT
Fachtagung DGMP, Freiburg, May

Tramecon, Alain; Kuhnert, Jörg
Enhancements and validation of FPM fluid structure interaction module applied to curtain airbag deployment
NAFEMS World Congress (NWC2013), Salzburg (A), June

Vecchio, Irene
3D image analysis for characterization of materials microstructures
Advances in Mathematical Image Processing, Annweiler, October

Vecchio, Irene
Stochastic models in materials science
Young Researcher Symposium, Kaiserslautern, November

Vecchio, Irene; Schladitz, Katja; Redenbach, Claudia
Analysis of closed-cell polymer foams and automatic model fitting with random Laguerre tessellations
11th ECS Kaiserslautern, July

Vecchio, Irene; Schladitz, Katja; Redenbach, Claudia
Image based characterization and modeling of closed-cell polymer foams
EUROMAT 2013, Sevilla (E), September

Velasco-Forero, Santiago; Angulo, Jesus
Morphological simulation of textures by iterated morphological viscous operators by reconstruction
11th ECS Kaiserslautern, July

Velasco-Forero, Santiago; Angulo, Jesus
Supervised morphology for tensor structure-valued images based on symmetric divergence kernels
Geometric Science of Information Paris (F), August

Velasco-Forero, Santiago; Angulo, Jesus
On nonlocal mathematical morphology
11th ISMM, Uppsala (S), May

Wächtler, Timo
Mean droplet size in stirred extraction columns: From 1D simulation to 3D FPM approach
Young Researcher Symposium, Kaiserslautern, November

Weber, Dietmar
Tire Parameter Identification
ITWM Research Days »Grey-Box Models and Model Reduction«, Kaiserslautern, December

Wegener, Raimund; Marheineke, Nicole
ProFil: Stochastische Produktionsprozesse zur Herstellung von Filamenten und Vliesstoffen
Mathematik für Innovationen in Industrie und Dienstleistungen, BMBF-Statusseminar, Bonn, June

Wirjadi, Oliver; Godehardt, Michael; Schladitz, Katja; Wagner, Björn; Rack, Alexander; Gurka, Martin; Noll, Andreas
Detection of layered structures in fibre reinforced polymer employing synchrotron and laboratory X-Ray CT
EUROMAT 2013, Sevilla (E), September

Wirsen, Andreas; Lang, Patrick, Groß, Tjorben
Anforderungen an ein Überwachungssystem zum Schutz von Turbosätzen vor kritischen subsynchronen Resonanzen
6. Essener Tagung Turbogeneratoren in Kraftwerken: Technik - Instandhaltung - Schäden, Essen, February

Zausch, Jochen; Latz, Arnulf
Three-dimensional micro- and macro-scale modeling of lithium ion batteries
2nd Conference on Materials for Energy, Karlsruhe, May

Zausch, Jochen
Cell design and battery assessment by computer simulations on multiple scales
Workshop Fraunhofer-Allianz Batterien, Novi (USA), September

Zausch, Jochen
Von der Mikro- zur Zellskala: physikalisch basierte Modellierung zur Bewertung von Zelldesign und Batterieperformance
Workshop Fraunhofer-Allianz Batterien, Kaiserslautern, July

Zausch, Jochen; Schmidt, Sebastian; Latz, Arnulf
Not only for electromobility: Physics based 3D simulations of Li-ion batteries
Automotive CAE Grand Challenge, Hanau, April

Zausch, Jochen; Taralova, Vassilena, Taralov, Maxim; Iliev, Oleg; Latz, Arnulf
From Micro to Macro: Modeling and imulation of Lithium Ion Batteries on Multiple Scales
ModVal 10, Bad Boll, April

Zemitis, Aivars;Iliev Oleg; Steiner Konrad; Klein-Heßling, Walter, Sonnenkalb, Martin; Freitag, Martin
Simulation of Multiphysics in a NPP Containment using Combined Codes with Different Spatial Resolution
11th Internactional Conference of Numerical Analysis and Applied Mathematics 2013, Rhodes (GR), September 2013

