ANNUAL REPORT

2009

CONTENT

PREFACE

Despite the economic crisis, the ITWM has continued to grow and was able to close out 2009 with a positive operating result. Declining income was offset by project revenues from research promotion and economic stimulus plans from the German Federal Government and the State of Rhineland-Palatinate, in particular. Many of the newly granted projects are long-term investments, so we assume that 2010 will be another successful year for the ITWM in spite of the continued economic crisis.

In this connection, success does not necessarily mean the continued growth of the institute. Our overriding goal is to increase financial profits by the end of 2011 to at least the level of 2008. This requires additional effort in the increasingly difficult awarding of industrial projects as well as strategic measures which should have a stabilising effect in the mid-term and long-term in regard to financial profits. This includes the expansion of existing business areas as well as the establishment of new business areas by broadening our spectrum of capabilities. In this context, our cooperation with the University of Kaiserslautern plays an essential role. Five new professorships in mathematics with a direct link to fields of application of the ITWM have been announced, some of which have already been filled. In addition, with the founding of the "Felix Klein Centre for Mathematics", an institutional link of research and education has been established between the Fraunhofer ITWM and the Department of Mathematics.

An additional building block in the strategic interaction with the University of Kaiserslautern is the newly founded "Innovation Centre for Applied System Modeling". This centre, promoted in equal parts by the Fraunhofer-Gesellschaft and the State of Rhineland-Palatinate, is a location in which the university's advanced, application-oriented fields of research are networked with the Fraunhofer Institutes. It combines the disciplines of mathematics/computer science and engineering in common research and development projects. In the mid-term, new business areas will arise, which will also sustainably strengthen the competitiveness of the ITWM.

In 2009 the ITWM Futures, our future themes, was started. This also represents a measure for the long-term development of new business areas. With the motto "Innovation through mathematics – mathematics for innovation", five socially and economically relevant themes have been promoted and advanced. There was already a great deal of preliminary work in these areas within the institute, but they had not been emphasised before, because the work was of an interdepartmental nature. In the process, the ITWM focus lies in the role of mathematics as a driver of innovation for:

Personalised medicine: The theme addresses the improvement of the effectiveness of therapies as well as cost savings through the use of optimized medications in the scope of a greater individualisation of therapies. In order to achieve this, as much of a patient's health-relevant data as possible – biotechnological, geometric, historical, genotype and gene expression profile – must be incorporated in connection with treatment plans. By covering patterns in such clinical data and through the modelling, simulation and optimzation of the therapy process, mathematics can make significant contributions to this field.

Robust and secure financial markets: The financial crisis in 2008 showed how susceptible the global and, consequently, the national financial markets and economies are to uncertainties. In the framework of the ITWM Futures, mathematical models and algorithms for the recognition and avoidance of risks should be developed for such processes as well as for the efficient calculation of risk indicators and key figures. This theme which plays a key role for the stability of financial markets is of the greatest importance for the personal financial management of investors. Through such processes risks can be identified at an early stage and new protection methods can be provided through more effective safeguarding.

Renewable energies: The share of renewable energies in our energy supply increases continuously. Wind, solar, hydroelectric and geothermal energies as well as the use of regenerative

raw materials will radically change the energy supply. Just as important as the environmentally-friendly generation of energy is its effective use for the provision of the desired services: Mobility, light, heat, production, maintenance. The ITWM Futures addresses the generation, storage, distribution and control of the use of renewable energies from a mathematic perspective. Those are themes which are indispensable for the mathematic modelling, simulation, prognosis and optimzation.

Vehicle technology: Modern passenger and commercial vehicles are complex systems which are produced in a large number of different model variants and are used in variegated and heterogeneous ways. With this multitude of variants and utilisations, optimzation within the development process is imperative in terms of partly competing features like driving dynamics, comfort, power and affordability. In light of continually shortened development times and cycles, the mathematical methods play a central role in the virtual product development of vehicles.

Stochastics and homogeneity in processes and materials: The fact that controlled knitting or weaving processes produce very consistent textiles is not a surprise to anyone, but the fact that turbulent, very irregularly acting currents help to produce especially homogeneous fleeces is less obvious. Concrete, fibre-reinforced plastics or foams, for example, are mixed products of which one actually only knows the probability distributions of the components, but they also exhibit a very consistent or homogeneous structure. Haphazard fluctuations can also stabilise processes and thereby produce regularity. In the ITWM Future stochastic models for production process and product behaviour should help to clarify how regularity arises from apparent haphazardness.

Our urgently needed expansion construction successfully passed all elements of the approval procedures in 2009 and we can assume that the constructions measures will be completed by the end of 2011. At this point I would like to take the opportunity to thank the Fraunhofer-Gesellschaft and the State of Rhineland-Palatinate, in particular, for making allowances for our extraordinary growth and setting the course for the expansion, even though only four years have passed since we moved into the new Fraunhofer Centre.

The ITWM appears in a whole “new” light in our 2009 annual report: at times mysterious, at times ultramodern, at times cryptic. The artists Ingo Bracke and Jochen Dewerth have installed both fleeting and enduring images in the ITWM which effectively illustrate this time in our annual report.

I wish you a stimulating and informative reading and would like to express my warmest thanks to all partners of the ITWM for the good collaboration and the trust they have placed in us.

Prof. Dr. Dieter Prätzel-Wolters
Director of ITWM

1 *Final discussion on mathematics congress*

MATHEMATICS CONGRESS AT BERLIN

With the "Mathematics in Practice" congress on March 24th in Berlin, the Fraunhofer Institutes ITWM and SCAI linked their successful activities in 2008, the Year of Mathematics. Cornelia Quennet-Thielen, State Secretary in the Federal Ministry for Education and Research, and Prof. Hans-Jörg Bullinger, President of the Fraunhofer-Gesellschaft, opened the event, where the representation of high-level members of the industrial sector also emphasised the importance of modern mathematics as a cross-sectional technology for economic and innovative power. Despite the enormous importance of mathematics for technology and society, it is often limited to a shadowy existence in the general public and in schools. In order to counteract this, many students were also invited to the convention and were given the opportunity to apply their mathematical knowledge in modelling workshops.

SIAM FELLOW

The Society for Industrial and Applied Mathematics (SIAM) selected Prof. Helmut Neunzert for its Fellows Program; with this distinction, SIAM recognised his outstanding contributions in the field of applied mathematics. He is amongst the 183 experts who were nominated during the annual meeting in Denver. The Society for Applied Mathematics was founded by mathematicians working in the industrial sector in the US in 1951 and currently has over 11,000 members worldwide: mathematicians, computer scientists, engineers, mathematics teachers and students.

BERTHOLD-PREIS

Hans Rieder and Dr. Martin Spies from the Image Processing department were honoured by the German Society for Non-destructive Testing (DGZfP) in Münster with the Berthold-Preis. With this distinction, the DGZfP honoured the years-long work of the two ITWM scientists in the development of a powerful ultrasonic process for the non-destructive testing of complex components on the example of ship propellers, which are difficult to test on the basis of their curvature and material characteristics. Hans Rieder and Martin Spies pursued an "integral approach" in the process: modelling and simulation of the testing application are only a part of the whole, which also includes the testing and the evaluation of the results. In a similar manner to that of medicinal computer tomography, the raw data can be prepared in a two- or three-dimensional image in order to recognise errors in the material or in weld seams and to prevent any material failures.

FRAUNHOFER VISION TECHNOLOGY DAY

The Fraunhofer Alliance Vision held its second Technology Day on October 8th and 9th at the Fraunhofer ITWM. Innovative technologies for industrial quality assurance with image processing play an important role in modern production processes; different processes are used depending on the task. Material characteristics of the test subject, production environment, metrological requirements – these are parameters which must be taken into consideration in the selection of the right technology. Technology Day provided an overview of potential processes and the current state of technology in short lectures. The central focus was on the inspection and characterization of surfaces, optical 3d measurement technology and object recognition, as well as various image-providing processes like X-ray, thermography, ultrasound, terahertz, microwave and shearography.

1 *Better than cinema: Science in 3d at the Technology day*

2 *The Fraunhofer-Truck*

FRAUNHOFER-TRUCK

The large lorry was a particular highlight: The Fraunhofer truck was available for two days for viewing in the centre's parking lot. On the occasion of the 60th anniversary of the Fraunhofer-Gesellschaft, the newest developments from the areas of health, environment, energy, safety and communication were presented in the spacious interior of the truck and sent on a tour of Germany. The Fraunhofer truck was especially interesting for school classes: The available tours were completely booked up within just a few days.

SELECTED LANDMARK OF IDEAS

The innovative symposium with affiliated trade exhibition "Digital Engineering for Commercial Vehicles" in the Fraunhofer Centre were first-rate. The emphasis of this symposium is the exchange of experience between researchers and users. The symposium is a component of the innovation cluster "Digital Engineering for Commercial vehicles" in which the Fraunhofer ITWM and the Fraunhofer IESE, together with the cluster partners from the industry, analyze and optimize the digital inner life of tractors, lorries and excavators. The goal of the cluster is to expand the knowledge of the high-tech experts from research and industry in step with actual practice. The two Fraunhofer Institutes also brought the digital inner life of the heavy machines closer to the public with an open day at the end of October, which was arranged coinciding with the pending ceremonial act for awarding the prize on October 28th and attracted several hundred visitors to the Fraunhofer Centre.

OPEN DOORS AT ITWM AND IESE

1 *The artist and his creation: Doug Fitch in the "Listening Chair"*

2 *Light on! Exhibition opening to Ingo Bracke´s light drawings*

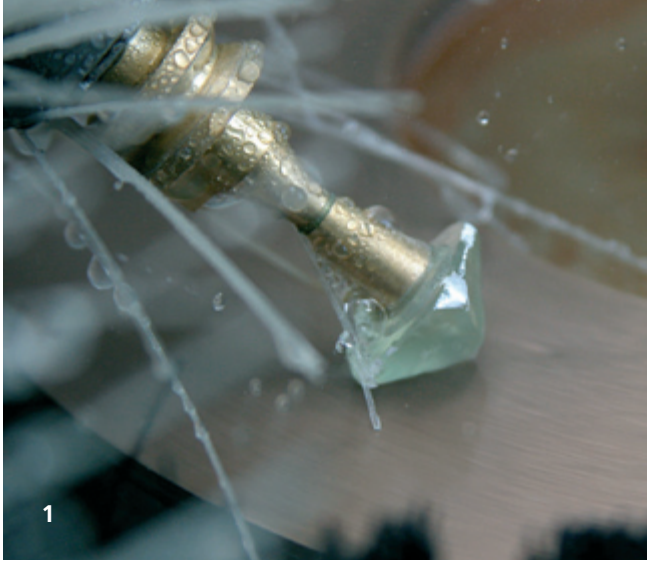
In addition to conducted tours of the buildings, films and lectures, there was a series of exhibitions in the atria of the two institutes on the open day: The ITWM came up with error search on leather, flooding simulations and the visualization of multidimensional data; the IESE opened its laboratory facility for life assistance systems and offered robotics workshops. On commercial vehicles like an agricultural machine from John Deere or a truck-mounted crane, the visitors were able to get a glimpse of the technologically elaborate inner life of such machinery. A miniature excavator also introduced visitors to excavators. The event was not without culture, either. Two sculptures from New York artist Doug Fitsch were unveiled in the ITWM. "Listening Chair" and "Library Chair", which the artist called "applied sculptures": objects which were created to be used and to additionally provide a stimulating atmosphere. Actors Hannelore Bähr and Reinhold Weiser introduced the two chairs with a scenic reading.

LIGHT INSTALLATION

For two months the light drawings of Ingo Bracke were on display on facades and in the atria of the Fraunhofer ITWM in Kaiserslautern. The architecture became the grounding and image space where the light artist cast his web of lines and in which he left traces of his writing. Observers unexpectedly saw the light images of Bracke extending and transforming into the room. To his side, in contrast as well as in congruence, was the painter Jochen Dewerth. Like Bracke's light drawings, his work emphasises written gestures which, by contrast, he developed and set up in dark rooms. The two are not unlike the macro images generated in the institute or 3d models of spongy tissues.

AWARD FOR GREEN HPC

At the opening address for the International Conference for High Performance Computing SC2009 in Portland, the Fraunhofer ITWM was awarded a special prize: the Institute's dedication to the use of environmentally-compatible computer technology was honoured with one of the HPCwire Readers' and Editors' Choice Awards. In this connection, special attention is paid to the sustainable use of high-performance computing technology. The annually awarded HPCwire Awards highlight product success and awareness level within the worldwide HPC community.



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JOSEPH-VON-FRAUNHOFER-PREIS 2009

Emeralds, rubies and the likes are referred to as colored gemstones by experts. They sparkle and shine with varying intensity, depending on the cut. A new machine can achieve the best possible cut and extract up to 30 per cent more precious stone from the raw material.

"We were astounded when our customer, Markus Wild, approached us and we were not at all certain whether mathematics could offer a solution for the very complex problem of volume optimization of gemstones," says Dr. Anton Winterfeld from the Optimization department. Jointly with his colleague Dr. Peter Klein, he received one of the 2009 Joseph von Fraunhofer prizes for the development of GemOpt, a new industrial process for the volume-optimized utilization of colored gemstones.

In contrast to diamonds, there are innumerable combinations of types and proportions of cut, and types of facet patterns for colored gemstones. When chosen correctly, the interplay of these variables ensures the luster in the stone, its shine. Sometimes just a few facets are sufficient to make a gemstone sparkle, sometimes several hundred. The task was to set limits on what seemed to be infinite and to calculate the optimal volume. The mathematical approach, which finally resulted in a solution, originated from the area of general semi-infinite optimization. This involved a new type of algorithm, which had until now only been theoretically defined. The team at the ITWM continued to develop this approach and implemented it for this specific problem. The result is an outstanding achievement, also in scientific terms. The second essential part of GemOpt is process control, which Dr. Peter Klein has worked out. For this he ascertained precisely how raw gemstones behave when processed and transferred his findings to the control unit of the machine.

The machine runs fully automatically. First of all, the raw stone is measured. On the basis of these data, the computer calculates optimal embedments, proportions and facet patterns for different basic geometries. The customer then opts for one of the proposed solutions and the machine begins cutting. The process control unit is finely balanced, so that the machine does not split the stones as it cuts them. The system then moves seamlessly on to the polishing step. The 17 axes ensure that the stone can move along any desired path. The machine cuts the facets to ten micrometers exactly – the stones are therefore perfectly geometric. A further advantage is that the machine can produce identical stones – ideal for necklaces. Cutting with the machine can result in up to 30 per cent more weight. This puts a significantly higher price on the stone.

Fraunhofer

1 *Polishing of a tsavorit*

2 *The laureats: Dr. Anton Winterfeld and Dr. Peter Klein*

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INSTITUTE PROFILE

Computer simulations are an indispensable tool in the design and optimzation 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 competences 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

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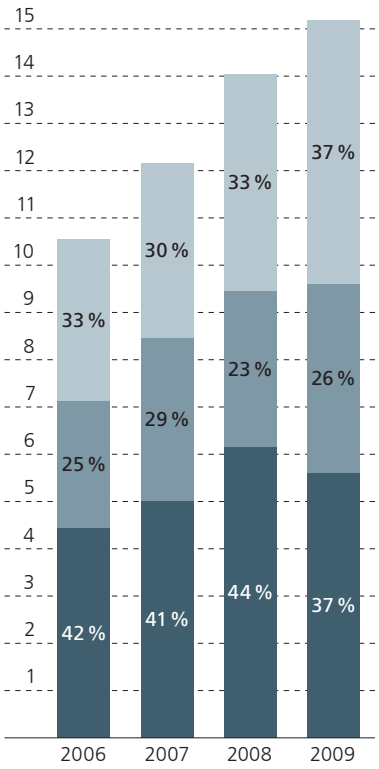
Manuela Hoffmann, Prof. Dr. Ralf Korn, Katharina Parusel, Markus Pfeffer, Brigitte Williard, Michaela Grimberg-Mang, Anja Nitschky, Prof. Dr. Helmut Neunzert, Prof. Dr. Dieter Prätzel-Wolters, Dr. Marion Schulz-Reese, Prof. Dr. Axel Klar, Prof. Dr. Stefan Nickel

BUDGET

Operating budget development in million €

- industry
- public projects
- base funding and Fraunhofer-internal programs



Naturally, the worldwide economic crisis has also left its mark on the ITWM. Industrial revenues fell by nine per cent in comparison with the fiscal year 2008, but they were still far above the figures from 2007. In the sectors of motor vehicles and machinery construction, in particular, a fairly significant decline in orders was recorded in 2009. Altogether, however, the ITWM benefited again from its widely diversified commercial sectors, so that deficits in industries which were shaken by the crisis could be compensated for by new orders in other sectors. The fact that the high percentage of financial profits from orders from foreign companies could be sustained in 2008 and 2009 was especially promising.

In the meantime, it is also worth noting that over 47 per cent of industrial profits came from small and medium-sized companies. However, 2010 will reveal whether the ITWM can master the crisis situation in the mid-term. In comparison with many other Institutes of the Fraunhofer-Gesellschaft, the ITWM was far above the average with an industrial profits share of 37 per cent based on the 2009 operating budget.

Therefore, on the whole, the year can be considered a very successful one for the ITWM. The operating budget increased by an additional eight per cent in 2009 and the fall in industrial profits was more than compensated for by the increase in profits in the public sector. In comparison with 2008, profits from public projects increased by more than 30 per cent. The hope is that the results achieved in these projects will affect an increase in industrial profits in the mid-term.

As before, the ITWM remains a sought-after cooperation partner for other Fraunhofer institutes, and as a result, an additional increase of subsidies from internal programs was recorded in 2009. In spite of everything, the ITWM looks optimistically to the future and attempts to remain competitive in order to maintain its successful market position by expanding

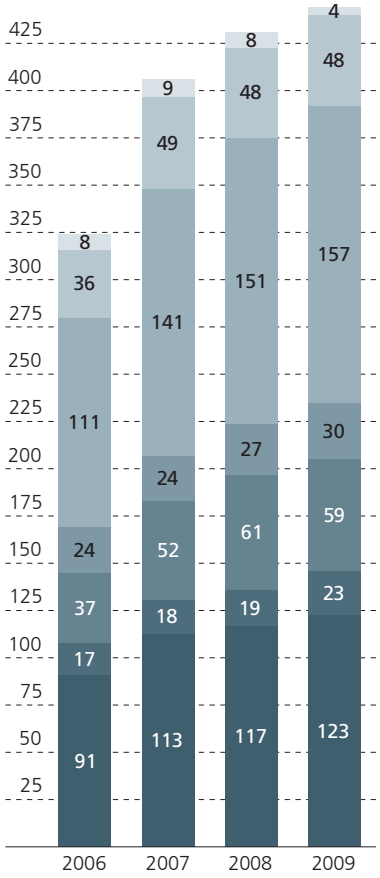
into new fields of expertise and intensification of mathematical research in promising application areas.

Budget development*	2006	2007	2008	2009
Operating budget	10550	12163	14035	15170
Investments	332	1720	383	894
Total	**10882**	**13883**	**14418**	**16064**

*thousand €

PERSONNEL DEVELOPMENT

In consideration of the economic crisis, personnel development in the ITWM was approached more cautiously than in recent years in at least a few departments. On the whole, a growth of over eight per cent was recorded in the personnel department. Twelve new employees were hired in the ITWM in 2009 and six resigned. The high number of 59 postgraduates is a further indication of the attractiveness and the level of scientific excellence of the ITWM. Additional strategic alliances with the University of Kaiserslautern which were established in 2009, should further intensify the development of new staff. It should also be mentioned at this point that 12.8 million Euros were raised from Fraunhofer and the State of Rhineland-Palatinate for the "Kaiserslautern Innovation Centre for Applied System Modeling". The centre, commonly built with IESE, was officially opened in January 2010 and initially set up for four years. Common strategies and projects should be advanced more efficiently in the innovation centre, which should ultimately contribute to the establishment of new commercial sectors in the innovative areas of applied mathematics and computer science. With the new innovation centre, mathematics and computer science contribute to the further strengthening of the overall profile of Kaiserslautern.