Zupan, Eva; Zupan, Dejan; Linn, Joachim; Saje, M.
Quaternion-based dynamics of geometrically exact Cosserat rods
4th Canadian Conference on Nonlinear Solid Mechanics (CanCNSM 2013), Montreal (CDN), July

Andrä, Heiko
Kontaktmechanik
University of Kaiserslautern, Winter term 2013/14

Bitsch, Gerd
Professorship of "Mechatronik, Robotik und CAE-Simulation"
University of Applied Sciences, Kaiserslautern, Dept. of Applied Engineering Sciences

Burger, Michael
Control of Mechanical Multibody Systems
University of Kaiserslautern, Summer term 2013

Burger, Michael
Dynamics of Mechanical Multibody Systems
University of Kaiserslautern, Winter term 2013/2014

Dreßler, Klaus
Durability Load Data Analysis
University of Kaiserslautern, Summer term 2013

Fünfzig, Christoph
Einführung in algorithmische Geometrie und geometrische Modellierung
University of Applied Sciences, Saarbrücken, Dept. of Computer Sciences, Winter term 2013/2014

Korn, Ralf
Professorship of "Stochastische Steuerung und Finanzmathematik"
University of Kaiserslautern, Dept. of Mathematics

Küfer, Karl-Heinz
Probability and algorithms
University of Kaiserslautern, Winter term 2013/14

Küfer, Karl-Heinz
Theory of scheduling problems
University of Kaiserslautern, Summer term 2013

Kuhnert, Jörg
Finite Pointset Method (FPM): Meshfree Industrial Solver in Fluid and Continuum Mechanics
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PARTICIPATION IN FAIRS AND CONFERENCES

ACM 2013
San Diego (USA), February, Lecture

Advances in Mathematical Image Processing
Annweiler, October, Lecture

Advances in Mathematics of Finance – 6th General AMaMeF and Banach Center Conference
Warschau (PL), June, Lecture

AFS Spring Conference 2013
Minneapolis (USA), May, Exhibitor, Lecture

Arbeitstagung der IT-Manager der Fraunhofer-Gesellschaft
Kassel, November, Lecture, Poster

14th Asia-Pacific Conference on NDT
Mumbai (IND), November, Lecture

Automotive CAE Grand Challenge
Hanau, April, Lecture

Battery+Storage
Stuttgart, October, Exhibitor

bauma 2013
München, April, Exhibitor

51. Bildverarbeitungsforum »Moderne optische Elemente für die optimale Bildgewinnung«
Darmstadt, March

52. Bildverarbeitungsforum »3D-Bildanalyse von Oberflächen: Form, Textur und Funktionalität«
Konstanz, July

53. Bildverarbeitungsforum »Standardisierung und Performanzanalyse«
Braunschweig, October

Building Bridges, Conference in honor of Claudia Klüppelberg
Braunschweig, August, Lecture

CallCenterWorld 2013: Internationale Kongressmesse für Call Center Management
Berlin, February

chassis.tech plus 2013 – 4. Internationales Münchner Fahrwerk-Symposium
München, June

Chemiefasertagung 2013
Dornbirn (A), September, Lecture

CMN 2013 – Congress on Numerical Method in Engineering
Bilbao (E), June, Lecture

Composites Europe 2013
Stuttgart, September, Exhibitor

Control 2013
Stuttgart, May, Exhibitor

CVC-Jahrestagung 2013
Wörth, October, Poster

Daimler EDM-CAE-Forum
Stuttgart, July, Exhibitor, Lecture

D-CON 2013
Lübeck, March

DGZfP-Jahrestagung 2013
Dresden, May, Lecture, Poster

DKM – Internationale Fachmesse für die Finanz- und Versicherungswirtschaft
Dortmund, October

DMV/ÖMG-Tagung – Mathematics for the Planet Earth
Innsbruck (A), September, Lecture

DVM-Arbeitskreis Betriebsfestigkeit Tagung: Die Betriebsfestigkeit als eine Schlüsselfunktion für die Mobilität der Zukunft
Herzogenaurach, October, Exhibitor

EAGE 2013
London (GB), June, Exhibitor

Energy Finance Conference 2013
Essen, October, Lecture

EnMat II
Karlsruhe, May, Lecture

Erice 2013 Workshop
Erice (I), June, Lecture

ESOP/ETAPS 2013
Rom (I), March, Lecture

6. Essener Tagung: Turbogeneratoren in Kraftwerken – Technik – Instandhaltung – Schäden
Essen, February, Lecture

Etailment Expo2013: E(motion)-Commerce – Lösungen für den Handel 2020
Berlin, November, Exhibitor

EUROMAT 2013
Sevilla (E), September, Lecture, Poster

European Automotive Coating - 20. DFO Automobil Tagung
Potsdam, May

European Conference on Operational Research EURO XXVI
Rom (I), July, Lecture

11th European Congress of Stereology and Image Analysis
Kaiserslautern, July, Lecture, Poster

28th European PV Solar Energy Conference and Exhibition
Paris (F), September, Lecture, Poster

13th European Symposium on Comminution and Classification
Braunschweig, September, Lecture, Poster

European Wolfram Technology Conference 2013
Frankfurt/M., June, Lecture

E-World 2013
Essen, February, Lecture

FILTECH 2013
Wiesbaden, October, Exhibitor, Lecture, Poster

FSTTCS 2013
Guwahati (IND), Deuember, Lecture

GCPR 2013
Saarbrücken, September

GeoDict User Meeting 2013
Kaiserslautern, September, Lecture

Geomathematics in Honor of W. Freeden's 65th birthday
St. Martin, April, Lecture

Girls Day im Bundeskanzleramt
Berlin, April, Exhibitor

13. GMM/ITG-Fachtagung Analog 2013, Entwicklung von Analogschaltungen mit CAE-Methoden
Aachen, March, Poster

GOR
Karlsruhe, April, Lecture

GTC – GPU Technology Conference
San Jose (USA), March, Poster

Hannover Messe
Hannover, April, Exhibitor

Hofer Vliesstofftage 2013
Hof, November, Exhibitor, Lecture

IAM Workshop "Monte Carlo: Basic Methods and Recent Advances"
Ankara (TR), April, Lecture

IAMG 2013
Madrid (S), September, Lecture

IASS Tagung
Berlin, May

ICORS 2013
St. Petersburg (RUS), July, Lecture

IEEE Cluster 13 Conference
Indianopolis (USA), September, Lecture

11th Internactional Conference of Numerical Analysis and Applied Mathematics
Rhodes (GR), September, Lecture

6th International Conference of the ERCIM WG on Computational and Methodological Statistics
London (GB), December, Lecture

7th International Conference on Computational and Financial Econometrics
London (GB), December, Lecture

5th International Conference on Coupled Problems 2013
Ibiza (Spanien), June, Lecture

International Conference on Geometry and Physics of Spatial Random Systems
Freudenstadt, September, Poster

International Conference on Parallel Computing – ParCo
München, September, Lecture

5th International Conference on Porous Media and Annual Meeting of the International Society for Porous Media
Prag (CZ), May, Exhibitor, Lecture, Poster

Intersolar 2013
München, June, Exhibitor

ISC'13 – International Supercomputing Conference
Leipzig, July, Exhibitor, Lecture

Jahrestagung Kerntechnik
Berlin, May

Kraftwerk Batterie
Aachen, February, Poster

AWARDS AND PRICES

Linux Plumbers Conference
New Orleans (USA), September, Lecture

LMS European Vehicle Conference: Smart simulation and testing for optimized mechatronic system's design
München, October, Exhibitor, Lecture

MCDM 2013
Malaga (S), June, Lecture

MESHFREE 2013
Bonn, September, Lecture

Microscopy Conference 2013
Regensburg, August, Lecture

Model Reduction of Complex Dynamical Systems 2013 (ModRed 2013)
Magdeburg, December, Lecture

ModVal 10
Bad Boll, March, Lecture

NAFEMS World Congress 2013
Salzburg (A), June, Lecture

NAFEMS-Seminar: »Innovative Anwendungen der Strömungssimulation in der Produktentwicklung«
Wiesbaden, March, Lecture