COSTUMERS AND COOPERATION PARTNERS

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- Adam Opel AG, Rüsselsheim und Kaiserslautern
- Albany International, Saint-Junien (F)
- Assenagon GmbH, München
- AUDI AG, Ingolstadt
- Ballard Corporation, Burnaby (CDN)
- BASF SE, Ludwigshafen
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FRAUNHOFER GROUP INFORMATION AND TECHNOLOGY

Shorter innovation cycles have turned IT knowledge into a perishable commodity. The Fraunhofer Information and Communication Technology Group (ICT) provides support in the form of customized solutions, consulting, and contract research for new products and services. The Fraunhofer ICT Group comprises 14 institutes as full members (among them also the Fraunhofer ITWM) and three associated members, representing a workforce of roughly 3000 employees and a yearly budget of approximately 175 Million Euros. Its central office in Berlin serves as a one-stop shop, referring customers to the appropriate contacts.

The complementary focal fields of the participating institutes cover the entire value chain of the ICT industry. The business areas are:

- Medicine
- Automotive
- Production
- Digital Media
- Energy and Sustainability
- Financial Services
- Security
- E-business
- E-government
- Information and communication technologies

The Fraunhofer-Gesellschaft is the largest organization of applied research in Europe. As a non-profit organization, it currently maintains approximately 80 research units – including 59 institutes – at more than 40 locations throughout Germany. A staff of approximately 17,000 employees – mainly qualified scientists or engineers – works for the annual research budget of 1,6 billion Euros. More than half of industrial profits stem from projects with small and medium-sized enterprises. The Fraunhofer-Gesellschaft deals with research and development projects ordered by economy, the state, and the public sector. International cooperation is supported by Liaison Offices in the USA and in Asia.

Research Topics of the Fraunhofer-Gesellschaft

- Adaptronics
- Construction Technology
- Energy
- Information and Communication Technology
- Medical Engineering, Environmental and Health Research
- Microelectronics
- Nanotechnology
- Surface Technology and Photonics
- Production
- Traffic Engineering and Logistics
- Defense and Security
- Materials and Components

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TRANSPORT PROCESSES

- FLEXIBLE STRUCTURES
- FLOW
- GRID-FREE METHODS
- HEAT, DIFFUSION, RADIATION
- MODEL REDUCTION

Head of Department
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The work of the department Transport Processes is characterized by the mathematical modeling of complex technical/natural-scientific problems and the development of efficient algorithms for their numerical solution. From a mathematical point of view, the respective problems from areas such as fluid dynamics, radiative transfer, acoustics, and structural mechanics are based on partial differential equations. From the clients' point of view, problems comprise the optimization of products, the technical design of production processes, or simulation based measurement methods. The past year was initially characterized by the signs of the economic crisis. In the second half, however, there was an enormous upturn in contract research. The department looks to the coming year with great optimism.

The field "Flexible Structures" deals with the software tool FIDYST (Fiber Dynamics Simulation Tool), thus being especially attractive for clients producing technical textiles or engineering the respective machines. However, new tasks also arise as a result of these activities, such as the subsequent, elaborately represented optimisation of needle patterns in the production of nonwovens.

Within the field "Flow", we offer the development of optimal fluid-dynamical solutions of our customers' problems; a large part of these currently come from the area of mechanical engineering. We work on technical improvements on the basis of fluid-dynamical computations (for example applying software tools such as FLUENT), as well as on optimal mathematical solutions, usually for appropriately simplified models.

With FPM (Finite Pointset Method), the group "Grid-Free Methods" has developed its own solver for a wide range of continuum mechanical problems, particularly focused on the area of fluid dynamics. FPM is a grid-free method and as such perfectly adapted for the solution of problems with a flow area changing in time (multiphase flows, free surfaces). The software is meanwhile being sold by the company NOGRID GmbH. From the spectrum of work in the past year, we present the simulation of machinable production processes.

The field "Heat, Diffusion, Radiation" has its roots in projects with respect to the cooling of glass by thermal radiation and heat conduction. These have always been accompanied by projects in the field of parameter identification, mostly in the surroundings of glass industry, which have essentially contributed to the development of mathematical competences. As a new, strategic, far-reaching theme for the entire department, the design of freeform lenses is being pursued. Here, a completely new algorithmic approach was developed, which is far superior to existing solutions.

The central objective of our research work in the field "Model Reduction" is the development of a MATLAB® toolbox for the model reduction of large multiphysics FE systems. The special feature of this toolbox is its capability for parametric model reduction. Besides, the group is also working on the further development of an audio-visual VR system, by which the acoustic situation of rooms (buildings, machine halls, and vehicles) can already be experienced during the planning phase..

DESIGN OF FREEFORM LENSES

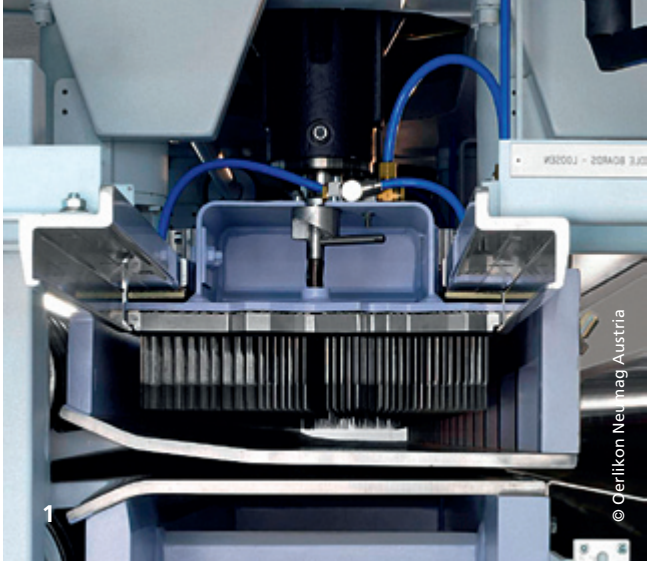
Christian Leithäuser, Sabine Repke, Dr. Robert Feßler, Dr. Jörg Kuhnert, Dr. Raimund Wegener, Maike Lorenz, Dr. Matthias Schäfer, Jan Marburger, Simon Schröder, Dr. Martin Hering-Bertram

Dr. Jevgenijs Jegorovs, Dr. Norbert Siedow, Oliver Tse, Walter Arne, Dr. Ferdinand Olawsky, Dr. Simone Gramsch, Johannes Maringer, Sergey Antonov, Dr. Dietmar Hietel, Dr. Jan Mohring

With freeform optics, surfaces can be illuminated according to individual parameters. On the basis of the desired light distribution on the screen and a given light source, the light rays on the freeform surface are broken or reflected in such a way that the desired image appears on the screen. Since no additional elements are required for dimming or projecting and only the area which really should be illuminated actually is illuminated, freeform optics achieve an energetically optimal performance in a compact design.

Freeform optics can be used in a variety of ways. In optical measurement technology freeform lenses can be used for the creation of striped patterns which are necessary for the measurement of three-dimensional objects. Unlike currently used DOEs, which generate undesired inhomogeneities (speckle) based on interference, freeform lenses provide fully homogeneously illuminated lines. In image processing, freeform optics can be used for homogeneous illumination of surfaces which could otherwise only be seen from an extremely unfavourable angle. The area with the largest application potential for freeform optics is general lighting with LED light sources. The advantages of LED can only be utilised in an economically optimal manner if they are combined with freeform optics in order to only provide light where it is really needed. At an art exhibition a painting should be illuminated and not a large section of the wall it is hanging on; a street lamp should homogeneously illuminate the street, but not the nearby houses. In the automotive sector the electric car is a part of the future; in order to consume as little energy as possible, LEDs are also used in this application. In combination with freeform optics, the dimmed headlights, for example, can also bring light to the street loss-free without dimming technology.

In recent years the ITWM has developed an algorithm for the design of freeform optics and implemented it in software with which it is possible to calculate freeforms in only a few seconds. If design was the time-intensive part of the production of freeform optics in the past, today it is the production itself. As a result, the Fraunhofer ITWM has combined its efforts with the Fraunhofer Institute for Production Technology and the Fraunhofer Institute for Applied Optics and Precision Engineering in the economically strategic FREEFORM alliance in order to promote the breakthrough of complex freeform optics in medium-sized industry on the basis of the special competences of the three institutes. The vision of the WISA FREEFORM is to design, produce and measure individual freeform optics within 30 minutes.



OPTIMIZATION OF NEEDLE PATTERNS IN THE PRODUCTION OF NONWOVENS

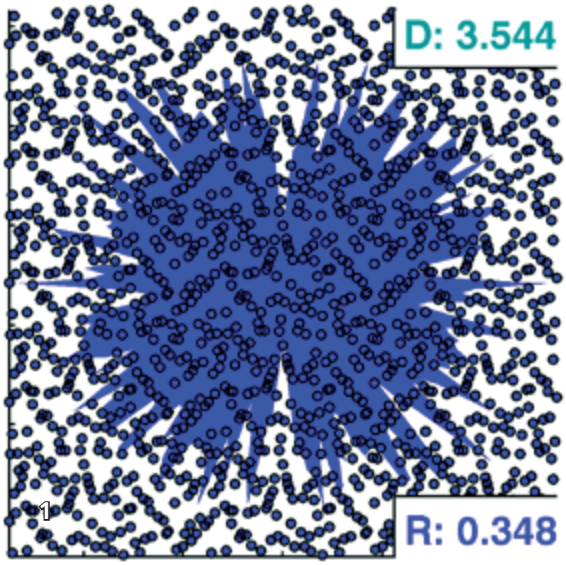
1 *Needle machine of Oerlikon Neumag Austria*

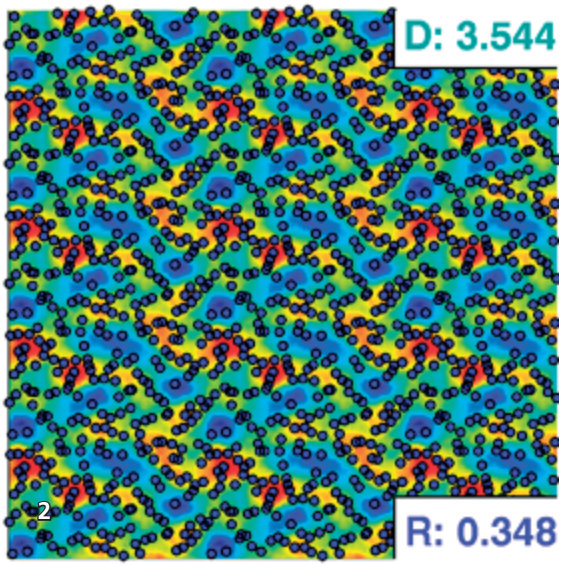
Needle punching is a well-established method to bond nonwovens mechanically. The needle punching process is based on the needles penetrating into the material with barbs perpendicular to the nonwoven surface. In the process, a part of the fibres in the nonwoven material is reoriented to the direction of the needle punch so that an interlocking of the fibres occurs. The qualities of the nonwoven are heavily dependent on the line layout and the process parameters: Number of needles per linear metre, stroke frequency or feed per stroke, belt speed and working widths.

An important production characteristic is the penetration density, which is defined as the number of punches per area square of the felt. Homogeneous penetration densities are desirable, because they determine the strength and strain characteristics of the nonwoven. By contrast, stripes or patterns on the material surface should be avoided. In close collaboration with Oerlikon Neumag Austria, the Fraunhofer ITWM has developed a software tool to simulate the needle punch pattern and optimise the positions of the needles in the board according to specified process settings.

The simulation of the needle punch pattern in the nonwoven can be easily described. The coordinates of every needle in the needle board are known in the machine and cross machine direction. Without draft they are transferred directly to the punches in the nonwoven fabric. Hereby, the feed per stroke in the machine direction is multiplied by the sum of the corresponding number of strokes. Since the material shrinks from the needle punching and is also warped in the machine direction as a result of the transport by rolls, the ITWM has enhanced this simple description through the inclusion of a draft model for the realistic simulation of the needle pattern and has implemented it in a software tool. A comparison of the needle punch patterns in the nonwoven simulated with draft to the punched nonwoven fabrics of Oerlikon Neumag Austria showed a very high level of congruence.

On the basis of the innovative enhancement of the simulation of needle punch patterns with a realistic draft model, needle boards can be evaluated and compared for different process conditions, particularly for various working points of the feed per stroke. The ITWM has developed multiple evaluation criteria for this purpose, which reproduce the perceptions of the human eye and thereby reproduce the subjective evaluation of the needle pattern in quantifiable sizes. Of particular importance is the criterion density distribution, which determines the homogeneity of the needle punching, and the evaluation criterion of the directional distribution, which serves for the analysis of stripes in the punch pattern. These two methods form the basis for





the automated optimisation of existing needle patterns and for the automatic construction of new needle boards with customer-specific requirements. Additional methods for the evaluation of the needle punch patterns originate from statistics and Fourier analysis.

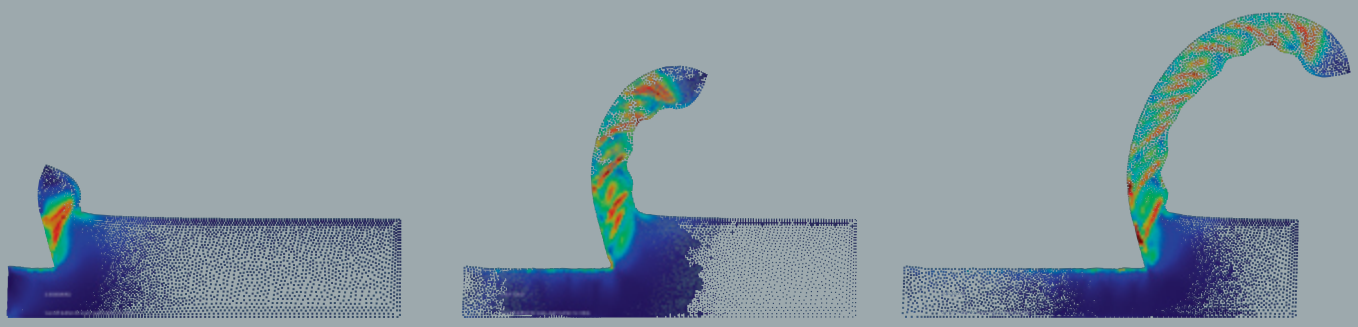
The earlier procedure for the construction of needle boards consists of the manual positioning of needles on the board. In the process, the experience of the design engineer plays an important role in the development of the needle arrangement. With the simulation of needle punch patterns and the implementation of evaluation criteria, the manual construction of needle patterns can be supported to a considerable extent. The evaluation methods provide the design engineer with information about the zones in the nonwoven fabric exhibiting inconsistent penetration densities or markings. In addition, the simulation tool provides the possibility of identifying any such needles which cause these problems through a so-called inverse search. In doing so, the design engineer is supported in the decision as to which needles require repositioning on the needle board in order to attain a better punch pattern. Naturally, this concept can be generalised and expanded in order to design a needle board under full automation. In the process, needles are successively placed on the board in adherence to the construction conditions, such as the hole diameter or web thickness. In doing so, each new needle is added in such a way that the produced nonwoven fabric has optimal characteristics. The quality of a needle position is always determined by the evaluation criteria mentioned above.

This approach provides us with the opportunity not only to evaluate one simulated needle punch pattern but also several needle punch patterns with varying process parameters (e. g. for various feeds per stroke or drafts). Combining these measures of quality offers the advantage of constructing needle boards that produce a good needle punch pattern for multiple working points.

The successful development of simulation-based evaluation criteria for needle punching as a basis for automated needle board construction as well as their implementation as software with an operator-friendly user interface now enables Oerlikon Neumag Austria to develop needle patterns with customer-specific process parameters and with improved nonwoven characteristics in shorter times than in the past.

1 *Needle-punched nonwoven fabric section: Directional distribution*

2 *Needle-punched nonwoven fabric section: Density distribution*



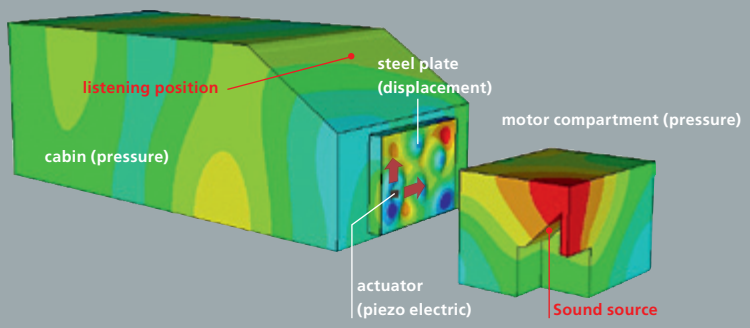
1

FPM – GRID-FREE SIMULATION OF MACHINABLE PRODUCTION PROCESSES

1 *Chip formation on a nickel-based alloyed steel (contours of plastic deformation)*

The Finite Pointset Method (FPM) is a numerical simulation method which has been developed at the ITWM for ten years now. FPM allows for a very efficient solution of compressible and incompressible flow problems. The method is particularly attractive because it is grid-free, thus enabling the user to get high-quality computation results without requiring an FE grid, only on the basis of an easy to handle numerical point cloud. Especially essential is the formulation of the method in the form of a Lagrange method, i. e. the point cloud moves with the flow, thus transporting physical information in a natural way. The complete waiver of a grid reduces the effort of the user essentially to the formulation of sensible physical initial and boundary conditions. FPM can be applied in a particularly efficient way to flows with free surfaces and multiphase flows, the Lagrange approach resulting in the correct description of the free surfaces' dynamics, without any additional algorithmic effort.

The inclusion of material laws into the FPM methodology is an important element. For example, if FPM is applied to classical flow problems, Newtonian material behaviour, which is described by a linear dependence of the viscous forces of the shear rate, is normally presupposed. For real materials the Newtonian approach is often insufficient. In addition to the viscous forces, solid body stresses and strains which reflect the elastic and plastic material behaviour also arise. Metallic materials, for example, distinguish themselves through their yield behaviour. When the yield stress is exceeded, the material begins to flow locally. The flowing represents a mixture of viscous, elastic and plastic processes. The FPM developments are currently concerned with the integration of descriptions of metallic materials. The focus lies on material models according to Johnson-Cook and Zerilli-Armstrong. The goal is the simulation of chip formation processes. Due to efficiency purposes this is relevant to run the highest possible machining speeds in industrial production. That means technological problems which appear to be solvable only with great difficulty when not using the simulation approach. Some of the advantages of FPM can be fully revealed in machining: the machining process exhibits dynamically free surfaces, the grid-free approach enables the discretising of the problem in a natural way, and the numerical solution does not depend on the grid topology. In addition, the influence of coolants can be optimally integrated into the model. On the on hand, the workpiece, tool and coolant form different phases interacting by impulse and energy exchange. But on the other hand they differ only by different material characteristics and therefore their interaction easily can by modelled in FPM.



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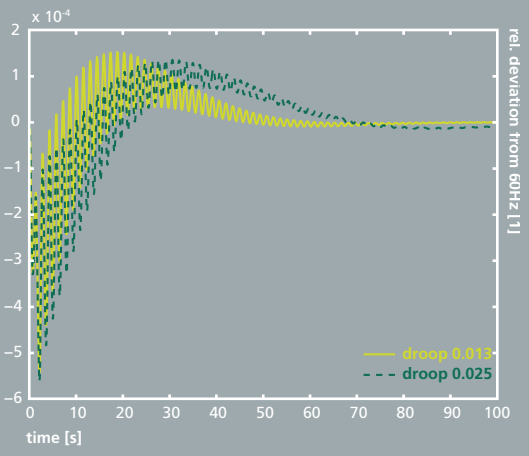

2

PARAMETRIC MODEL REDUCTION

In the simulation-supported design of machines or systems, one has to consider multiple levels of detail for different physical effects from structural mechanics, acoustics, thermal transport or electronics. In order to simulate an electric circuit or a mechanical gear, engineers normally go back to commercial programs like PSpice or SIMPACK®. They describe a system by differential-algebraic equations (DAE) with individual components requiring typically less than 100 degrees of freedom. On the other hand, in order to predict how changes of geometry of material characteristics affect a component, a description by partial differential equations is unavoidable. The resulting Finite Element Models often include several hundred thousand degrees of freedom. In order to describe the embedded system, the large FE models must, therefore, be replaced by small DAE systems with as similar an input/output behaviour as possible, but with much fewer state variables. For important design tasks like geometry optimisation and sensitivity analysis or the identification of model parameters from measurements, these reduced models must also be parametric. In particular, it must be possible to create reduced models for new parameter sets without generating and reducing FE-models from scratch.