Nonlinear Partial Differential Equations and Applications
Rouen (F), June, Poster

NUMTA 2013
Falera (I), June, Lecture

ORAHS 2013
Istanbul (TR), July, Lecture

Particles 2013 – 3rd International Conference on Particle-Based Methods
Stuttgart, September, Lecture

PowTech-Partec
Nürnberg, April, Exhibitor, Lecture

REORDER + CAV 2013
St. Petersburg (RUS), July, Lecture

40th Review of Progress in QNDE
Baltimore (USA), July, Lecture

Risk Management Reloaded
München, September, Lecture

Rmetrics 2013
Meielisalp (CH), July, Lecture

SAE 2013 World Congress & Exhibition
Detroit (USA), April, Lecture

SC13 – Supercomputing
Denver (USA), November, Exhibitor, Lecture

SCCH 2013 – 4th Conference Scientific Computing and Cultural Heritage
Heidelberg, November, Lecture

Science meets Tires – Visionen für die Reifentechnik
Aachen, September, Lecture

SEG 2013 – Society of Exploration Geophysicists
Houston (USA), September, Exhibitor

Seminar »Inspektion und Charakterisierung von Oberflächen mit Bildverarbeitung«
Karlsruhe, November, Exhibitor, Lecture

Seminar des DGZfP-FA Ultraschallprüfung
Berlin, November, Lecture

SPS / Drives / IPC
Nürnberg, November

SURCAR – 26th International conference on automotive body finishing
Cannes (F), June

DVM-Tag 2013, ELEKTROMOBILITÄT – Zuverlässigkeit und Sicherheit des Elektrofahrzeugs
Berlin, April

1. Technologieforum Bildverarbeitung
Unterschleißheim, November

TechTextil 2013
Frankfurt/M., June, Exhibitor

The Battery Show
Novi (USA), September, Exhibitor

The Future of Life Insurance
Hannover, May, Lecture

treffpunkt-Firmenkontaktmesse
Kaiserslautern, June, Exhibitor

Truck & Bus World Forum 2013
Lyon (F), November, Poster

UCLA/IPAM Workshop "Convex Relaxation Methods for Geometric Problems in Scientific Computing"
Los Angeles (USA), February, Poster

UseR! 2013
Albacete (E), July, Lecture

VDI Nutzfahrzeuge 2013 – Truck, Bus, Van, Trailer
Celle, June, Exhibitor

VDI-Konferenz | Simvec Spezial – Simulation des Werkstoffverhaltens für automobile Anwendungen
Baden-Baden, December, Exhibitor, Lecture

VDI-Tagung: Fahrer im 21. Jahrhundert
Braunschweig, November, Exhibitor

VDI-Tagung: HMI und unterstützende Systeme in mobilen Arbeitsmaschinen
Ulm, December, Exhibitor

VDI-Tagung: Reifen–Fahrwerk–Fahrbahn
Hannover, October, Exhibitor

VI-grade – 5th Users Conference
Marburg, April, Exhibitor, Lecture

Wehrtechnisches Symposium »Schwingungsbelastbarkeit von Bundeswehr-Radfahrzeugen«
Trier, March

Wissenschaftstag der DGVFM
Berlin, April, Lecture

3rd workshop on thin structures
Naples (I), September, Poster

Young Researcher Symposium
Kaiserslautern, November, Lecture

Ackermann, Heiner
1st prize for best scientific reportage "Von Puzzlern lernen"
University of Kaiserslautern, May

Fraunhofer ITWM, Fraunhofer IESE
Gründungsförderer des Jahres 2013
Diemersteiner Kreis, Kaiserslautern, September

Leithäuser, Nele
2nd prize for best scientific reportage "Mathematik, die Leben rettet"
University of Kaiserslautern, May

Lojewski, Carsten; Machado, Rui; Simmendinger, Christian
Joseph von Fraunhofer Prize 2013
Fraunhofer-Gesellschaft, München, June

Nagapetyan, Tigran
Best Team Perfomance
OCCAM 5th UK Graduate Modelling Camp 2013, Oxford (GB) ,April

Schwienteck, Jan
Prize for exzellent doctoral thesis
Kreissparkassenstiftung Kaiserslautern, June

Vecchio, Irene
3rd Prize – Best Paper Award
Nachwuchsring des (CM)², Innovationszentrum Applied System Modeling, Kaiserslautern, November

OWN EVENTS

elektro:camp »2013.05«
Kaiserslautern, August

11th European Congress of Stereology and Image Analysis 2013
Kaiserslautern, July

Felix-Klein-Sommerschule 2013
Kaiserslautern, October

FhGFS User Meeting
Kaiserslautern, May

Gesundheitstage am Fraunhofer-Zentrum: Geprüft auf Herz und Rücken
Kaiserslautern, November

Conference: Operational Risk – Management and Measurement
Frankfurt/M., March (in cooperation with KPMG and Center for Financial Studies)

Minisymposium at 5th Interpore Conference: 3d image based microstructures and properties simulations
Prag (CZ), May

OptiRisk-Workshop: Application of Hidden Markov Models and Filters to Financial Time Series Data
London (GB), April

OptiRisk-Workshop: Monte Carlo Methods in Finance: Basic Methods and Recent Advances
London (GB), May

Praktiker-Workshop: Monte Carlo Methods in Finance: Basic Methods and Recent Advances
Kaiserslautern, October

Seminar: Lastdaten – Analyse, Bemessung und Simulation
Kaiserslautern, June

Seminar: Statistische Methoden in der Betriebsfestigkeit
Kaiserslautern, March

Seminar: Systemsimulation in der Fahrzeugentwicklung
Kaiserslautern, March

StoREgio-Workshop: Prognose und Steuersysteme: Thema Metering
Kaiserslautern, September

Research Days: Greyboxmodels and Modelreduction
Kaiserslautern, December

Vernissage des Bildhauersymposiums 2013
Kaiserslautern, August (in cooperation with Skulpturen Rheinland-Pfalz e. V.)

Vortragsreihe des Arbeitskreises »Bildanalyse und Mustererkennung Kaiserslautern« (BAMEK)
Kaiserslautern, January - December

Workshop des Fraunhofer-Innovationsclusters DNT: Simulation/ Virtuelle Produktentwicklung
Kaiserslautern, September

Workshop des Fraunhofer-Innovationsclusters DNT: Statistik und Nutzungsvielfalt
Kaiserslautern, September

Workshop: Basis-Spreads und OIS-Discounting
Kaiserslautern, September

Workshop: Das Heston Modell und seine Anwendung
Kaiserslautern, October

Workshop: Data Mining in Produktion und Fertigung
Kaiserslautern, May

Workshop: Einführung in R
Kaiserslautern, January

Workshop: Finanzmathematik und R
Kaiserslautern, October

Workshop: Interaktive Fahr- und Betriebssimulation FUMI
Kaiserslautern, June

Workshop: Kredit Rating
Kaiserslautern, October

Workshop: Monte-Carlo Methoden in Finanz- und Versicherungswirtschaft
Kaiserslautern, October

Workshop: Projection Methods - Theory & Practice
Kaiserslautern, June

Workshop: R für Fortgeschrittene
Kaiserslautern, February

Workshop: Regime-Switching Models in Finance: Statistics and Optimization
Kaiserslautern, November

Workshop: Von Material bis Modul – Batteriesimulationen in der Fraunhofer-Allianz Batterien
Kaiserslautern, July

Lecture series »Blick über den Tellerrand«
Kaiserslautern

Hadeler, Karl Peter
(University Tübingen, Biomathematik)
Die unerklärliche (In-)Effektivität der Mathematik
January

Lachmann, Thomas
(University of Kaiserslautern, Psychologie)
Was ist Legasthenie? Über 100 Jahre Forschung und kein bisschen klüger (?)
February

Jenet, Harald
(Präsident des Landgerichts Kaiserslautern)
Der Glaube an den Rechtsstaat: Gedanken zur Wahrnehmung der Justiz in der Öffentlichkeit
March

Gropengießer, Frank
(Mathematiker und Ex-CEO)
Der Mathematiker als CEO – Segen oder Fluch?
May