For this purpose, a new approach to parametric reduction, Matrix Matching, was developed at the ITWM and incorporated into the Fraunhofer Model Reduction Toolbox (MRT). It solves many problems where conventional methods fail: In geometry optimization, for example, interpolation can take place between reduced systems whose original FE models are meshed differently. An additional outstanding feature of the Matlab® toolbox, which was originally developed for the import and reduction of ANSYS® models, is a flexible library of problem-adapted reduction methods comprising modal, moment and singular value based approaches. In particular, FE models which arise from fluid-structure or structure-heat coupling and are characterized by asymmetric matrices, non-proportional damping or many input channels can be embraced. In the meantime there is also an interface for the analysis tool PSAT for power supply systems and models which are derived from measurements rather than numeric models can also be interpolated.

The work was embedded in a large industrial project, the Marie Curie Network Smart Structures, a cooperation with Fraunhofer LBF and the BMBF project NetMod.

1 *Optimal positioning of a Piezo patch for active noise reduction on the basis of a parametrically reduced multiple field model*

2 *Sensitivity analysis for an electrical transport network using a parametrically reduced model; frequency fluctuation at Generator 3 through fault at Bus 12*

FLOW AND MATERIAL SIMULATION

- MICROSTRUCTURE SIMULATION AND VIRTUAL MATERIAL DESIGN
- HYDRODYNAMICS
- COMPLEX FLUIDS
- MECHANICS OF MATERIALS

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The department works on multi-scale modelling and development of efficient and robust simulation methods and software tools for a virtual material design integrated into the product development. In the product and process design the understanding and the consideration of local structural property-relationships of the fluids and materials on which they are based are crucial in many applications. The development, preparation and specific application of industrially suitable multi-scale and multi-physics methods distinguishes the unique position of the department. In every regard 2009 was the most successful year since the founding of the department ten years ago and has led to considerable personnel growth. Contrary to the general economic trend, projects and cooperations with industry are being expanded significantly and resulting in an additional increase of income, both in percentage and absolute terms. The broad networking in knowledge was advanced through the expansion of the interdisciplinary cooperation at the research hub Kaiserslautern as well as through international cooperations.

With our GeoDict software, which is currently used by many customers and is distributed internationally, all essential heterogeneous material structures such as packed beds non-woven fabrics, textile fabrics and composite materials can be generated and combined in true-to-life parameters. In addition, structural property-relationships of porous materials and composite or hybrid materials can be quickly and efficiently calculated with different modules (permeability, filter efficiency, diffusion coefficients, thermal conductivity, elasticity properties). In addition to the broad material-scientific applications, there are special tools for the design of filter media, fuel cells and press felts for paper machines.

The developments in the field of hydrodynamics are concentrated on efficient numerical methods and software for flow simulation and upscaling methods to master local phenomena. The enhancements of our filter design software SuFiS were continued through a long-term cooperation with IBS Filtran. The correct prediction of local particle concentrations is numerically challenging for both the filtration of dirt particles and the design of separation systems by means of field flow fractionation. For floading simulation we are developing CoPool, a special software solution for the evaluation of overflow malfunctions in nuclear reactors, along with RisoSim for the risk management of the overflow safety of sewer systems.

The simulation of material mixtures, granulates, fibre or particle suspensions all the way to solid body behaviour can be realised through appropriate modelling of the structural change effects between the fluids and particles and adequate numerical methods for continuum mechanics. All processes involve dense suspension flows where physical effects must be taken into consideration in addition to the complex rheology. In the CoRheoS software platform multi-physical phenomena can be easily combined and expanded. The transport and mixture of powders and granulates as well as powder injection moulding processes are current simulation applications, as is the production of fibre-reinforced plastics and concrete components.

An additional emphasis is the thermo-mechanical and acoustic design of complex composites and porous materials in their specific application behaviour. The efficient handling of multiscale models is based on the robust, adaptive 3d grid generation algorithm for large volume data (TopMesh), efficient, non-linear finite element implementations (FeelMath) and gradient-based topology optimization method (TopLevel). Along with questions of material design, such as the development and dimensioning of innovative door materials, projects usually involve multifunctional design questions in comprehensive cooperations i. e. thermo-mechanical properties of wheel steel structures, deformation behaviour of filter media and filter bags, biomechanical behaviour of tissues and implants.

DEVELOPMENT OF NEW MATERIALS FOR DOORS AND PORTALS

In the selection of door materials, multiple criteria must be evaluated in a manner similar to that of other industries, such as motor vehicle construction. Additionally, the layer construction of door leaves for special applications must be evaluated. In the process, the great advantage of simulation techniques over measurement and testing processes is the fact that evaluation is possible without the production of prototypes. In the scope of the project, simulation techniques and evaluation methods were specially developed for the selection of door materials which can be used for the dimensioning and optimisation of doors in regard to thermal insulation, fire protection properties and break-in resistance.

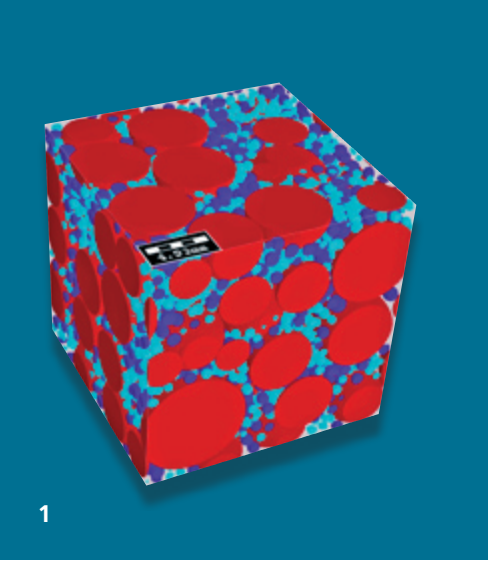
The starting point of the optimisation was the grouping of country-specific requirements in a criteria catalogue. Along with standards like the German Energy Saving Ordinance (EnEV), these requirements also include trade barriers such as import duties in countries outside of Europe. Finally, a corresponding performance and requirement catalogue for the material requirements was created, which enabled the creation of a problem-adapted material data base with new and conventional door materials.

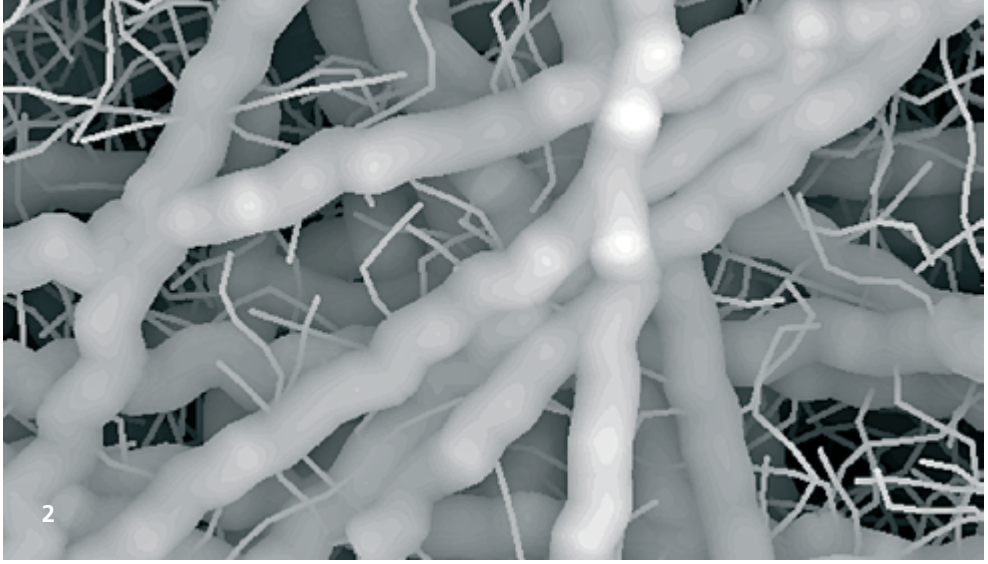
By using the developed simulation techniques, the properties of new and conventional materials could be evaluated and compared very quickly. In doing so, it was revealed that innovative materials (insulators, fire protection materials, fibre-reinforced plastics, composite boards) have great potential in regard to the manufacture of innovative doors.

In order to also prepare the company Biffar for changing requirements and new markets, it was provided with software tools developed at the Fraunhofer ITWM and its employees were trained in its use. A software tool which is now in use automatically calculates the heat transfer coefficient of the door in accordance with DIN EN ISO 6949 on the basis of the door design (door height, width, frame) and the construction of the door leaf. In this manner it can be ensured that the current requirements on thermal insulation are already fulfilled during the design process.

Kilian Schmidt, Dr. Ralf Kirsch, Konrad Bartkowski, Dr. Jochen Zausch, Dr. Sebastian Schmidt, Dr. Katrin Roberts, Dr. Jürgen Becker, Xingxing Zhang, Marco Buck, Priv.-Doz. Dr. Heiko Andrä, Dr. Liping Cheng, Dr. Erik Glatt, Dr. Andreas Wiegmann

Ulrich Egger, Cornelia Tillmanns, Dr. Aivars Zemitis, Dr. Zahra Lakdawala, Dr. Uldis Strautins, Dr. Dariusz Niedziela, Priv.-Doz. Dr. Arnulf Latz, Clement Zemerli, Dr. Konrad Steiner, Dr. Stephan Rief, Dr. Matthias Kabel, Inga Shklyar, Tobias Zangmeister, Iuliana Matei





MICROSTRUCTURE SIMULATION OF PAPERS AND DENSE SPHERE PACKINGS

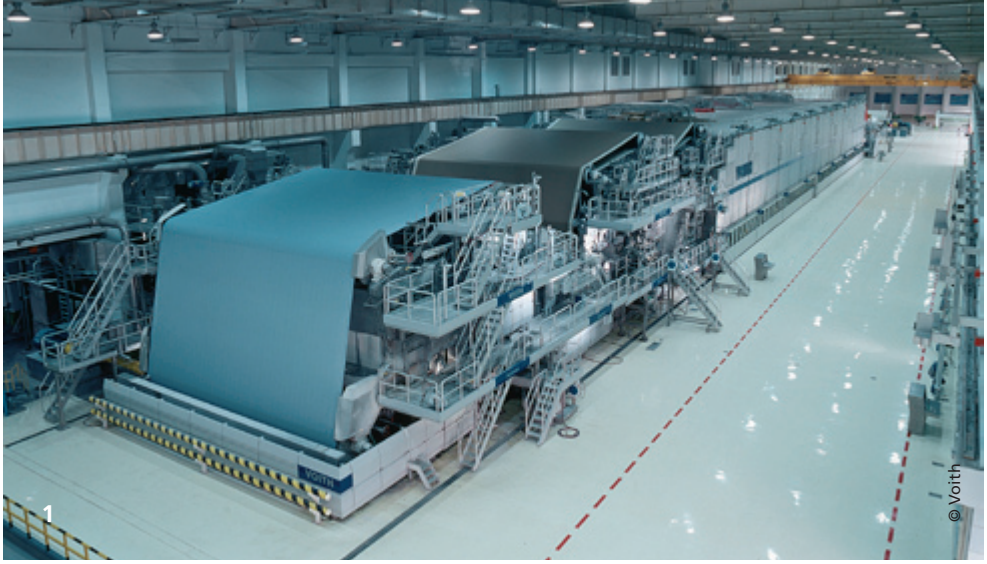
1 *Three-dimensional visualization of sphere packing*

2 *Visualization of virtual paper CT as vREM*

Properties of existing materials can be described by theories, measured by experiments or characterized by simulations on computer tomographical 3d images (CTs). For new materials, the applicability of theories is sometimes questionable and the development through experiments on prototypes is laborious and expensive. Therefore, there is a great interest in developing new materials by means of computer simulations. For this virtual material design a realistic structure model is required, where the variations one wants to investigate, are described only by a few parameters. These models can be converted to virtual CTs (vCTs).

In addition to the models for synthetic fibres and sintered structures, in the past year the model for sphere packings was improved and a new model for paper fibres was developed. One of the difficulties with sphere packings is the great variation in sphere sizes. On the one hand these variations are intentionally used for the material design, one example are construction materials. On the other hand they occur in real media like the fill material of dams or in natural soil. As a result of these variations, given size distributions can only be realized with very large numbers of spheres. To maintain high packing densities for these large numbers of spheres, meaning solid volume fractions of over 60 per cent, unacceptably long computing times were required in the past. With improved algorithms, these times have been reduced to a few hours for realistic examples. The model for paper fibres was developed, because the existing model of straight fibres with a constant cross-section was not sufficient to model real cellulose fibre media. Paper fibres have great fluctuations in fibre width, irregularities in cross-section form and local bends, which can be precisely reproduced in the new model. Cellulose fibre media with high density have only become possible through a change of the structure-generating mechanism.

For all vCTS, whether it involves sphere packings, cellulose fibres or other materials, the properties resulting from the geometry are important. Since real CTs and vCTs can be treated identically by a computer program, comparing all calculated properties with one another is no problem at all. The uniform representation as vCTs also enables all properties to be calculated for all material types. All structures and properties can be simulated with the GeoDict software. Thereby all calculations can also be performed by our partners.



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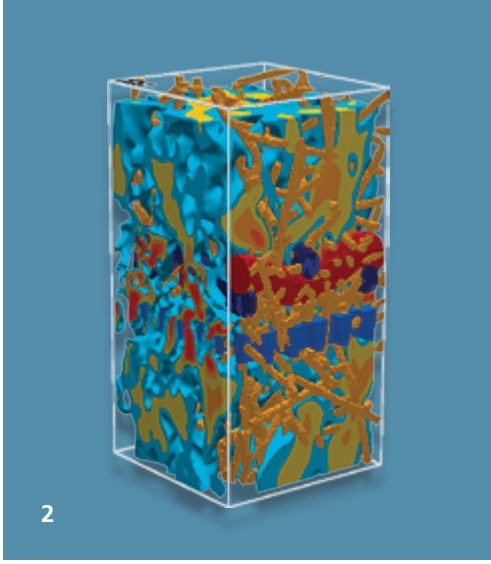


2

ANALYSIS AND OPTIMIZATION OF PAPER MACHINE CLOTHINGS

The basic principles of the paper manufacturing process are the same today as they were almost 500 years ago. The only difference is that forming, pressing and drying are optimized and fast processes within modern paper machines. Starting with a fibrous suspension (1 per cent dry solids content), the emerging paper web is transported through the paper machine on clothings at a speed of up to 2,000 m/min (120 km/h). Along with the transport of the paper web, these mostly textile structures also have the important task of supporting the dewatering of the paper.

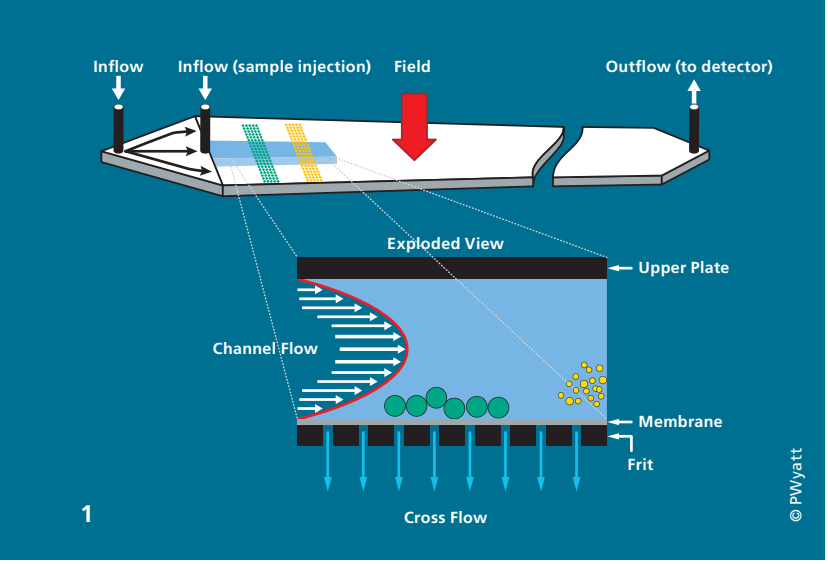
In close collaboration with the company Voith Paper Fabric and Roll Systems, the behaviour of press felts is analyzed and simulated at the Fraunhofer ITWM. This type of clothing is an essential component of the mechanical dewatering within the press section of the paper machine. The optimised dewatering within the press reduces the use of thermal energy in the drying section, which considerably reduces energy costs and the impact on the environment.

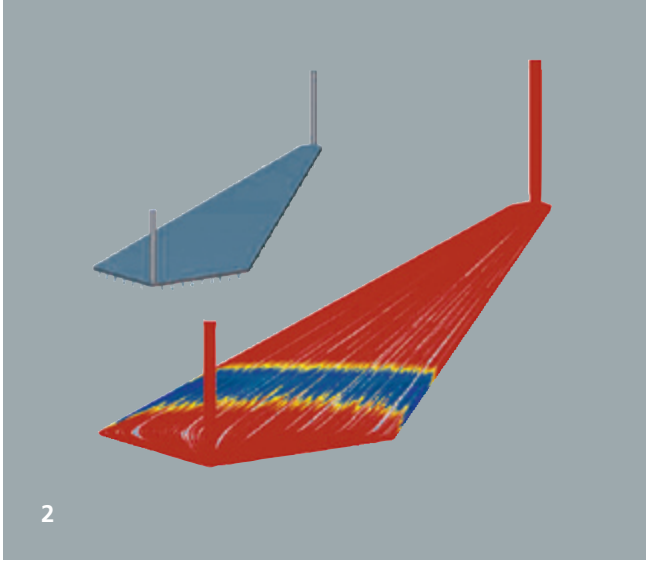
The mechanical dewatering is a complex fluid dynamical process which is influenced by effects ranging from the micro-scale (textile structure) to the macro-scale (press rollers with up to 1 m diameter). Accordingly, the analysis is also done by a multi-scale simulation. The starting point on the micro-scale analysis is a flow simulation by means of the GeoDict software developed at the Fraunhofer ITWM. In the persued approach, GeoDict provides the capability of analysing both real and virtually created press felt structures.

By means of the NipDict software a multitude of machine parameters can be combined on the macro scale with the data acquired from the micro-simulation. In addition to the dewatering performance, this simulation also provides better insight into the dynamics of mechanical dewatering in order to support new developments. Along with the analysis of existing press felts and paper machines, the simulation also provides the capability of testing innovations in the early stage of development. In doing so, the artificial generation of virtual and innovative structures with the corresponding dewatering simulation guarantees a technological advantage.

1 *The paper web is dewatered step by step in the different sections of a paper machine. Modern clothings guarante optimal performance.*

2 *Simulation of fluid flow through a virtual press felt; the press felt is composed of a fibre layer (yellow), a woven (dark red and dark blue) and a membrane (blue). In the membrane and the woven layer the higher flow speeds (red) brought about by the lower porosity can be seen clearly.*





ASYMMETRICAL FLOW FIELD-FLOW FRACTIONATION

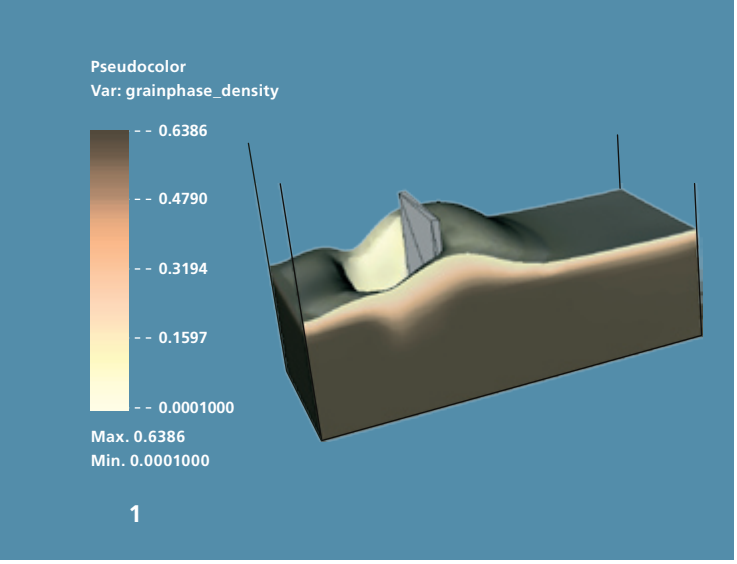
1 A sketch of the device and the separation process can be viewed on the picture

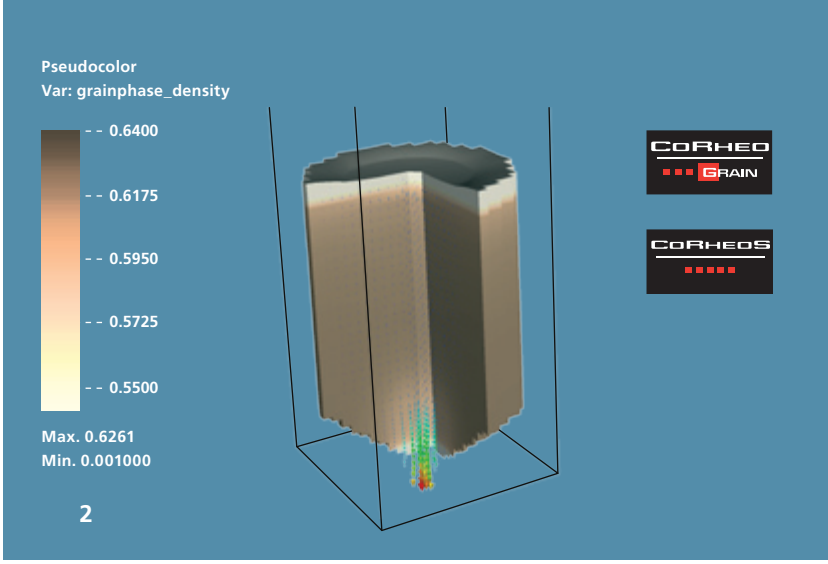
2 The figure illustrates a computational domain together with patchlines obtained in one of the simulations.