Petersen, Sonja
(University Stuttgart, Historisches Institut)
Zwischen Fingerspitzengefühl und Helmholtz – Zum Verhältnis von Naturwissenschaft und Musikinstrumentenbau im 19. und 20. Jahrhundert
June

Jackson, Myles W.
(Gallatin School of New York University (USA), Wissenschafts- und Technologiegeschichte)
Gene und Rassen in der US-amerikanischen Medizin des 20. und 21. Jahrhunderts
September

Verhulst, Ferdinand
(University of Utrecht (NL), Mathematisch Instituut)
Henri Poincaré (1854 - 1912), impatient genius
October

Wiese, Hans-Ulrich
Vorstand a. D. der Fraunhofer-Gesellschaft
Entwicklung des Erfolgsmodells Fraunhofer seit seinen Anfängen
November

Michael Welker
(University Heidelberg, Systematische Theologie (Dogmatik))
Ist der Dialog zwischen Theologie und Naturwissenschaften heute noch sinnvoll?«
December

GUESTS

Arnold, Martin (Martin-Luther-University Halle-Wittenberg)
Numerik für Mehrkörpersysteme
March

Bauchau, Oliver (University of Michigan-Shanghai (CHN))
Flexible Multibody Dynamics
April

Ben-Israel, Adi
(Rutgers Business School (USA))
Workshop »Projection Methods - Theory & Practice«
June

Betsch, Peter (University Siegen)
Modellierung von Reifen mit geometrisch exakten Schalenmodellen
September

Brown, Donald
(King Abdullah University of Science and Technology, Thuwal (KSA))
Multiscale poroelastiticity models
May - July

Byrne, Charles (University of Massachusetts, Lowell (USA))
Workshop »Projection Methods - Theory & Practice«
June

Cegielsk, Andrzej
(University of Zielona Góra (PL))
Workshop »Projection Methods - Theory & Practice«
June

Censor, Yair (University of Haifa (IL))
Workshop »Projection Methods - Theory & Practice«
June

Ciegis, Raimondas (Vilnius Gediminas Technical University)
Stability and convergence analysis of FDS for non-classical mathematical models
October

Davidi, Ran (Stanford University (USA))
Workshop »Projection Methods - Theory & Practice«
June

Dergunov, Ilya
(Goethe University Frankfurt)
Projektarbeit IPConcept
February - April

Elfving, Tommy
(University of Linköping (S))
Workshop »Projection Methods - Theory & Practice«
June

Hecht, Heiko (Johannes Gutenberg-University Mainz)
RODOS-Simulator
January

Hennig, Christian (UCL London (GB))
Gaussian Mixture Modelling and the Number of Clusters
November

Herman, Gabor T.
(City University of New York (USA))
Workshop »Projection Methods - Theory & Practice«
June

Heyden, Anders (Lund University (S))
Geometrische Modellierung / Mathematische Methoden der Bildverarbeitung
May

Jouve, Francois
(University Paris Diderot (Paris 7) Laboratoire J. L. Lions (F))
Form Optimierung für periodische Strukturen
January

Kohl, Matthias
(Hochschule Furtwangen)
R-Pakete zu Robuster Statistik
February, July, September

Leyendecker, Siegrid
(Friedrich-Alexander-University Erlangen-Nürnberg)
Diskrete Mechanik und Optimalsteuerung von Bio-Mehrkörpersystemen
August

Lichtenheldt, Roy
(Deutsches Zentrum für Luft- und Raumfahrt Oberpfaffenhofen)
Lokomotion planetarer Rover auf nachgiebigen Sandböden – Ein partikelbasierter Ansatz zur Simulation in der Terramechanik
August

Londono, Jaime Alberto (Universidad Nacional de Colombia, Bogota (CO))
A new european logistic-type option pricing model
October

Mamon, Rogemar (University of Western Ontario (CDN))
Mortality modelling with regime-switching for the valuation of a guaranteed annuity option
November

Meyer, Arnd (TU Chemnitz)
FE-Numerik für geometrisch nichtlineare Schalenmodelle
July

Negrut, Dan
(University of Wisconsin (USA))
On Fast Computers and Their Use in Mechanical Engineering: From the Dynamics of Granular Material to the Motion of the Mars Rover
November

Niedziela, Maciej
(University Zielona Gora (PL))
Viscoelastic Materials
May, August

Panasenko, Grigory
(University St. Etienne (F))
Asymptotische Homogenisierung und Dimensionsreduktion in PDE's
July/August

Pupashenko, Daria
(Hochschule Furtwangen)
Robuste Statistik
January - December

Rave, Stephan (WWU Münster)
DUNE-pyMOR: Model Order Reduction with Python and DUNE
December

Sanz-Solé, Marta
(Universitat de Barcelona (E))
An Introduction to the European Mathematical Society
February

Schäfer, Bernd
(Deutsches Zentrum für Luft- und Raumfahrt Oberpfaffenhofen)
Lokomotion planetarer Rover auf nachgiebigen Sandböden – Ein partikelbasierter Ansatz zur Simulation in der Terramechanik
August

Spangl, Bernhard (BOKU Wien (A))
R-Pakete zu Robuster Statistik
February, July, September

Struckmeier, Jens
(University Hamburg)
Particle Methods in Numerical Mathematics
October

Wardetzky, Max
(University Göttingen)
Diskrete nichtlineare Schalenmodelle
April, October

Zupan, Dejan
(University Ljubljana (SLO))
Cosserat-Balkenmodelle
February

COLLABORATION IN BOARDS, EDITORSHIPS

Ackermann, Heiner
- Operational Research: An International Journal (Reviewer)

Gerwalin, Elmar
- Fachgremium IT-Geschäftsprozessunterstützung der Fraunhofer-Gesellschaft
- IT-Strategiekreis der Fraunhofer-Gesellschaft
- Fachgruppe IT-Controlling der Gesellschaft für Informatik (Deputy Speaker)

Andrä, Heiko
- Journal Of Computational Physics JCOMP (Reviewer)
- Structural and Multidisciplinary Optimization SMO (Reviewer)
- Latvian Science Council (Reviewer)

Iliev, Oleg
- International Society for Porous Media (Past President)
- Mathematical Modelling and Analysis (Editor)
- Journal of Porous Media (Editor)
- Springer Proceedings in Mathematics & Statistics, Volume 45 (Editor)
- SIAM Multiscale (Reviewer)
- Transport in Porous Media (Reviewer)
- J. Comp and Appl. Math (Reviewer)
- Chemical Eng. Journal (Reviewer)
- Computational Geoscience (Reviewer)

Korn, Ralf
- Deutsche Gesellschaft für Versicherungs- und Finanzmathematik (Vice Chairman)
- Scientific advisory council of DISC (University of Kaiserslautern)
- European Actuarial Journal (Editor)
- Mathematical Finance (Associate Editor)
- Mathematical Methods of Operations Research (Associate Editor)
- Imperial College Press/World Scientific: "Quantitative Finance Series" (Editor)
- Springer Briefs in Mathematical Finance (Editor)
- Scandinavian Statistical Journal (Associate Editor)
- Reviewer for DFG, AQAS, Studienstiftung des Deutschen Volkes, Humboldt-Stiftung

Küfer, Karl-Heinz
- Working group "OR in health care" of GOR (Chairman)
- Mathematics of Operations Research (Reviewer)
- Medical Physics (Reviewer)
- ORSpektrum (Guest Editor)
- Zentralblatt für Mathematik (Reviewer)
- Mathematical Programming (Reviewer)

Kuhnert, Jörg
- Scientific Committee, ESI Group, Paris (F) (Member)
- Geotechnik (Reviewer)
- Applied Mathematics and Computation (Reviewer)

Maasland, Mark
- Fraunhofer Vision Alliance (Member)

Neunzert, Helmut
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- International Committee for Applied Mathematics in the European Mathematical Society (Member)
- ECMI-Series „Mathematics in Industry" (Editor)

Ostermann, Isabel
- International Journal on Geomathematics (Reviewer)
- Computers & Geosciences (Reviewer)