Asymmetrical Flow Field-Flow Fractionation, AFFFF, is simple and robust approach for separation of nano- and micron- size particles in solutions and dispersions. The technology is well developed and widely used by large and by small pharmaceutical companies. A leading product in this area is ECLIPSE from Wyatt Technology Europe GmbH. The design of ECLIPSE is based on careful analytical study of fluid flow and of separation in a microchannel.

Further improvement in the performance of the devices can be achieved via mathematical modeling and computer simulation. Three dimensional flow simulations allow for obtaining a detailed view on the flow within the spacer, as well as on the particles transport there. Compared to the analytical considerations, the CFD (Computational Fluid Dynamics) simulations provide more detailed information in the case of complicated geometry. This information supplements the analytical considerations in optimizing the flow regimes and in further improving the design and the performance of the device. In particular, simulations with different size and/or location of the injection pipe allow to study the influence of these parameters on the focusing area. Another important parameter influencing the focusing zone is the flow rate distribution between the two inlets in the case of injection through a separate pipe. In this case the CFD simulations allow for observing the location of the focusing zone for each reasonable flow rate distribution for any selected shape and size of the spacer. The size and the shape of the focusing area influences significantly the particles separation during the elution stage, and therefore its study is useful for further improvement of the design of the fractionation device. CFD simulations allow for evaluation and pre-selection of designs, without building expensive prototypes.

CFD simulations allow to study not only the focusing zone, but also the time history of the fractionation during the elution stage. In this way, an optimized flow control at the inflow during the elution stage can be selected.





SIMULATION METHODS FOR GRANULAR FLOWS: CORHEOGRAIN

Flowing granular materials are the basis of many industrial processes. Because of their complex physical properties, they place high demands on the simulation, that is to say the modelling and numerical solution. The difficulties in the modelling arise from the necessity to integrate physical effects like stagnation and a maximum packing density into a hydrodynamic model. The numerical difficulties arise from the complexity and non-linearity of a model of this type.

The Complex Fluids Group has developed such a model and demonstrated its industrial applicability in the scope of several successful projects. Different non-linear, finite volume methods were developed for the numerical solution. Modelling and numerical methods are implemented in the CoRheoGrain software – a module of the CoRheoS software platform. From the reading of arbitrary geometries to the visualisations, CoRheoGrain is able to cover the simulation of granular flows. An important advantage of CoRheoGrain in comparison to particle-based methods like DEM is the treatment of the granular material as a continuum. This enables the simulation of both slow and fast granular processes with industrially-relevant material volumes and realistic particle sizes of different granulates and powders in the customary CFD context with similar computation times. The microscopic interaction of particles becomes part of the continuum modelling here. In addition, the parallelisability of CFD processes can be achieved very effectively and is intensively investigated. These results can be applied directly to the method in CoRheoGrain for the further reduction of simulation times.

In the past year the application field for CoRheoGrain was greatly expanded once again by the interaction of moving components with granular media. Building on the initial success of promising testing (Figure 1), an industrial project for the simulation of mixing machines with rapidly moving components was successfully completed. In doing so, enhancements arose for the simulation of the flow behaviour in silos. Inserts are often used for the improvement or the control of the flow behaviour. For example, the CoRheoGrain software can play an important role in the optimisation of the type and position of such components. In Figure 2 a simple version of one such silo is shown with an insert. This approach, as well as the complete parallelization and the more precise modelling of the behaviour of granulates on solid walls will continue to improve the usability and the quality of CoRheoGrain simulations in the coming year.

1 *Test process for the visualisation of the interaction of moving components with a granular medium; the plate is moved horizontally through the granulate at a constant speed.*

2 *Intermediate stage in the simulation of the emptying of a silo through an outlet at the bottom; the bulk material is homogeneously distributed in the silo at the beginning of the simulation.*

IMAGE PROCESSING

- MICROSTRUCTURE ANALYSIS
- SURFACE INSPECTION
- SIGNAL ANALYSIS FOR RAILWAY SYSTEMS
- ULTRASONIC IMAGING

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Thanks to the continuous and reliable work of the department, Kaiserslautern is now considered an important image processing location. This shows not only in the appointment of the department manager to the Fraunhofer Alliance Vision coordinating council and to the advisory board of the Heidelberg Image Processing Forum. Moreover, users within the Fraunhofer-Gesellschaft increasingly turn to the department with image processing questions, so the ITWM is now the first stop for image processing questions in the Fraunhofer Alliance Leichtbau.

We are especially pleased that sustainable projects with several local companies materialized in the past year; this includes projects with Wipotec Wägetechnik, Keiper, Blue Order and Glatz Feinpapiere. In the process, multiple opportunities arise to strengthen regional industry with the help of modern image processing methods. Long-time experience in the development of algorithms and software for industrial image processing and for quality assurance, in particular, combined with new mathematical methods, is incorporated into the solution of the widest range of inspection tasks. Classical image processing such as edge enhancement or covariance analysis is applied as much as the use of efficient algorithms for determining extremal values in high-dimensional spaces or for determining the similarity of images and image sequences.

In addition to the work groups for railway signal analysis, surface inspection and microstructure analysis, ultrasonic imaging has established itself as the department's latest research focus. Methodical networking with the other groups has improved significantly in the past year. This work group provided a particular highlight in winning the 2009 Berthold Prize. This scientific prize of the Deutsche Gesellschaft für Zerstörungsfreie Prüfung e. V. was awarded for the development and use of an efficient ultrasonic process for the non-destructive testing of ship propellers, among other things.

With the analysis of locally-triggered spectra, primarily in the context of terahertz tomography, as well as the analysis of scanning electron-microscopic, electron-tomographic and FIB tomographic images, the department tapped into new fields of application. This naturally also raised new problems, such as the segmentation of the image components being relevant for an analysis. Numerous collaborations with domestic and foreign research institutions were pursued in the past year and accelerated the use of research results within projects. Collaborations with the Ecole des Mines in Fontainebleau, the Civil Engineering Department at the University of Kaiserslautern, the Darmstadt University of Applied Sciences and the University of Linz were particularly fruitful.

The most important innovation of the past year for the organization of work within the department was the introduction of the internally-developed graphic algorithm design tool ToolIP, which now simplifies development, testing and optimization of algorithm chains for surface inspection tasks. In addition, ToolIP facilitates the method exchange, in particular, between the microstructure analysis and surface inspection work groups.

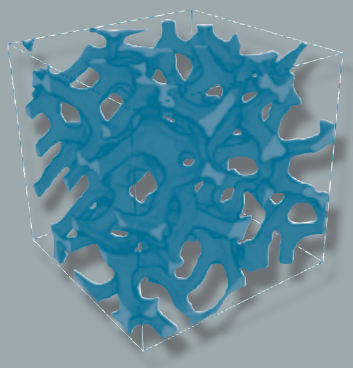
QUANTET – QUANTITATIVE ELECTRON TOMOGRAPHY

The micro and nanostructures of materials determine their characteristics to a considerable extent. Classical 2d structural analysis on the basis of light micrographs of even cuts or polished sections is often unable to provide the necessary structural information. This holds in particular for new materials, because the high complexity of the structures is not reproduced. Even with the high spatial resolution in scanning electron microscopes (SEM) or transmission electron microscopes (TEM), a clear characterisation of complex structures is only conditionally possible. On the basis of a series of transmission-electron-microscopic (TEM) or scanning-transmission-electron-microscopic (STEM) images in various path orientations, the (S)TEM nanotomography (or electron tomography) provides 3d image data with resolutions in the nanometre range on electron-transparent samples. In doing so, quantitative structural analysis for nanoparticles, mesoporous materials, sol-gel materials, carbon nanotube systems, block copolymers, etc. is possible. However, the requirement is that the sample preparation and imaging technology are combined with a special image analysis attuned to this technique.

Together with Fraunhofer IFAM and ISC, the influences of imaging parameters, reconstruction, image processing and segmentation for the precision of quantitative analysis results were investigated for the first time in order to be able to quantitatively analyse electron-tomographic image data of material structures. Surprisingly the special characteristics of the 3d image data attained by means of electrotomography – low signal-to-noise ration, artefacts through the missing displacement angle range, anisotropic grid – did not present a major obstacle for the correct quantitative evaluation of the image data. The segmentation was identified as the primary difficulty en route to a largely automated process, because the most prevalent reconstruction techniques – weighted back projection and the iterative SIRT (Simultaneous Iterative Reconstruction Technique) algorithms led to a size-dependent grey value distribution, as was shown in an elaborate simulation study: Small particles appear darker on average than large particles. This effect is only influenced slightly by the image and reconstruction parameters and could lead to systematic errors, such as in determining the particle count, particle size distributions, etc. Therefore a segmentation process was developed which is based on line cuts in manually selected candidate regions and the determination of local signal-to-noise relationships of the foreground and background. The correct quantitative analysis on the basis of this manual segmentation is possible without difficulty using the 3d image analysis system MAVI (Modular Algorithms for Volume Images). The segmentation, however, is time and cost-intensive and only conditionally reproducible through the subjective influence. Therefore, it must be replaced by an automatic process.

Thomas Eckert, Rebekka Malten, Dr. Stephan Didas, Dr. Claudia Redenbach, André Liebscher, Hellen Altendorf, Hans Rieder, Priv.-Doz. Dr. Martin Spies, Franz Schreiber, Björn Wagner, Michael Godehardt, Thomas Redenbach

Thomas Weibel, Erwin Kraft, Henrike Stephani, Martin Braun, Dr. Oliver Wirjadi, Dr. Ali Moghiseh, Kai Taeubner, Mark Maasland, Dr. Katja Schladitz, Dr. Ronald Rösch, Markus Rauhut, Irene Vecchio, Falco Hirschenberger



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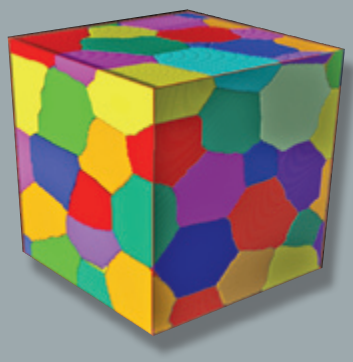

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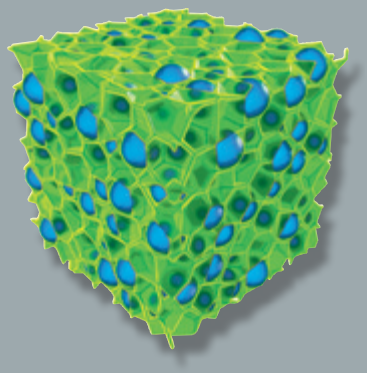


3

ANALYSIS AND MODELLING OF FOAM STRUCTURES

1 *Excerpt from the CT reproduction of an open-cell nickel-chromium foam from the company Recemat*

2 *Reconstructed foam cell*

3 *Visualization of a Laguerre mosaic, as is used for the modelling of open-cell foams; the generating point process is shown in blue, whereas the marked points are interpreted as spheres.*

Porous materials like open-cell foams form the basis for many modern applications. Ceramic foams from the automobile industry, for example, as a support for catalytic converters or metal foams as a light bumper can no longer be discounted – particularly from an environmental standpoint. An additional large field of application, regardless of the material, is the use as filter. All of these applications benefit from the complex microstructure characteristics of foams. The components produced from these exhibit a large, specific surface and a high level of torsional stiffness. For the development of new components, a basic understanding of the geometric parameters, like the average cell volume or the average strut thickness, are necessary. Average parameters are of interest for the characterisation of foams – particularly for the virtual material design, meaning the optimzation of components through simulation computing on geometric models. Assuming that a material is homogeneous, they permit the generation of corresponding stochastic geometric models.

The large variability of the microstructure of foams places high demands on the analysis processes. Classical two-dimensional image analysis methods are only capable of representing a small segment of the material and thereby lead to false conclusions. Three-dimensional image analysis of high-resolution microtomographic images has been established as an alternative in recent years. The model-based determination of the average geometric parameters represents the initial step for the quantitative identification of a foam. Distribution sizes extending beyond this can be determined through the segmentation of the individual cells, e. g. by means of watershed transformation. By creating a marked hard-core point process whose marks correspond to the volume distribution of the segmented foam and use it as a generator quantity for a Laguerre tessellation, a geometric model of the investigated foam is obtained. The characteristics of the model correspond to the average characteristics of the investigated microstructure.

Many of today's available methods for the evaluation and modelling of foam structures were developed or improved at the Fraunhofer ITWM. The institute's experience gathered over nearly ten years of work in the area of image-based material analysis forms the basis for the development of the image analysis software MAVI (Modular Algorithms for Volume Images). MAVI distinguishes itself through the preparation of specifically developed modules for the analysis and modelling of foam structures. The graphic development tool ToolIP additionally enables the intuitive combination of algorithms contained in MAVI on the basis of simple flow diagrams for new, powerful methods and simplifies the automatic application of various algorithms.

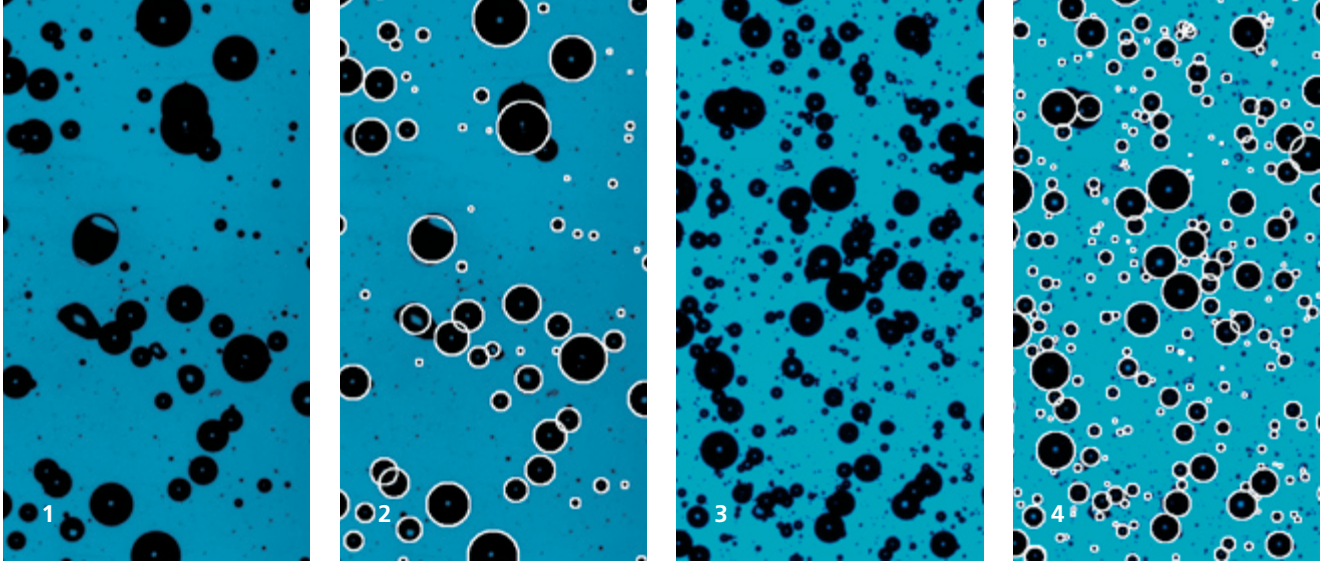


IMAGE ANALYSIS OF BUBBLE AND DROP FLOWS

Industrial chemical manufacturing processes are subject to a multitude of process parameters such as temperature, pressure, flow speed, etc., whose precise regulation can have a strong influence on the quality of a final product. The reliable recording of particle sizes represents the initial step in being able to regulate process parameters so that specific prescribed size distributions can be adjusted and guaranteed in the running process. The department's ILBAS (Inline Image Analysis of Bubble and Drop Flows) project in collaboration with BASF SE in Ludwigshafen and the professorship for Thermal Process Technology of Kaiserslautern University has been charged with this topic: the goal of the project is the recording of particle size distributions of bubbles, droplets and solids with image processing.

1 *Recording with low concentration*

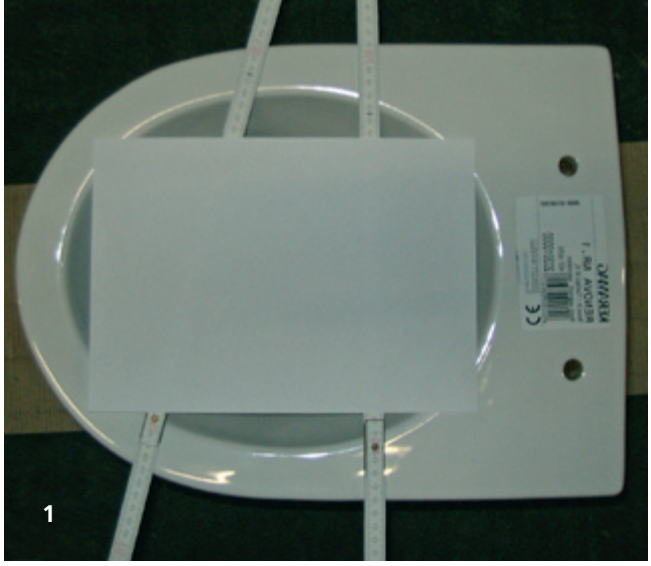
2 *Results for 1*

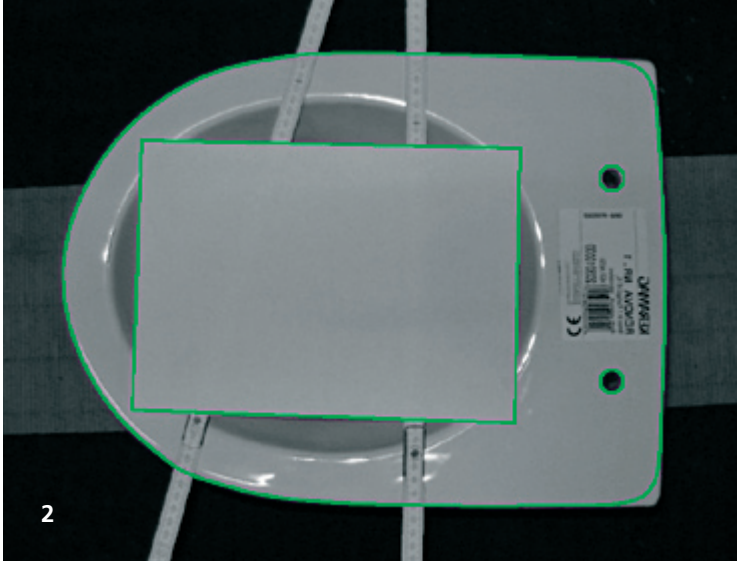
3 *Recording with medium concentration*

4 *Results for 3*

For this purpose, a testing structure was designed at the professorship for thermal process technology, which enables the creation of reproductions for various materials, material concentrations, flow rates and recording conditions. Numerous tests with water and oil provided large quantities of recordings in light which was reflected or which passed through. Drops are shown with very high contrast and sharpness in the light passing through. However, this reproduction process is only suitable for oil concentrations up to approx. 10 %, because with higher concentrations nearly the entire image area is covered with black drops. Evaluable concentrations can be reproduced in reflected light, however, they represent disproportionately higher challenges for the image processing. Algorithms were developed at the Fraunhofer ITWM which enable an estimation of the radial distribution of nearly circular particles for reproductions from light passing through. For this purpose, multiple procedures were used for the circle detection, such as the use of a distance transformation or the so-called Hough transformation. The common feature of the two processes is that the potential circuit points are shown as maximums in a data set calculated from the recordings. In the process, the robust treatment and detection of overlapping circular shapes is also possible within certain limitations. In order to be able to supply the most realistic results possible according to the known process parameters, two different algorithms were developed for smaller and medium-sized concentrations. The ITWM was able to rely on the extensive in-house algorithmic library for the implementation and evaluation and expand it for special applications. Through the graphic representation with the ToolIP program, corresponding prototypes could be developed quickly.

The project is being continued in the Centre for Mathematical and Computational Modelling with the professorship for Thermal Process Technology. The goal of the additional work is the evaluation of reflected light recordings and the examination of more general shapes than the circular shapes.





PERFECT-FIT TOILET SEATS

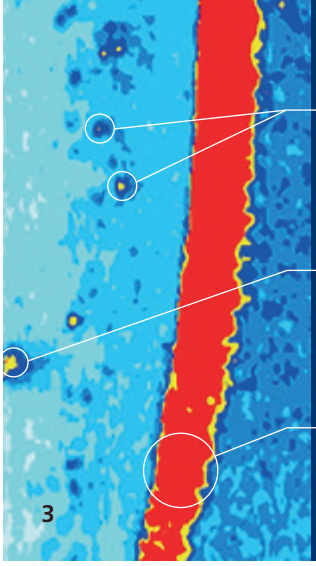
1 *Ideal photo for the calculation of the contours of the bowl*

2 *Bowl with detected sheet edges, holes and outside contour*

The goal of this project is the development of software for the company Hamberger Sanitary which finds fitting toilet seats in a database through a digital photo of a ceramic toilet bowl. Toilet bowls are fired in clay moulds and subject to severe fluctuations in shape as a result of production. This complicates the purchase of a fitting toilet seat. In this way, the spacing of the fastening holes can deviate by as much as 2 cm, because the holes are manually punched in the ceramic bowl before it has cooled down. The various designs represent an additional hurdle: there are square, round and even pointed ceramic bowl base shapes. The goal, therefore, lies in supporting the customer in the purchase of a toilet seat. In the process the lengthy measuring of length, width and hole spacing of the bowl can be completely dispensed by the customers. They only have to provide a digital photo of the bowl with an A4 sheet placed on top of it taken at a specific minimum resolution.

On the basis of such a picture of the bowl, the two holes and the edges of the A4 sheet are found by means of special Hough transformations. The entire image is now geometrically transformed using the known length relationships and angles of the A4 sheet, so that a perfect top view is represented. The greatest challenge in this project lies in the correct localization of the outside bowl contour, because light and contrast relationships as well as the precise position and orientation of the bowl are basically not known. Existing symmetries and characteristics of the contour of the bowl – such as the direction of curvature – are used. For the subsequent selection of a WC seat, a comparison between the detected contour and the contours from the database is performed.

The application is first used by the employees of Hamberger Sanitary, whereby a simple photo (cell phone) of a bowl can determine whether and which of their toilet seats are suitable. The greatest utility, however, arises from the integration of the software on the company website. The previous version of Hamberger Sanitary presented a correspondingly rough selection of fitting toilet seats after indication of length and width of the ceramic bowl and the hole spacing. This offering is significantly improved through the developed software because it includes the contours of the bowl in the search.



ULTRASONIC TESTING AND IMAGING OF SHIP PROPELLERS

Many propeller damages arise without direct external influences. They are, instead, the result of production and repair. During the casting of the propellers, which reach weights of up to 160 tons, turbulences can lead to sand inclusion and pores. The current state of technology consists of monitoring and strict adherence to a proven welding procedure as well as the subsequent dye penetration test in order to detect surface errors. However, if there are defects in the bulk, other efficient non-destructive testing techniques re required.

Together with Germanischer Lloyd AG in Hamburg, as a classification society, and with the propeller manufacturer Wärtsilä Propulsion Netherlands in Drunen, a powerful image-providing ultrasonic technique for the non-destructive testing of such complex components was brought to maturity. The concept which was developed for testing ship propellers can also be used on other complex components made of sound attenuating materials, such as off-shore components made of Duplex steels. In regard to the specific material and component characteristics and their influence on the ultrasonic wave propagation, the tomographic process SAFT (Synthetic Aperture Focus Technique) had to be modified: SAFT++ utilises the surface contour detected during the scanning process by means of mechanical devices or aircoupled ultrasound for correctly determining the reconstruction volume; in addition, the sound attenuation is taken into account in the scope of a pre-processing of the rf-data. This refined imaging process was experimentally validated on an entire series of test blocks and propellers provided by Wärtsilä Propulsion Netherlands. The process utilises mobile scanning equipment and an ultrasonic testing system developed specifically for this application with separate programs for data collection, reconstruction, visualization and evaluation. Optimized with respect to practicability, the efficiency of the process was examined in a series of on-site tests at the propeller manufacturer's facilities, on deck and in dry dock with a total number of 36 propeller blades. During these inspections, very difficult working conditions and environmental conditions at the various locations represented a great challenge as compared to measurements in the laboratory: bronze and silicate dusts in the foundry; humidity, spray water, chemicals and overspray from painting equipment during the overhaul of ships in dry dock.

The simulation methods and processes for ultrasonic tomography available in ultrasonic imaging group are used at ITWM in a similar manner on a number of components and materials for the improvement of defect testing.

1 + 2 *Testing of a mounted propeller in dry dock with the vertically affixed scanning unit*

3 *A representative result of the SAFT reconstruction in which the backwall and several small inclusions are imaged*

SYSTEM ANALYSIS, PROGNOSIS AND CONTROL

- DYNAMIC HETEROGENEOUS NETWORKS
- MONITORING AND CONTROL
- DECISION SUPPORT IN MEDICINE AND TECHNOLOGY
- PROGNOSIS OF MATERIAL AND PRODUCT PROPERTIES
- MULTISCALE STRUCTURE MECHANICS

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The complexity of many technological applications and industrial processes is steadily increasing; with biological systems it is naturally at a high level. Even if detailed system modelling is often only possible to a limited degree due to reasons of complexity, there is still an interest in prediction and control of the system states. For this purpose, the department develops methods which enable an enhanced system understanding on the basis of measurement data and expert knowledge as well as the most reliable prognoses possible and a control for the future system behaviour. Pure consultation services and customer-specific software development, as well as the department's own products are offered.

The thematic emphasis of dynamically heterogeneous networks is involved in the modelling and analysis of complex networked systems. Error-controlled mixed symbolic/numerical model reduction processes are the key for a deeper system understanding and an efficient simulation in the process. Currently these methods for the explicit consideration of parameter fluctuations are being enhanced – a feature which is gaining increasing importance specifically with the design of nanoelectronic applications.

In the area of monitoring and control the model-based controller or observer design is at the centre of activities. Robust control strategies, iterative learning control approaches, model predictive control and neuronal controllers methodically play an important role. Current applications are in the controller design for the active vibration damping and conditional monitoring of large technical systems.

The mission of the decision-making support in medicine and technology is the assistance in complex diagnosis and decision -making processes. In addition, methods of multivariate statistics, time series analysis, data mining, fuzzy logic and graphic exploration techniques are used. A current emphasis is the development of a data mining suite which enables a simple adaptation and manipulation for various industrial production processes.

In the area of prognosis of product and material characteristics, models for the prediction, classification and simulation are identified by means of measurement-based methods. An enhanced system understanding can be generated from the identified models by means of suitable analysis approaches, whereby simulation data bases are also used to increasing degrees for model creation, in addition to experimental test data. These processes are used with the prediction of service life specific values of automobile components and the prognosis of the residual error content of software modules, among other things.

The multi-scale structural mechanics emphasis deals with the development and conversion of numerical algorithms for solid body mechanical problems with materials which exhibit complicated time-dependent material laws in addition to a complex, multi-scale structure. By using asymptotic homogenisation techniques, the durability and service life under fatigue, contact problems with micro-rough surfaces, creep, impact loads and wear can be calculated. A current application emphasis is the calculation of mechanical properties for textile fabric structures.

The financial crisis has complicated the acquisition of industrial projects specifically from small and medium-sized companies, yet on the whole the reporting year was concluded rather successfully. The department activities in the sphere of computational biology and personalised medicine were additionally strengthened by new project activities and newly started promotional themes.

AUTOMATED, ROBUST CONTROLLER DESIGN FOR ACTIVE VIBRATION DAMPING

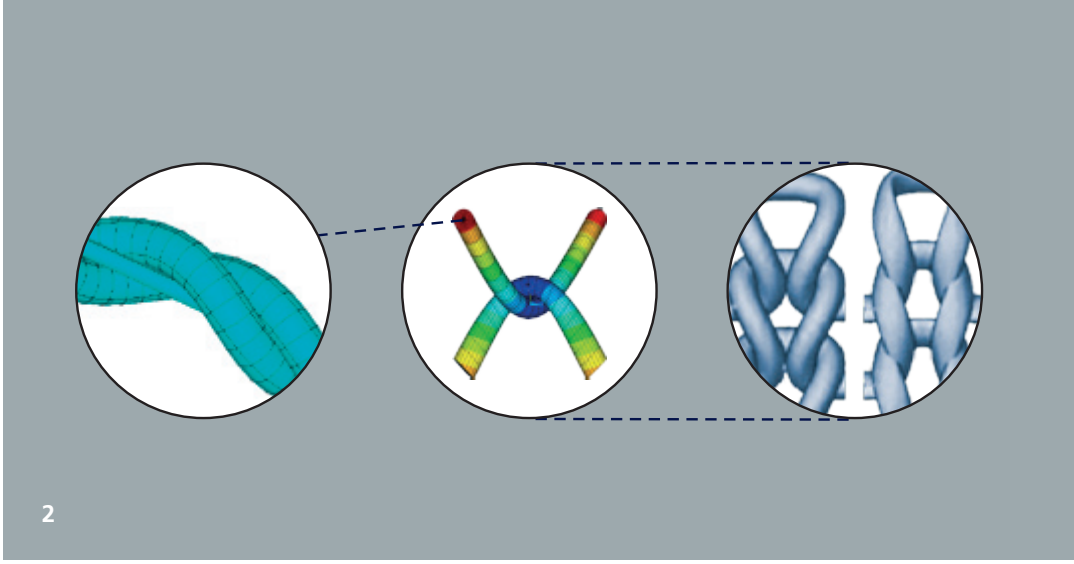
Oliver Schmidt, Dr. Alexander Dreyer, Alberto Venturi, Matthias Hauser, Alexander Nam, Dr. Julia Orlik, Anna Shumilina, Annette Krengel, Dr. Jan Hauth

Dr. Alex Sarishvili, Richard K. Avuglah, Christian Salzig, Dr. Andreas Wirsen, Dr. Patrick Lang, Dominik Stahl, Hans Trinkaus, Dr. Hagen Knaf

The controller design plays an important role in the design of an active vibration damping system. Only in the optimal interplay between structure and controller can the best possible damping be attained. That leads to an interplay in the design phase between structure optimization and controller design for the respective structure. In this way, changed actuator or sensor positions, for example, must be taken into consideration in the iterative optimization of the active structure. While tools like ANSYS or ADAMS are used for the structure modelling, the CAE tool Matlab is suitable for the controller design. Among other things, it provides a multitude of universally applicable functions for the widest range of control concepts. Suitable functions are selected for the respective control problem and the respective control loop description in each iteration is adapted to this.

By order of Volkswagen AG, a Matlab tool box was developed for automated controller design for active vibration damping in consideration of non-linear actuator behaviour. While the non-linearity is inverted with a precompensator, the actual active vibration damping takes place with a model-based linear controller which is to be optimized for the respective structure. In order to limit the work of the developer to the essential work steps of structure optimization and the design of the linear controller, the system adaptations in Matlab required for the controller design are automatically executed in the background guided through a graphic user interface (GUI).

Initially, the system model will be exported from the modelling tool used by Volkswagen. Simulink models of the open and closed control loops are created from the data files and the parameters of a state space model of the linear physical subsystem are determined. Simulations of the original simulator, the Simulink model of the open control loop and the simplified state space model can be compared with one another for the model validation. Then actuator and sensor positions as well as the vibration quantities to be damped are selected and the resulting transfer function is analyzed. In consideration of the desired frequency range characteristics for the control energy and the vibration damping behaviour, which are adjustable by the user in the form of weighting matrices, a model-based controller is then calculated. Time and frequency range analysis of the closed control loop of the linear subsystem as well as simulations of the controlled non-linear overall system, guided and visualized through the GUI, then provide the developer with the essential information about the damping behaviour of the designed active structure.



MODELLING AND SIMULATION OF EFFECTIVE MECHANICAL PROPERTIES OF FIBRE STRUCTURES AND TECHNICAL TEXTILES

1 *Microstructure of a bandage*

2 *Multiscale simulation for knitted textiles*

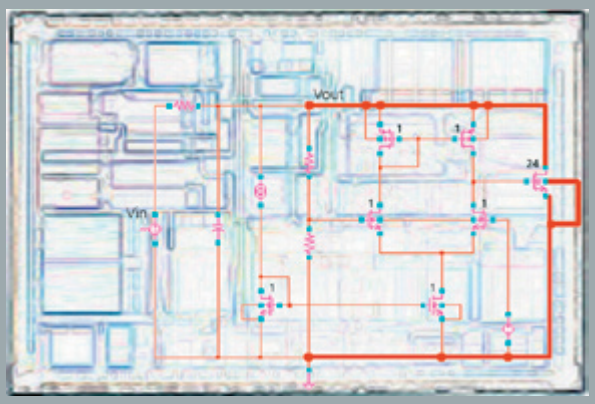
The focus of this research and development is on the mechanical multi-scale modelling and simulation of textiles and fibre materials with heterogeneous microstructure and special consideration of the contact between the individual threads. In the process, the problem becomes so complex with the different geometric length scales that a direct numerical simulation is no longer possible. Instead, a multi-scale approach is necessary for an effective calculation.

The well-known homogenization method was extended here for the mechanical analysis of contact problems in a textile microstructure and then deduced for an effective phenomenological material law. This effective constitutive law is determined through a series of periodic auxiliary contact problems on a unit cell from the textile microstructure and is elasto-plastic and non-linear on the basis of the contact between the threads.

The fact that the relation between the diameter and length of the fibres and threads in the textile structures assume very small values is taken advantage of for the numerical conversion of the corresponding calculation algorithm for the multi-scale problems. Together with the introduction of additional asymptotic considerations in regard to the thread diameter, the original three-dimensional periodic auxiliary contact problems on the textile microstructure can be reduced in dimension and the overall deformation can ultimately be calculated as a superposition of tension bending and torsion of a one-dimensional beam.

The finite element method can serve as a tool for the simulation of a representative structure cell of a textile. It was handled by Hermitian beam elements and enhanced and implemented for the treatment of thread contact problems in the FiberFEM software package specially developed at the ITWM. Along with the microstructure description of the textile in consideration, FiberFEM requires the fibre cross-section geometry as well as mechanical fibre parameters such as tensile stiffness, strength, durability and friction as input values. The effective mechanical behavoir of the textile is returned as an output.

In addition to the calculation of the effective mechanical material properties for a multitude of already existing woven and knitted textiles from technical and medicinal applications, the approach also offers the potential for an optimal design of new textiles with a prescribed mechanical characteristic profile.



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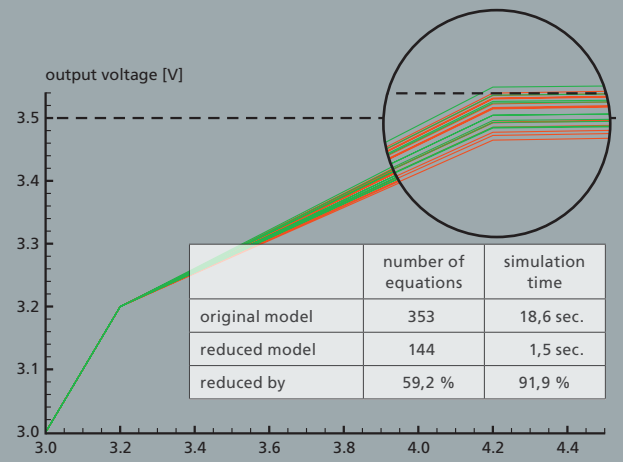


	number of equations	simulation time
original model	353	18,6 sec.
reduced model	144	1,5 sec.
reduced by	59,2 %	91,9 %

2

HIERARCHICAL SIMULATION OF NANOELECTRONIC SYSTEMS FOR THE CONTROL OF PROCESS FLUCTUATIONS

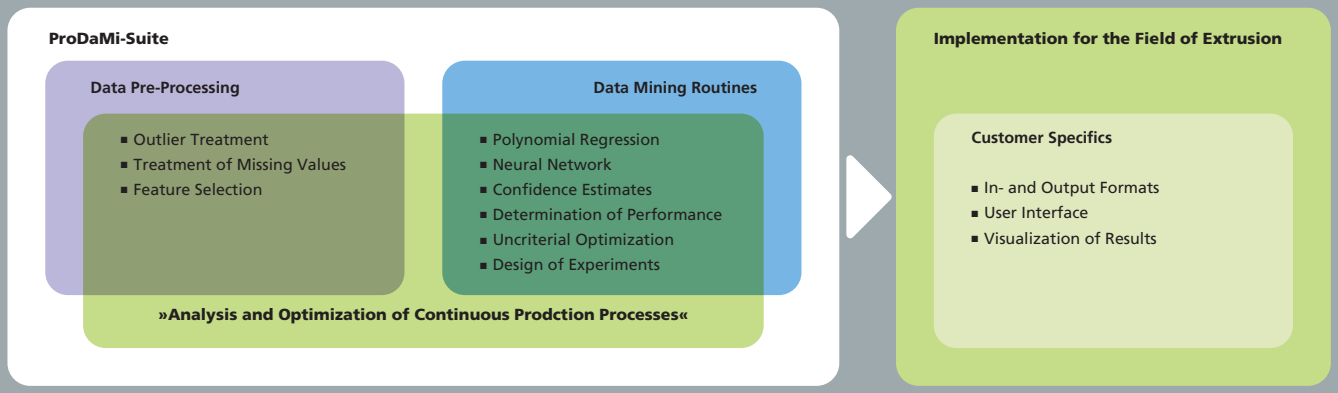
With the transition from micro to nanoelectronics, the control of production tolerances can no longer keep up with the reduction of the semiconductor component sizes. This leads to a drastic increase of the relevant parameter fluctuations in the system and to an increased number of circuits with a system behaviour which lies outside of the desired specifications. The goal of MAVO HIESPANA, therefore, is to support the developer in the design of robust circuits in order to minimise rejects due to defective circuits. In the process, the task of the ITWM is the handling of statistical process fluctuations at the system level in order to provide essential contributions to the optimization of nanoelectronic systems.

For the creation of a symbolic behaviour model with parameter tolerances on the system level, along with net lists and parameters, their distributions must also be extracted from the device and circuit information. That was achieved through the enhancement of the interface between the Cadence EDA tool and the ITWM's own software Analog Insydes. This interface enables the handling of continuous and discrete distributions from measurements of correlated and uncorrelated parameters. The generated symbolic model equations with parameter uncertainties can be used for the large signal, small signal and for the transient simulation or sensitivity analysis. In addition, Analog Insydes provides the capability of reducing the model equations in consideration of the parameter distributions with symbolic-numerical methods. For this purpose, data from a sensitivity analysis is used in order to avoid time-consuming Monte-Carlo simulations. Moreover, there are statistical error functions available which enable a comparison of distributions instead of individual nominal values and thereby guarantee a good approximation of the original system. In the process, the symbolic form and the statistical behaviour of the model are retained. The obtained behaviour model enables an efficient processing on the basis of the greatly reduced complexity, significantly faster simulations and additional insight into the effects of fluctuations of the relevant parameters on the system behaviour.

As an example of a system with parameter tolerances, a voltage limiter which should limit the output voltage to 3.5 volts is examined. In the process, the dimensioning of the seven MOSFET transistors and the two resistors of the potentiometers have a characteristic measure of tolerances. Through the symbolic-numerical reduction, 69% of all terms and 59% of the equations in the system were eliminated. This shortened the simulation time to less than one-twelfth without recognisably changing the behaviour of the output or losing significant system parameters.