Pfreundt, Franz-Josef
- ISC'13 Steering Committee (Member)
- ISC'13 Oil&Gas (Session Chairman)

Prätzel-Wolters, Dieter
- Research center "Center of Mathematical and Computational Modeling (CM)²", University of Kaiserslautern (Member)
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Rieder, Hans
- DGZfP Fachausschuss »Ultraschallprüfung« (Member)
- Deutsche Gesellschaft für Zerstörungsfreie Prüfung e. V. – DGZfP (Member)
- DGZfP Unterausschuss »Phased Array« im Fachausschuss Ultraschallprüfung (Chairman)
- VDE/VDI-Fachausschuss »Nichtlineare Systeme« (Member)

Rösch, Ronald
- Image Processing On-Line (Editor)
- Fraunhofer Vision Alliance (Member of Coordination board)
- Fraunhofer Lightweight Structures Alliance (Member)
- Heidelberger Bildverarbeitungsforum (Member of Advisory Board)
- IOP electronic Journals (Reviewer)
- Fraunhofer-Arbeitskreis Computertomographie (Member)
- Deutsche Gesellschaft für Materialkunde e. V. (DGM, Member)
- DGM-Arbeitskreis »Tomographie« (Member)
- DGM-Fachausschuss »Strahllinien« (Member)
- Deutsche Gesellschaft für Zerstörungsfreie Prüfung e. V. – DGZfP (Member)

Ruckdeschel, Peter
- Computational Statistics and Data Analysis (Reviewer)
- Communications in Statistics – Theory and Methods (Reviewer)
- Journal for mathematical modelling and analysis (Reviewer)
- Statistical Papers (Reviewer)
- Journal of multivariate analysis (Reviewer)
- Technometrics (Reviewer)

PATENTS

Scherrer, Alexander
- Physics in Medicine and Biology (Reviewer)

Schladitz, Katja
- Fraunhofer Lightweight Structures Alliance (Member)
- International Society for Stereology (Vice-President for Europe)
- Journal of Microscopy (Reviewer)
- Journal of the Royal Society Interface (Reviewer)
- Image Analysis & Stereology (Editorial Board)
- Praktische Metallografie (Reviewer)

Spies, Martin
- Deutsche Gesellschaft für Zerstörungsfreie Prüfung e. V. – DGZfP (Member, Member of Advisory Board)
- DGZfP-Fachausschuss »Ultraschallprüfung« (Member)
- DGZfP-Fachausschuss »Hochschullehrer« (Member)
- DGZfP-Unterausschuss »Modellierung und Bildgebung« im Fachausschuss »Ultraschallprüfung« (Chairman)
- DGZfP-Unterausschuss »Ausbildung« im Fachausschuss »Ultraschallprüfung« (Member)
- DGZfP-Unterausschuss »Phased Array« im Fachausschuss »Ultraschallprüfung« (Member)
- IEEE Transactions on Ultrasonics, Ferroelectrics & Frequency Control (Reviewer)
- Journal of the Acoustical Society of America (Reviewer)
- Journal of Computational Acoustics (Reviewer)
- Materials Evaluation (Reviewer)
- NDT&E International (Reviewer)
- Wave Motion (Reviewer)
- Ultrasonics (Reviewer)
- Acustica (Reviewer)

Stephani, Henrike
- International Conference on Pattern Recognition (Reviewer)

Vecchio, Irene
- Bernoulli Society (Member)
- Deutsche Gesellschaft für Materialkunde e. V. – DGM (Member)

Velten, Sebastian
- Computers & Operations Research (Reviewer)
- TOP (Reviewer)

Wagner, Andreas
- IEEE Transactions on Power Systems (Reviewer)

Wenzel, Jörg
- Mathematical Reviews (Reviewer)
- Zentralblatt der Mathematik (Reviewer)

Küfer, Karl-Heinz; Scherrer, Alexander; Bortz, Michael; Süss, Philipp; Monz, Michael
Anpassen einer Dosisverteilungs-Einstellung für ein technisches Gerät der Tumortherapie
German Patent No. 102010062079.3

EDITORIAL NOTES

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