1 *Circuit of a voltage limiter*

2 *The result of a Monte-Carlo simulation of the reference model (green) and the reduced model (red) shows that both models limit the output voltage to approx. 3.5 volts with increasing input voltage*



1

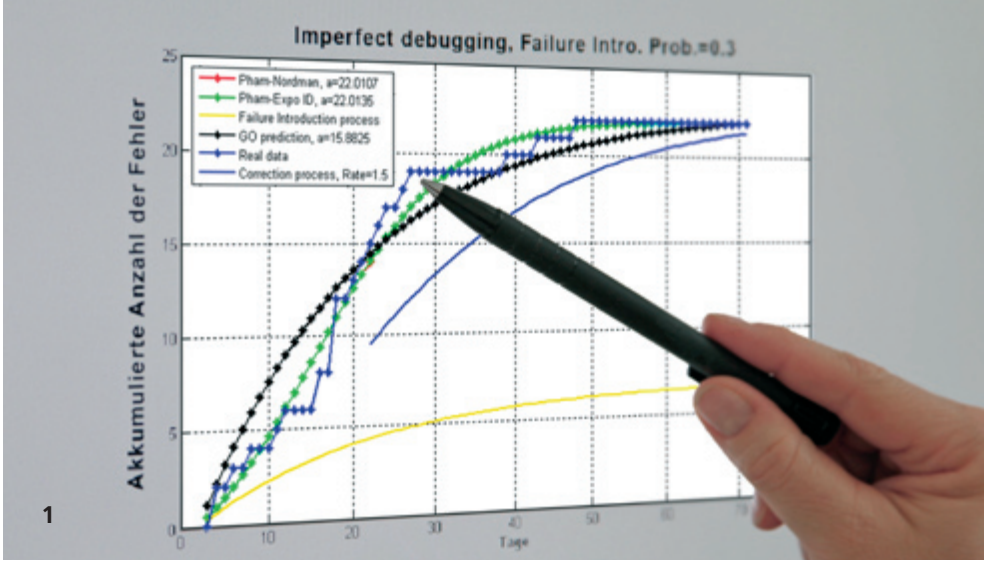
PRODAMI: DATA MINING TOOLS FOR USE IN PRODUCTION AND MANUFACTURING

1 *Realization of a Data Mining Tool from the ProDaMi-Suite*

In today's modern production and manufacturing lines operating and quality data are gathered to a great extent. Against a backdrop of increasing system complexity as well as a trend towards dynamic system structures, which is brought about by more frequent product changes, data mining processes represent a powerful support for cases of operative or planning decision-making. In spite of this, according to surveys by KDnuggets, only approx. 10 % of queried companies regularly use methods of data mining for technical or economical analysis and interpretation of their system data. The reasons for this certainly lie in the highly specialised demands which data mining places on the respective user, as well as in the complexity of the collected data itself. Within the field of software this has brought about a trend from data mining workbenches to so-called packaged solutions – custom tailored tools whose use only requires a low level of clearly limited special knowledge.

The ProDaMi project of the three Fraunhofer Institutes IOSB, IPK and ITWM addresses this trend: The compilation of a library of mining routines which are relevant in the production environment and well suited, for example, in regard to their stability or operability should put the project partners in a position to efficiently develop custom solutions for use in manufacturing and production. For this purpose, the library algorithmically covers the mining processes from the data reduction to the quality assessment of the results and additionally comprises detailed documentation, for example, of practice-relevant parameterizations of routines. Implementations of a concrete application can take place in various programming languages. Currently, C++, Matlab and Java are possible.

The development of a library itself takes place on the basis of six selected demonstrator applications: optimization of the glass drawing process, analysis of characteristic correlations in manufacturing systems, condition monitoring of chemical production systems, support in the master data compilation and process control of aquifer gas storage. The department administers a demonstrator for the application area of analysis and optimization of continuous production processes; plastic extrusion, for example, is located in this area. The demonstrator itself enables the analysis of dependencies between process and quality parameters of the observed process and thereby enables an improvement of the product quality. In addition, it supports the efficient planning of experiments for the creation of high-quality process models based on limited data volumes.



1

RELIABILITY ANALYSIS AND THE OPTIMAL PLANNING OF A SOFTWARE TEST PROCESS

1 *Prediction of residual error content or the reliability of a software product during the test process*

Software producing companies require an answer to the question: How must the quality assurance be planned and executed for the software to be compiled in order to provide an economically optimal product? In this case, economically optimal means that the total of the costs for quality assurance activity and the costs for the subsequent undiscovered errors is kept to a minimum. The answer to this question was the subject of the BMBF project Testbalance; the consortium consisted of industrial partners T-Mobile, SAP, Imbus AG and the Fraunhofer Institutes IESE and ITWM.

A significant contribution to the solution of the optimization problem described above and the primary task of the ITWM in the project was the estimation of the failure content respectively the reliability of a software product during the test process. For this purpose, both dynamic error models based on the failure occurrence times and static failure prognosis models based on software metrics were used. The possibilities for coupling the static prognosis models with the dynamic failure models (Software Reliability Growth Model, SRG) were investigated.

Despite a number of existing reliability growth models, in practice it is only possible with difficulty to determine a priori which model will provide a good prediction. The temporal constancy of the predictability performance is usually not provided either. The subjective decisions which ultimately lead to the selection of a specific prognosis model frequently prove to be less than optimal due to the complexity of the underlying failure processes. This model selection problem can be addressed with the Bayesian Model Averaging (BMA) approach. In the process, the individual model predictions of the SRG with the respective a posteriori model probabilities are weighed and dynamically added up to a BMA model prediction. The SRG models from the implemented model library and the BMA algorithm were applied to test data which was in advanced grouped in several classes with respect to the severity of the error. The results have clearly shown the better prognosis performance of the BMA approach in comparison to the selected single model performance.

In addition to the above-mentioned models, so-called “environmental factors” models were investigated in the project. This class of models enables inhomogeneities in the test processes to be taken into consideration, such as the change of the testing effort or the testing methodology on an individual model basis. The developed mathematical algorithms were converted in a Matlab-based prototype with graphic user interface and validated on real data from industrial applications.

OPTIMIZATION

- MEDICAL THERAPY PLANNING
- OPTIMIZATION IN VIRTUAL ENGINEERING
- OPTIMIZATION OF COMPANY STRUCTURES AND PROCESSES

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The central task of the department is the development of individual solutions for planning and decision-making problems in logistics, engineering and life sciences in close collaboration with partners from research and industry. The work is methodically characterised by the close interlinking of simulation, optimization and decision-making support. In the process, simulation is understood as the formation of mathematical models with the involvement of design parameters, restrictions and the quality measures and costs to be optimized. The core competences of the department are the development and implementation of application and customer-specific optimization methods for calculation of the best possible solutions for the design of processes and products. The unique feature is the close interlocking of simulation and optimization algorithms through optimization-driven discretisation patterns in consideration of approaches from multiple criteria, as well as the development and implementation of interactive decision-support tools. On the whole, optimization is understood less as a mathematical problem than a continuous process for which the department provides support through the development of adequate tools. The department is structured in three research groups.

The portfolio of the research group on optimization of company structures and processes comprises consultation and support in the modelling of logistical concepts as well as the development of individual software components. The group works with efficient strategies for transport logistics, with layout and load balancing for production processes, with models and algorithms for the planning and disposition of process sequences in hospitals as well as patient transport and OP scheduling and with the mathematical modelling of strategic and operative planning tasks in public passenger transportation.

The interactive therapy planning group develops new methods on the basis of optimization from multiple criteria for clinical radiotherapy planning. In collaboration with Massachusetts General Hospital, the German Cancer Research Centre, Fraunhofer MEVIS and the commercial partners Siemens Health Oncology Care Systems, Heidelberg, the research group is developing an innovative optimization and evaluation tool for radiotherapy planning, which provides medical physicists and practicing doctors with a means for weighing opportunities and risks in radiotherapy.

The use of mathematical optimization methods in the engineering discipline relies on modelling of physical relationships and technical processes and their representation in computer programs (Virtual Engineering). Work is currently underway in projects from the areas of electronic design, gemstone cutting, design of chemical processes, layout of adsorption cooling devices and in the optimization of rolling processes in the steel industry. Products and process layouts optimized through multiple criteria are presented to decision-makers in interactive decision-making support tools for appraisal and selection.

Despite the economic crisis, 2009 was characterised by growth; of particular note are the establishment of a fully automatic industrial process for coloured gemstone production with the Paul Wild GmbH Kirschweiler in daily routine operation, work in support of BASF SE in the care of their algorithms for the simulation of chemical process layouts, the advancement of the collaboration with ABB Västerås and Fraunhofer-Chalmers Centre in the optimization of hot rolling processes, the collaboration with SIEDA GmbH Kaiserslautern on a new release of the ambulance software Opti-Trans, the acquisition of Corning GmbH and DB Schenker AG as new customers and the advancement of work on the chassis configuration of commercial vehicles with Volvo 3P (Gothenburg). In addition to three promotions, highlights in the scientific area include the approval of two large BMBF projects, ADiWa and DOT-MOBI, as well as the recognition of the mathematical algorithms and process modelling for volume-optimized gemstone utilisation with the Josef-von-Fraunhofer Prize for the project group of Dr. Anton Winterfeld and Dr. Peter Klein.

ADIWA – ALLIANCE DIGITAL PRODUCT FLOW

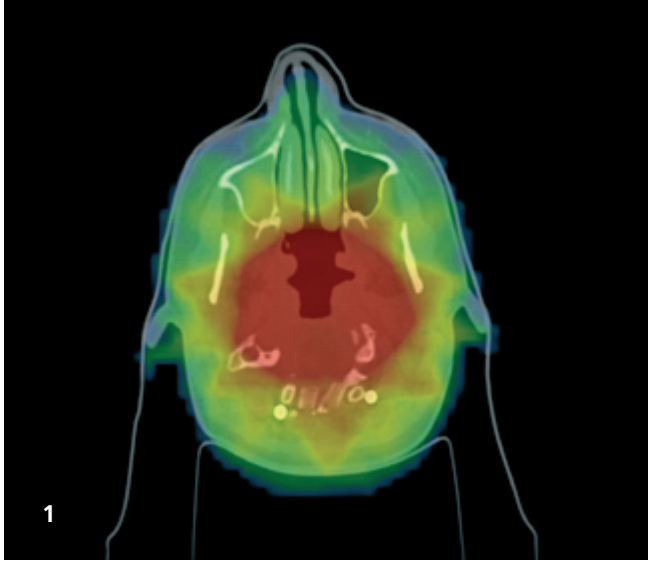
In the IKT 2020 program sponsored by the BMBF "Alliance Digital Product Flow (ADiWa)", software companies and research institutions have joined forces to research and demonstrate the potential of the internet of things for future intelligent business processes. Product and goods-oriented data flows are consolidated into complex events which, in turn, are used for modelling, configuration and execution of business processes.

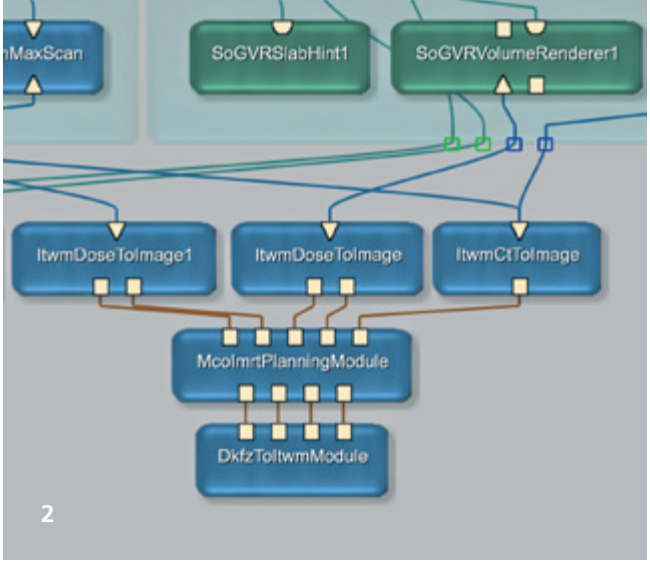
The ITWM is represented in ADiWa with the Optimization, System Analysis, Prognosis and Control departments. The development of the ADiWa concepts in the area of logistics are a central focus, whereby DB Schenker functions as an application partner. In the project's first year, the complex scenario of air cargo was selected. In an air-cargo transport chain from originator to recipient collaborate up to ten different providers of logistics services. This includes regional freight companies to domestic and international freight forwarding airlines, that are located and operate on different continents. In order to enable the IT networking along the transport chain, there are extensive international standardization processes (Cargo2000) whose implementation is far from concluded.

The planning of logistics processes has long been one of the main application areas of mathematical optimization methods. The classical travelling salesman problem (shortest round trip through a number of cities to visit) or the generation of optimal execution plans (scheduling) are well-known problems. ADiWa features logistics processes and raises new mathematical challenges. There are highly dynamic processes of general information of the internet of things; the planned standard process is only one possible scenario; a complex event can be generated at any time from the underlying control layers, which requires a potentially complex reaction, all the way to a complete reconfiguration of the logistics process. A simple example for this is the detour of a traffic jam with the support of a navigational device; however, this example lacks the underlying information level of the internet of things and the multitude of actors involved in the process. The latter involves a second characteristic which shapes the mathematical modelling in ADiWa: There is no central planning instance. Instead, decentralised planning actors must coordinate the provision of the transport chain for the benefit of the common customer. The calculation has to consider the decision-making levels of the actors adequately and cannot assume that all relevant information is stored in a central database. Therefore, cooperative decentralized decicion-making support processes are leading the development of mathematical models and processes for the logistics scenarios investigated in ADiWa.

Andreas Dinges, Dr. Peter Klein, Dr. Sebastian Velten, Ingmar Schüle, Jorge Ivan Serna Hernandez, Hendrik Ewe, Dr. Heiner Ackermann, Dr. Agnes Dittel, Neele Hansen, Bastian Bludau, Jasmin Kirchner, Uwe Nowak, Katrin Teichert, Christina Erben

Dr. Michael Monz, Dr. Michael Bortz, Richard Welke, Dr. Alexander Scherrer, Dr. Philipp Süss, Dr. Martin Pieper, Dr. Volker Maag, Tabea Grebe, Priv.-Doz. Dr. Karl-Heinz Küfer, Dr. Michael Schröder, Dr. Anton Winterfeld, Farid Derradji, Sabine Proll, Jan Schwientek, Dr. Martin Berger





DOT-MOBI SOFTWARE PLATFORM

1 Representation of the dose distribution for the current plan on a two-dimensional cross-section

2 Structure of IMRT planning components based on multiple criteria in Rondo as a MeVisLab network

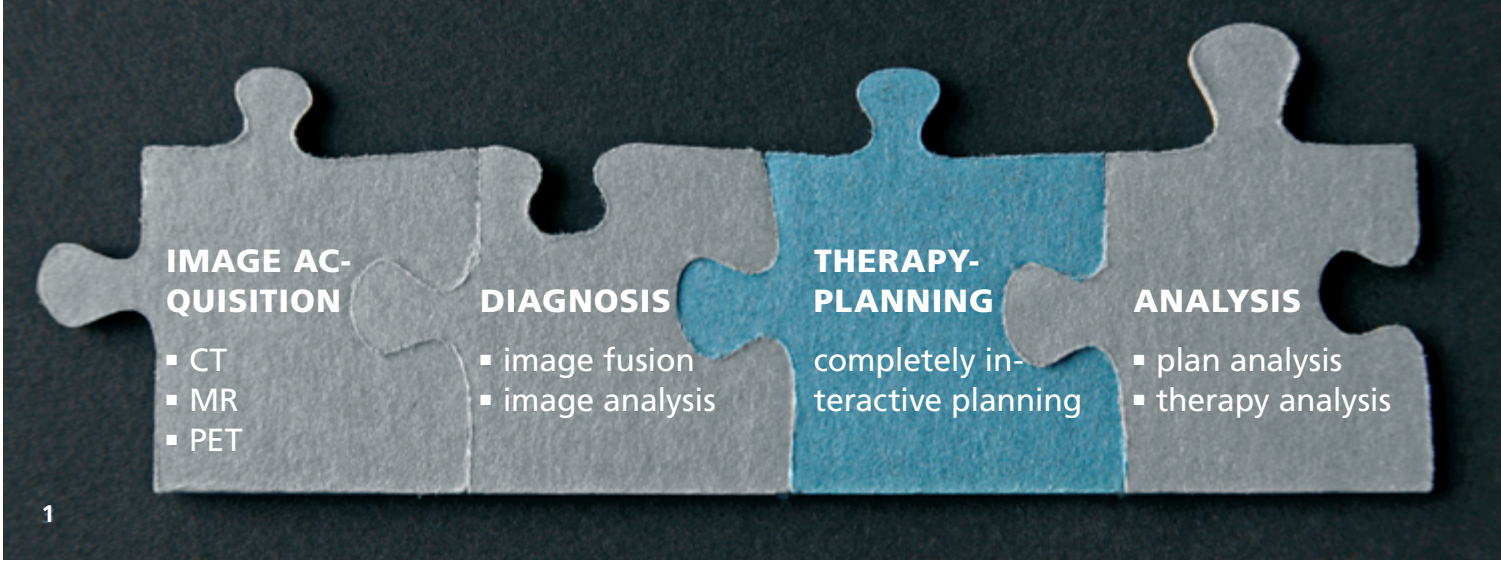
The collaborative research project DOT-MOBI financed by the German Federal Ministry for Education and Research started in 2009. It aims at setting up a common software platform for multi-modal diagnostics for oncological diseases and therapy optimization via molecular imaging.

The department of Optimization of the Fraunhofer ITWM is responsible for the therapy planning components of Rondo. It will enable a new form of planning for intensity-modulated radiation therapy (IMRT) – the completely interactive planning: All available information levels can be used interactively in order to design the plan according to the planner's notions.

Radiation therapy, including the IMRT, is a form of therapy which is individually tailored to the patient. In the process, computer tomography images and, if available, magnetic resonance or positron emissions tomography images are used in order to determine a treatment plan which weighs the risks of side effects against the risk of under-radiation of the tumor. In IMRT the intensity modulation offers a wealth of clinically advantageous plans which represent the various compromises between the considered risks. In the planning process the treating physician searches for the best compromise for the patient according to his or her opinion. Since the calculation of a good compromise already takes a few minutes, the planning may require several days in difficult cases.

In order to make the process more systematic and faster, the problem is approached as a multi-criteria optimization problem. After setting the planning goals for the tumor and the affected organs, the various compromises between these goals are determined. Then the multitude of acquired plans is visualized in an intuitive representation and the current plan is embedded therein. In this way, the planner conceives the possibilities and limitations of the case. Using the visualization interactively he or she can then exclude plans that now do not seem relevant any longer. At the same time, the visualization can be utilized to modify the current plan. Here, the quality of the plan for the organs or the tumor can be balanced out in real time. The combination of direct influence and the global overview enables a goal-oriented and fast planning process.

From the perspective of the planner, a successful compromise between the risks in the various organs does not, however, mean that the plan also corresponds to his or her desires in all aspects. For example, despite an acceptable overall score of the plan for an organ, the distribution of the dose in the organ may not correspond to the notions of the planner. Currently, he or she can only change the score for the entire organ to improve the dose distribution. In order



to enable precise intervention in the plan, the customary, previously passive visualizations of the plan – dose-volume histograms (DVH) and 3d dose distribution – will be equipped with interactive planning tools within the DOT-MOBI project.

In the DVH the dose in every organ and potentially multiple tumor parts is depicted as a curve. For each dose level the curve shows the percentage volume of the entire organ in which the dose exceeds the given level. Instead of assessing the plan quality in an organ by a single number the quality of the current plan is encoded in a curve. Offering tools to interactively modify plans to meet an aspired point on the curve therefore offers more detailed planning options. From a mathematical perspective that represents a challenge, because the resulting problem formulations potentially include many local optima.

Mathematically more straight forward problems suffice to offer tools that work on the 3d dose distribution. However, a local adaptation can lead to the appearance of a new, undesired effect somewhere else. Hence, planning tools for the design of 3d dose distribution are of little use without good control of these side effects. Thus, the challenge is to find a mathematical model which enables effective adjustments and simultaneously controls side effects.

A successful realization of the planning tools described above, however, still does not result in a successful realization of the completely interactive planning. For this purpose, the changes of the plan brought about with one tool must be balanced with the changes occurring at the other information levels. Otherwise the planning process will consist of seesaw changes. In addition, the problems must be solved in the shortest time possible in order to enable interactive use. Not lastly, a successful design of the user interaction is sought after. The challenge to develop a successful synthesis of decision-making support and the underlying mathematical processes under these various aspects will be met in DOT-MOBI.

1 *Schematic layout of the desired "Rondo" software platform in the DOT-MOBI project*

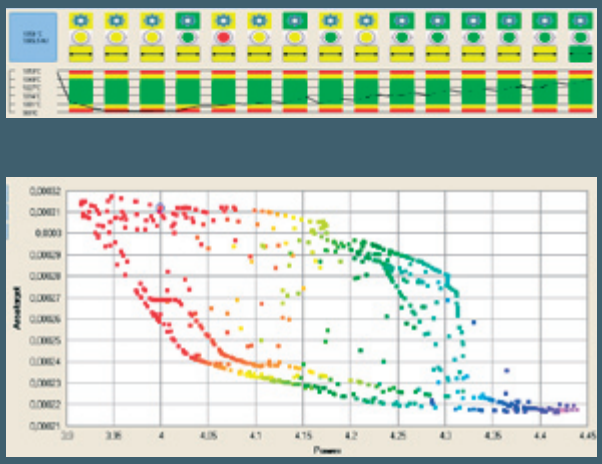
ALGORITHMS FOR THE CREATION OF PRODUCTION PLANS AND SCHEDULES

1 *Optimized production planning contributes to reduction of stocks and thus avoidance of tied-up capital.*

In many companies increased customer requirements (short delivery times, flexible product design) stand in opposition to other economic interests (high resource utilization, low stocks). In order to ensure company success in the long term, the creation of optimized production plans and schedules plays an essential role.

In general, a quantity of production orders which typically consist of a multitude of individual activities must be scheduled under limited resources to create such a schedule. The goals, on the basis of which the quality of a plan is measured, are varied and are oriented towards the indicated requirements. The criterion usually considered the most important is a delay of completion of production orders which is as short as possible. In addition, a low as possible earliness, a short processing time and the stability of the plan play a major role. The client of the project is proALPHA Software AG from Weilerbach. The central product of this company is an integrated ERP system for medium-sized industrial companies which includes the component Advanced Planning and Scheduling (APS). The task of this component is the automatic creation of production plans and schedules with the goal of minimizing delay, early completion and processing time.

In the initial phase of the project a new planning algorithm for APS was developed and tested on the basis of real customer data. In doing so, the SchedulerLab class library developed within the department was used, on the basis of which scheduling algorithms can be implemented and tested. The new algorithm is based on a list-scheduling procedure and uses methods from constraint programming for the management of feasible solutions. In addition, with the help of these methods a production order can be planned in such a way that it is completed as close as possible to a specific date. By doing so, the stability of the created plans is significantly improved and the delay of production orders is reduced. In addition, larger problem instances can now be solved without breaking them down into multiple subproblems. A further important requirement in the creation of the plan is the targeted use of overload capacities. These capacities should only be used if they actually lead to an improvement of the plan. With the possibility of selectively permitting overload capacities, the complexity of the problem is increased considerably. The adjustment of the algorithm so that the use of overload capacities can be optimized is the subject of the ongoing second phase of the project.



MULTI-CRITERIA OPTIMIZATION OF HOT ROLLING MILLS

By order of ABB Corporate Research and in collaboration with the FCC in Gothenburg, a research project for the optimization of hot rolling mills based on multiple criteria in the steel processing industry was begun in 2008. During hot rolling the metallic workpiece is at first heated up above its recrystallization temperature then given the desired form after passing through multiple rotating pairs of rolls (consisting of so-called working and supporting rolls).

In modern rolling facilities complex, electronically-controlled rolling systems are used. For the design and control of these systems, multiple criteria, such as the energy consumption, process speed and the quality of the final product must be taken into consideration. Since no solution which optimally fulfils all of these criteria at the same time can be found, it involves a classical multi-criteria optimization problem. The optimization parameters include continuous quantities like the temperature of metals or the adjustable roll gap, as well as discrete parameters like the number of roll pairs to be used. An initial preliminary study dealt with the use case of the operator of a rolling system who has to monitor the rolling and to adapt the parameters in running operation using the measurements and past experience in order to increase the capacity, to achieve an especially good product quality or to save energy. As an auxiliary tool in these considerations, the ADM™ Tool software developed by ABB offers a simulation of the rolling process as well as the possibility of a single-criterion optimization in Matlab. With the development and integration of multi-criteria algorithms in ADM™ Tool, as well as the provision of suitable interaction tools, the decision-making should be facilitated and made more intuitive for the user.

In the course of the project, ADM™ Tool was expanded by a component for the calculation of Pareto optimal solutions as well as for the automatic creation of Pareto sets, which is based on the so-called Pascoletti-Serafini approach. This approach distinguishes itself in comparison to other scalarization methods through a high numerical robustness. It was successfully tested on a real example with 15 roll pairs and five different target functions. In addition, a GUI component was developed for the evaluation of the calculated solutions as well as for the navigation of the Pareto set. It enables the operator to change his preferences without having to engage in the details of the underlying mathematical reformulation. The software is appropriate for the analysis and improvement of rolling systems as well as for the training of new employees, because the correlation of different target functions can be interactively demonstrated with it.

1 *Sheets and bands are produced by rolling so-called slabs.*

2 *User interface for the interactive navigation of a pre-calculated Pareto quantity for a hot-rolling mill*

FINANCIAL MATHEMATICS

- OPTION PRICING
- CREDIT DERIVATES
- CREDIT RISK
- PORTFOLIO-OPTIMIZATION
- INSURANCE MATHEMATICS
- INTEREST RATE MODELS

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The Financial Mathematics department concentrates on the development of models and algorithms for the evaluation of financial derivatives; valuation, optimization and risk assessment of portfolios; as well as the analysis of special risks (e. g. default risk). This spectrum is enhanced with the use of modern methods of financial mathematics for problems of the insurance industry, particularly in asset liability management. The technical emphases of the department are (financial) mathematical modelling, the numerical implementation of valuation methods, statistical data analysis and the development of corresponding software tools. Typically the projects comprise development, investigation and comparison of financial-mathematical models from both a theoretical and a practical perspective. The department's industrial partners come from sectors such as investment banking and asset management, national banks and special banks, insurance companies and pension funds and consulting companies specializing in the banking and insurance areas.

In the option pricing focus, innovative market models are investigated which represent the present market prices very well, but also model the price movement of the underlying securities realistically enough. The subject of portfolio optimization is the determination of an optimal investment strategy. In practice, investment decisions of funds managers are still often based on variants of the one-period model of Markowitz. The development of modern continuous-time portfolio optimization, however, has advanced to such an extent in the meantime that many algorithms are available for practical application and implementation. In the area of credit risk we support credit institutions in the implementation of the equity guidelines (Basel II) from a statistical perspective. Credit rating or scoring involves the validation of existing bank-internal rating systems as well as their re-conception and recalibration. Important for the implementation are the adjustments to the portfolio of the respective credit institute and support with back testing and stress testing later on. Credit derivatives, as a jointly responsible catalyst for the financial crisis, represent a particular challenge in regard to their valuation. Unlike in the stock market, no standard credit model has emerged yet. Specifically in the valuation of complex products and portfolios with several underlying default-risk-afflicted financial titles there continues to be a great demand on appropriate mathematical modelling. In the insurance mathematics focus, the ALMSim software was developed for the support of insurance companies in the implementation of solvency guidelines (Solvency II), which enables both the individual and joint modelling of assets and liability. In the area of interest models we work with generic valuation methods which accommodate the vast multitude of complex interest rate derivatives.

In 2009 the collaboration with the University of Cambridge was further intensified. In addition to regularly held workshops, many employees and postgraduates utilised the excellent working possibilities at the University of Cambridge for two-to-four-week research visits in order to initiate and advance new research projects. In regard to economic returns, we have once again enhanced our client portfolio with industrial partners, however the complicated economic conditions resulting from the financial crisis are clearly felt. Our collaboration in publicly financed projects was successfully continued in the BMBF joint project Alternative Investments: modelling, statistics, risk management and software and the medium-sized-oriented internal research project (MIR) for the valuation of stock options programs. The "Implementation of Modern Methods of Portfolio Optimization in Practice", a project promoted by the Rhineland-Palatinate Foundation for Innovation, was successfully concluded at the end of 2009.

ASSET-LIABILITY-MANAGEMENT

Dr. Johannes de Kock, Roman Horsky, Melanie Hollstein, Dr. Jörg Wenzel, Prof. Dr. Marlene Müller, Dr. Christina Erlwein, Dr. Peter Ruckdeschel, Sascha Desmettre

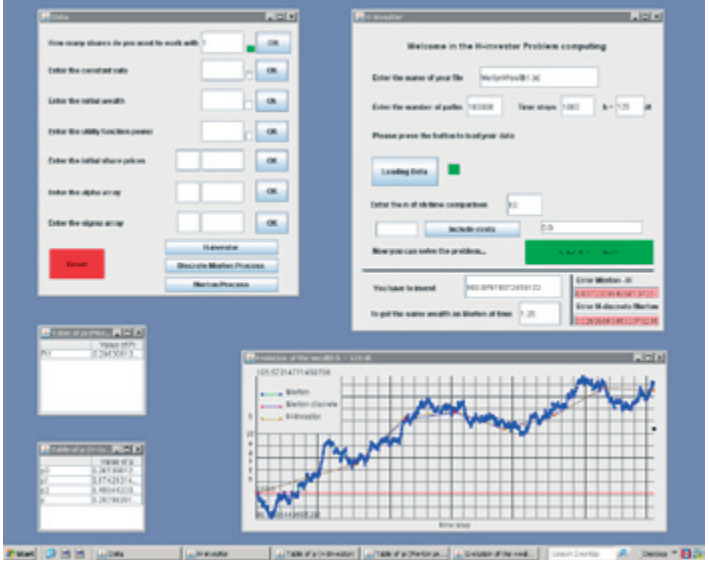
Dr. Stefan Lorenz, Andreas Wagner, Tilman Sayer, Nataliya Horbenko, Dr. Kalina Natcheva-Acar, Prof. Dr. Ralf Korn, Dr. Georgi Dimitroff, Dr. Sarp Kaya Acar

Following several successful industrial projects in asset-liability management, the current focus lies in the further development of the simulation tool ALMSim. Meeting the customer needs is the main priority in the development. Particular issues are for example parallel computing and extracting formulas from a text document.

The newly created user application should demonstrate the variety of applicabilities of our ALMSim software. In this respect we investigate a portfolio of seven asset classes on the asset side and a lifelong pension with guaranteed minimum interest on the liability side. It is important that not only the already existent contracts are analysed but also the number of newly acquired insurance contracts is modelled in dependence of the realized rate of return. Roughly speaking a higher realized rate of return tends to increase the number of new customers and a low realized rate of return causes an outflow of customers. In order to avoid high-risk strategies additional Solvency II rules are implemented. Technically this is achieved by the penalty term in the objective function preventing the resulting strategies from violating the Solvency II criteria.

According to the Solvency II rules the optimal strategies must reckon with possible crash-scenarios for the asset classes. Moreover a possible increase of the interest rates should also be taken into account, since this may have an impact on the liability side. An increase of the interest rate has a greater impact than a decrease since in the balance sheet only the prices of the assets but not of the liabilities are updated.

An additional link between assets and liabilities is provided through the modelling of the insurance premiums. Those are modelled as a fixed partion of the income. The income depends on the interest rates indirectly through the inflation. In our reference example (in case that the long term interest rates are higher than the guaranteed rates) the optimal trading strategy is highly conservative due to the possible crash-scenarios. However, if the long-term interest rate is set below the guaranteed level the optimal trading strategy becomes more risky and avoiding a shortfall of the solvency capital is nearly impossible.



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MODERN METHODS OF PORTFOLIO OPTIMIZATION

1 *Screenshot of the ITWM portfolio optimization prototypes*

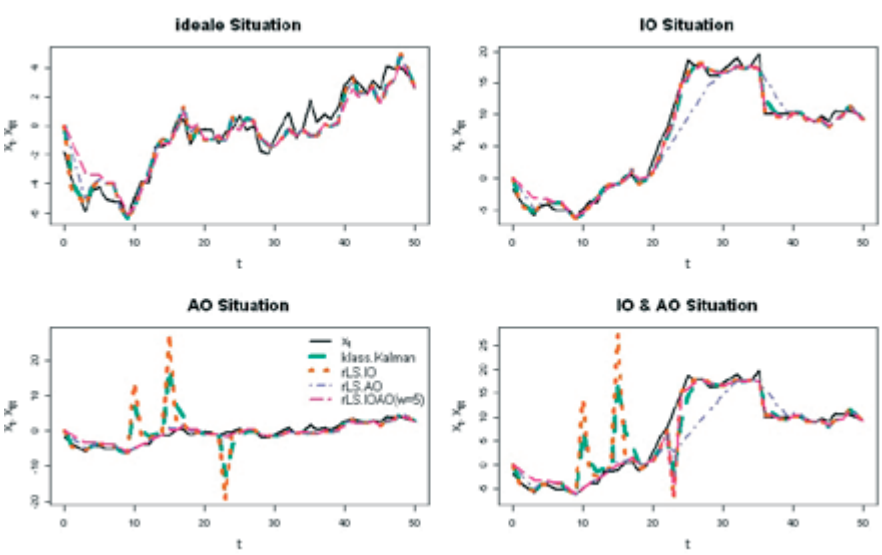
The work of Harry Markowitz in the 1950s may be considered as the starting point of modern portfolio optimization. A second milestone in this area is the work of Robert C. Merton at the end of the 1960s. While Markowitz considered a one-period model with a time of trade only at the beginning, trading and price changes happen continuous in the continuous-time model of Merton.

Neither the one-period model nor the continuous-time model is directly applicable in practice. It is clear that trading must be done at various discrete points in time in a real trading strategy. A realistic model therefore should lie between the approaches of Markowitz and Merton. Chris Rogers made a breakthrough in regard to the applicability of the Merton strategy. His approach shows that you can attain similarly good results to the ideal continuous-time case with a discreet-time trading strategy, which deviates only slightly from the Merton continuous-time strategy.

Transaction costs are an important aspect in a realistic portfolio optimization. In continuous trade – as in Merton's model – the continuous rebalancing of the portfolio leads to the certain ruin of the investor. Therefore, at ITWM a practical model for the calculation of good strategies with proportional transaction costs was developed, which for the first time can deal with investment decisions with an arbitrary number of stock shared.

Specifically in light of recent developments, explicit consideration of crash scenarios has proven indispensible for good risk management. For this purpose worst-case portfolio optimization has developed at ITWM and is further being developed to provide an innovative contribution to modern portfolio theory.

In the research project "Implementation of Modern Methods of Portfolio Optimization in Practice", promoted by the Rhineland-Palatinate Foundation for Innovation, Fraunhofer ITWM investigated the above-mentioned approaches for portfolio optimization in practice and created a software prototype in which modern and classical methods were implemented and should support the investor in his investment decisions.



1

FILTERS OF FINANCIAL TIME SERIES

1 *Typical time series paths illustrating the mentioned outlier type.*

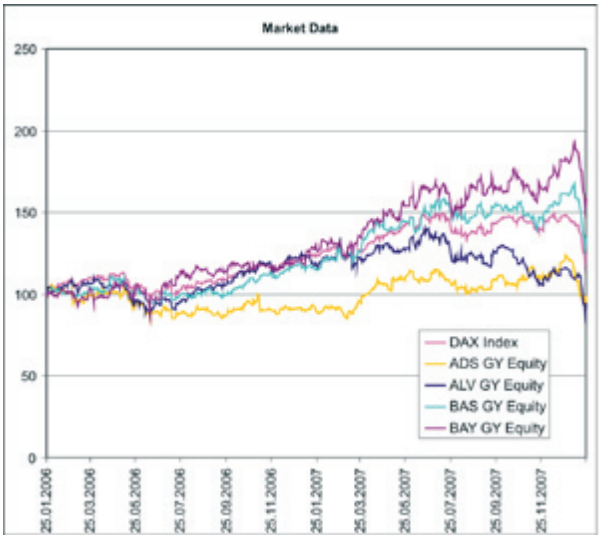
Capturing certain stylized facts of the observed series and estimation of model parameters are crucial in modelling financial time series. For these two issues, filtering techniques to reconstruct a noisy signal provide an appropriate tool.

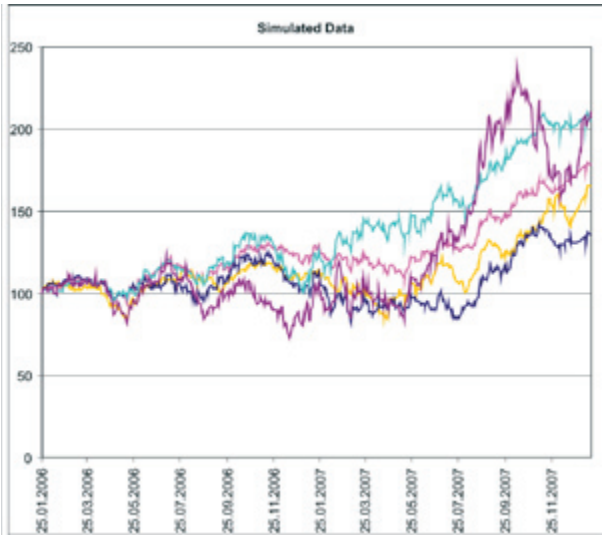
A very flexible and frequently used model class in this context consists of state space models where the time dynamics is modelled by a certain state variable which is only indirectly observable to the statistician. An important subclass is given by so-called "Hidden Markov models" in which the state evolves according to a hidden Markov chain. Information about this Markov chain can only be attained through filter techniques applied to the observation process. The parameter estimation uses the filtered processes to adaptively determine the parameter. This is done by means of an expectation maximization (EM) algorithm.

We develop and use Hidden Markov models to model time series on the financial market such as alternative investments and to decide upon optimal investment strategies in a portfolio based on the predicted rate of return series.

In our applications, we must take into account outliers, i.e. data which cannot be explained by our model. Therefore we also use ideas and techniques from Robust Statistics in order to limit the influence of individual observations on the conclusions being drawn. In the state space model, outliers arise on both model layers, i. e. either endogenously (IO), entering the state layer and hence propagating, or exogenously (AO), only affecting single observations on the observation layer and hence not propagating. A robustification therefore must seek a compromise between fast signal tracking (IO) and attenuation of dubious observations (AO). In the past year, a hybrid method was developed and implemented in the statistical software R, which simultaneously tackles both goals – albeit with a certain time delay.

In economic applications, the model parameters (state transition matrix, innvation and error covariances) typically are unknown and have to be estimated from the observations simultaneously to the reconstruction of the states. To this end one usually uses EM-type algorithms. We also initiated the robustification of this algorithm, so far only for Euclidean state space, though. Continuing this work, we are about to close the gap to Hidden Markov models, generalising these techniques to discrete state spaces.





1

THE MULTI-ASSET-HESTON-MODELL

1 *Realizations of simulated paths reflecting the correlation structure of the original data*

For pricing and managing medium-term and long-term equity options the model of Heston is widely applied in practice and appeals with its richness and simplicity.

The Heston model caters for volatility smile and skew, and its parameters have a direct economic interpretation. The latter is advantageous when the range of liquidly traded options does not fully cover the maturity of the option which is to be priced. Recently, in the finance industry the need emerged for adequate pricing models for valuing medium-term and long-term options which are written on two or more assets.

The need stems from medium-term and long-term options embedded in financial products in retail banking, insurance, and the pension fund business covering products such as principal protected notes, minimal return guarantees as part of unit-linked life-insurance products, and portfolio insurance.

We meet this demand by proposing a model to price and manage medium-term and long-term multi-asset options. We have developed and implemented a parsimonious multi-asset Heston model, together with a generic Monte Carlo simulation routine for derivative pricing.

The market calibration algorithm, being the true novelty of our approach, is theoretically justified and consistently implemented. It is especially customized to market situations where no cross-asset options are liquidly traded and it is not possible to back out cross-asset correlation parameters. For this situation we developed a hybrid approach for identifying the model parameters consistent with option price data and asset price data.

In particular, we combine information from option price data for calibrating the implied parameters of each single-asset sub-model and information from asset price data for calibrating the empirical cross-asset dependence parameters.

FINANCE ALLIANCE CAMBRIDGE – KAISERSLAUTERN

There was a considerable intensification of the scientific collaboration in the second year f the Cambridge-Kaiserslautern Finance alliance, which was established by a Fraunhofer ICON project on the ITWM side and by a CERF project on the part of the University of Cambridge. An entire series of new research projects was started along with the work in the four main areas of continued development and practical implementation, which are continuous-time portfolio optimization models, asset-liability management, dynamic Bayesian processes, new stock price models as well as new methods for risk management in banking and insurance. These research projects have consequently led to the first working papers. In particular the work was carried out in the following areas:

- Factor modelling with Levy processes
- Analysis of variable annuities
- Monte Carlo simulation in a single- and multiasset Heston Modell
- Valuation of American call options with stochastic dividends
- Modelling of the valuation of executive stock options
- Filter methods and robust parameter estimation for financial time series
- Valuation of options on highly volatile underlyings

Further common activities included three workshops in Cambridge and two in Kaiserslautern, whereby the introductory workshop of the Cambridge-Kaiserslautern Financial Alliance in May 2009 in Kaiserslautern, with numerous visitors from industry and research, can be considered as great success. The active exchange between the two partners is also documented by twelve multi-week research visits by ITWM employees and postgraduates in Cambridge. In 2009 an internationally high-ranked scientific curatorship was also successfully assembled, for which the outstanding financial mathematicians Mark Davis (London), Phil Dybvig (Washington) and Nizar Touzi (Paris) were acquired.

In 2010 common project applications with the companies Cambridge Systems Associates and teckpro AG (Kaiserslautern) will be submitted in order to introduce the know-how resulting from the partnership into industrial projects. In addition, an enhanced presence in the English financial market is sought after through continuing education seminars. Ultimately, the Cambridge-Kaiserslautern Finance Alliance should be established as one of the pilot projects of the planned Fraunhofer activities in Great Britain.

1 *Entrance area of the Centre for Mathematical Sciences in Cambridge*

2 *Prof. Chris Rogers at the introduction workshop of the Financial Alliance in the ITWM*

MATHEMATICAL METHODS IN DYNAMICS AND DURABILITY

- STATISTICAL MODELS FOR VARIABLE USAGE AND DURABILITY
- SIMULATION OF MECHATRONIC SYSTEMS
- STRUCTURAL MECHANICS AND CAE-DURABILITY
- COMPONENT PROPERTIES DEPENDING ON THE CASTING PROCESS

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The department works with the modelling and simulation of dynamically stressed mechanical and mechatronic systems. In particular, statistical methods and optimization processes are methodically used for the modelling of ranges of uses and variants in addition to multi-body simulation (MBS) and finite element methods (FEM) for the system and component analysis. In our industrial projects we work with reliability, durability, structural dynamics and system dynamics in the motor vehicle industry.

Despite the economic crisis, collaboration with industrial partners from the motor vehicle industry was expanded to a large extent in 2009. The expansion of the Fraunhofer Innovation Cluster Digital Engineering for Commercial Vehicles (www.nutzfahrzeugcluster.de), in which the department deals with the overall coordination and a significant share of projects, continued successfully. Under our lead management, existing activities for design criteria, system simulation, on-board simulation and structural mechanics with industrial partners Bosch, Daimler, John Deere, Keiper, Schmitz Cargobull and Volvo were expanded by new initiatives for the themes energy efficiency and ground and interaction simulation. In the process, renowned partners such as Bomag, BPW, Liebherr and EvoBus were acquired as new partners for the Innovation Cluster.

We develop methods for the statistical modelling of product usage by the customer – both for the derivation of design criteria for reliability and for the optimization of factors such as energy efficiency and fuel consumption, which are largely dependent on the range of application. Statistical methods play a central role for the dimensioning for reliability and approval of components, in particular. This begins with the definition of design criteria and ends with the evaluation of tests for the verification of durability with statistically verified processes.

For us, system simulation involves the modelling of complete vehicles, axes or test systems in the optimal complexity so that kinematics and motion sequence, as well as the power transmission, in particular, are correctly calculated in advance. In doing so, both the interaction of a large number of moving components and the behaviour of complex power elements and actuators are modelled. On the other hand, the modelling depth is constrained on the basis of limited time and hardware resources and in regard to the assignment of model parameters. An emphasis of our method development for system simulation is the theme of invariant system excitation. In this connection, identification processes (iterative learning control) and optimal control processes, as well as suitable modelling methods for the mechanical external contact (tyres, digital roads, excavating, ploughing) are developed and applied.

The stresses on the individual, more or less deformable components arise from such a simulation of system dynamics as dynamic internal forces. These sectional strains are then carried over to local stresses and service life estimates through structural mechanical simulation. We develop methods for the service life calculation of structures with non-linear behaviours and apply these in industrial projects. An increasingly important emphasis is the simulation of severely deformable structures such as cables, hoses, elastomers and hydraulic supports, air springs and tyres. In the process, work is carried out on different modelling levels, from continuum-mechanically detailed FE models to simplified macroscopic models.

Through collaborations, foundries like HegerGuss and Gienanth utilise our expertise in the area of casting process simulation. For MAGMA GmbH of Aachen, we are both a user of their software and a development partner. The central focus of our research activities is the question of how one can systematically draw conclusions about component characteristics from the results of casting process simulations..

JUROJIN

Oliver Weinhold, Dr. Dominik Jung, Reinhard Priber, Dr. Albert Marquardt, Michael Burger, Ilker Nikelay, Thorsten Weyh, Lilli Engelhardt, Dr. Anja Streit, Dr. Michael Speckert, Sonja Baumann, Dr. Nikolaus Ruf

Sebastian Seifen, Dr.-Ing. Gerd Bitsch, Steffen Polanski, Sascha Feth, Dr.-Ing. Joachim Linn, Clarisse Weischedel, Thomas Halfmann, Dr. Bernd Büchler, Dr. Klaus Dreßler, Martin Obermayr, Dr. Sabrina Herkt, Yekta Öngün, Michael Kleer, Kerstin Gerding, Thomas Stephan, Oliver Hermanns

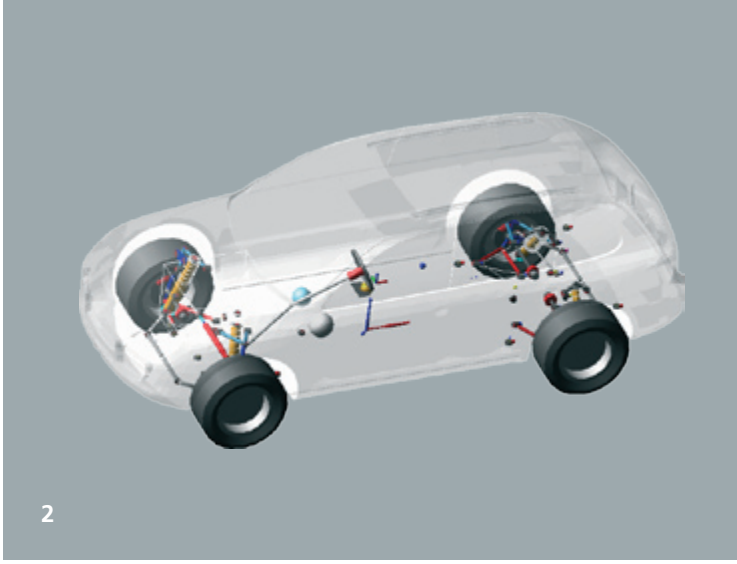
The safeguarding of mechanically stressed components against failure is a central task in the development process. Failure during operation is unacceptable particularly in the case of safety-critical components or subsystems such as wheel trunks or entire axes. In order to ensure that no failures can be expected, even in unfavourable or harsh operating conditions, testing is performed on prototypes. Since the production process is prone to variation, the same components under the same operating conditions show varying durations of service life. A statistically significant conclusion about durability, therefore, always requires several tests.

In practice, two great challenges must be faced in this process: Tests are expensive and normally cannot be performed in great numbers; in many cases the test sequence is concluded after a specific amount of time and components are not tested until failure. These two issues, in other words a lower number of testing results and testing partially without component failure, establish general conditions in which many classical statistical processes for predicting service life duration are no longer applicable. In order to meet these conditions, special statistical processes for the planning and evaluation of service life tests were developed at the Fraunhofer ITWM. The method development was and is continually enhanced by application projects with industrial partners. In the process, a fruitful cooperation over many years with Daimler is of particular note.

A typical task in this connection might involve answering the question of whether verification is better implemented with many short tests or with a few long tests. The calculation of confidence intervals for the probabilities of failure – even with low numbers of test subjects – is also a focus. The processes developed at the ITWM were implemented in the JUROJIN software package. JUROJIN, which finds practical use with several automobile and commercial vehicle manufacturers, supports users in

- Planning of service life tests
- Evaluation of data with selected methods
- Graphic data preparation
- Consideration of small sample size
- Utilisation of all information from fatigue tested specimens without failure
- Calculation of continuative testing plans for premature failures
- Variant comparison of different charges / suppliers
- Prognosis of still pending component failures

1



2

INVARIANT EXCITATIONS FOR SIMULATING OFF-ROAD TRAVEL FOR AN ALL-TERRAIN VEHICLE

1 *Porsche Cayenne*

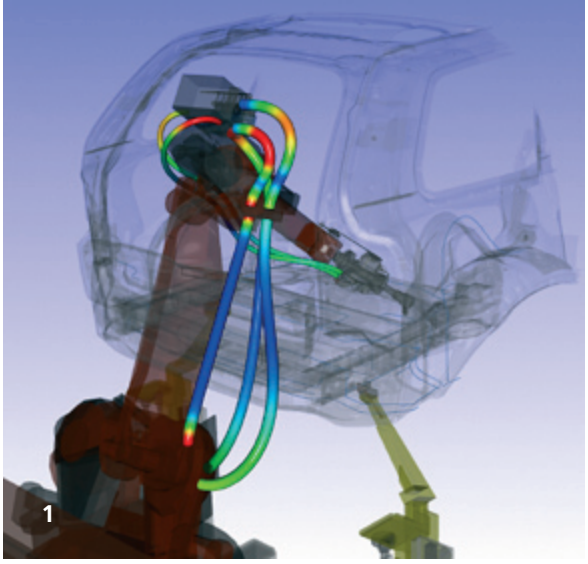
2 *Simulation model of a Porsche Cayenne*

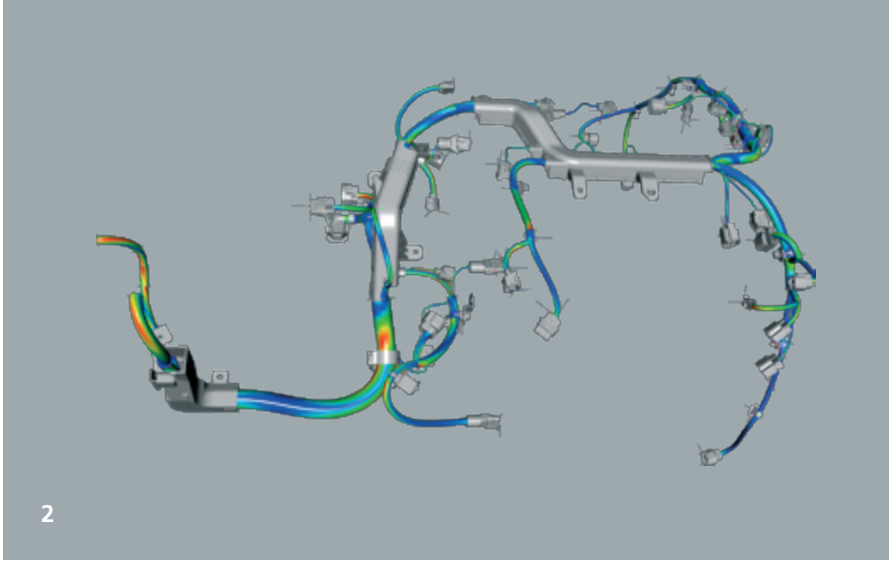
In virtual product development the dynamic behaviour of motor vehicles is simulated on a computer. For this purpose, fixed and flexible bodies with steering and power elements are connected to a multi-body system (MBS) and parameterized with the real physical characteristics. The engineer can virtually look inside the vehicle and calculate various physical load values at any arbitrary point. The correct excitation of the systems represents a key problem of the simulation of motor vehicles. Basically, the ground profile can be measured digitally and can be driven over with the full vehicle including tyres in the simulation. The parameterisation and the simulation of correct tyre models is often so laborious that the vehicle is cut free at the wheel hubs and excited by means of measured wheel forces.

However, in vehicle development it is also necessary to perform calculations on new variants before a prototype is available. Since the wheel forces depend on the vehicle variant, they cannot be transferred directly to another vehicle. Therefore an excitation which can be determined by computer and can be considered vehicle-independent is sought. This represents a special challenge particularly in the case of driving off-road, which is characterised by large pitch and roll angles.

For the determination of vehicle-independent or invariant excitations, calculation back from the measured (internal) values to external loads must generally take place. For this purpose, procedures were developed at the ITWM to exploit the structure of the underlying equations and use the correct numerics for determining the solution. The mathematical processes originated in the area of optimal control theory for differential-algebraic systems of equation.

A tyre replacement model was parameterized in this project, which included the most important dynamic characteristics of a tyre, but can be easily simulated. In the second step a virtual displacement profile is calculated, which generates the measured travel over terrain together with the tyre set model. This dynamic excitation is then transferred to a vehicle variant in which the excitation positions are adjusted according to the vehicle geometry. The replacement tyres are practically mounted on the new vehicle. This process was implemented for the off-road usage of a Porsche Cayenne. It is now possible to simulate the vehicle behaviour of similar vehicles or after modification of individual components before the prototype phase.





ASSEMBLY SIMULATION WITH FLEXIBLE CABLES AND HOSES IN REAL TIME

Hundreds of assemblies are installed in very narrow spaces during the production of vehicles. The available room is limited with a constant increase of components and connecting cables and hoses. At the same time, in order to be able to produce competitively, the cycle times must be kept to a minimum.

The challenge for the design engineer lies in guaranteeing both the operation and the installation of components at an early developmental stage and in the elimination of malfunctions or defects in mass production. Earlier, a simulation of the assembly in consideration of flexible lines was not possible and/or time-consuming.

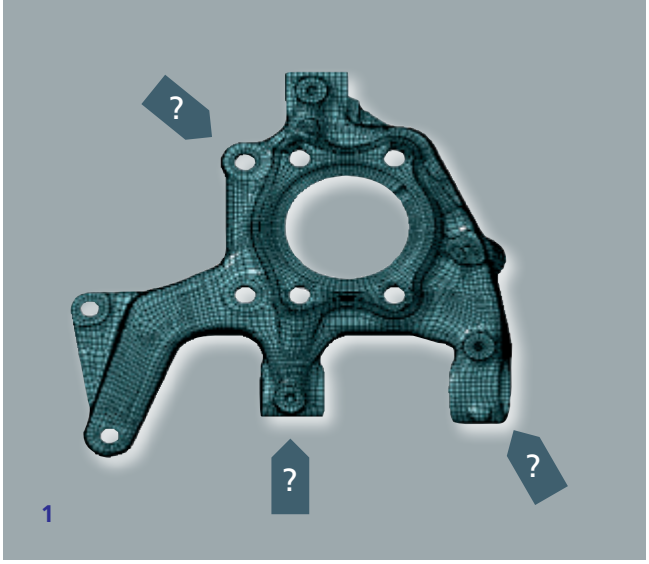
The Fraunhofer ITWM, in collaboration with the Fraunhofer-Chalmers Research Centre for Industrial Mathematics and the motor vehicle industry, developed the Industrial Path Solutions (IPS) software, which enables the combination of path and assembly planning with the simulation of flexible components like cables and hoses for the first time. In the development, high demands were placed on the physical correctness and the precision of the simulation results, as well as the computing speed. In the process, calculation of the movement of cables and hoses in real time was successful, so that interactive work and an immediate evaluation are now possible.

In this manner, ideal shapes, lengths and routeing of brake hoses, coolant and air suction hoses as well as various cable sets for electrical components were designed in projects with the motor vehicle industry. Millimetres and even centimetres were removed from lines without negatively influencing the service life, so the savings are immense. On the other hand, a cable which is too short would drive up the warranty costs. Now it is possible for the first time to determine optimal cable lengths for the respective installation situation. At the same time, the necessary paths and forces for the assembly are obtained as results. In doing so, the question of whether installation help or special tools must be made available for the assembly is answered for production planners.

Moreover, the applicability of the software is not limited to the automobile and commercial vehicle sector. It can be applied in aircraft, machinery and plant construction as well as in the fabrication of electronic and electrical devices.

1 *Simulation of supply lines on a robot*

2 *Simulation of the electrical wiring harness of a passenger vehicle engine*



1

DERIVATION OF SIMPLIFIED TESTS FOR UNDERCARRIAGE COMPONENTS

1 *Finite element model of a wheel trunk*

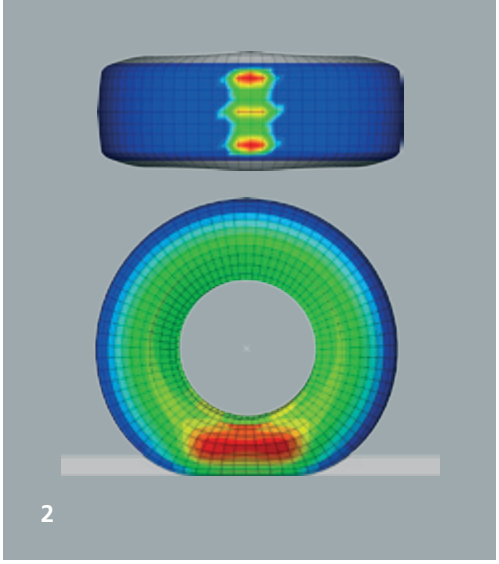
When testing components or subsystems of a vehicle on servo-hydraulic test stands, there is generally the problem that bearing conditions and excitation of the subsystem cannot precisely replicate cross-sectional forces in the travelling vehicle. In addition, the simplest possible test setup (meaning the fewest possible actuators) should be selected. In doing so, the creation of true-to-life stresses is further complicated.

For determination of an optimal test stand configuration, the fixation of the components, the impact areas of the actuators as well as the corresponding excitation can be varied. Therefore, simulations frequently require both a multi-body and finite-element calculation for each new task and each new excitation. As a result, they are generally very time and labour-intensive. Before construction of the real test stand, only a limited number of possible attachments can be calculated.

For the reduction of this calculation effort, a process was developed by the ITWM in collaboration with VW with which an optimal test stand configuration (under certain conditions) with corresponding excitation can be determined. The process is applied to undercarriage components such as wheel trunks and torsion beam axles.

Static states of the component are represented through the superimposition of inertia relief modes. In doing so, the expense of repeated multi-body simulations and finite element calculations, which would otherwise be necessary for each new fixation, can be dispensed with. For each test stand variant, optimal excitation time series are calculated and compared with one another. Whether higher stresses arise at the same positions in the test stand than in the vehicle is taken into consideration in the evaluation. In addition, the creation of new, undesired critical points must be avoided in the optimisation.

Through the automated calculation and evaluation of a multitude of various test stand structures, a good compromise between complexity of a test stand and realistic stresses can be found. The applied approach, therefore, is especially well suited for the derivation of tests with few actuators.



DETERMINATION OF TYRE CHARACTERISTICS WITH FINITE ELEMENT SIMULATIONS

The development process for agricultural machines requires the evaluation of various vehicle configurations within a short period of time, for which the use of different simulation methods is indispensable. The quality of results of the simulation depends heavily on the correct description of important system components.

For John Deere, among others, the method of multi-body simulation (MBS) is applied for the analysis of the entire system. In doing so, the modelling of the tyres plays a key role, because this represents the link between vehicle and ground, and for agricultural machinery it additionally contributes to a significant share of the suspension of the vehicle.

Tyre models in the MBS are predominantly based on spring-damper descriptions. The corresponding parameters require the determination of various tyre parameters which are derived from measurements on special tyre test stands. With tractor tyres such measurements have proven to be extremely difficult and costly – if not entirely impossible – because conventional tyre test stands cannot be used on the basis of the tyre dimension and the high stresses typically occurring during operation. Simulations on the basis of high-resolution, continuum-based models with which virtual tests are performed represent an alternative to testing on real tyres. Efficient, detailed finite element tyre models can be created with the TireTool software developed at the Fraunhofer ITWM. They take into account the internal structure, such as belt and carcass layers as well as different rubber mixtures of the tyre parts.

The validation of models takes place on the basis of easily determined measurement data, such as static rigidity, eigenmodes or footprints. Different stress scenarios, such as static rim shifts, handling or travelling over bumps are performed virtually, in a largely automated process. These results are used instead of measurement data in order to determine parameters for MBS tyre models. In the process, TireTool enables the efficient evaluation of simulation results. The tyre properties identified in this manner are used in an MBS vehicle model and the simulation results are compared with the measurement data of the entire vehicle. Optimization processes are used for the adjustment of individual parameters in order to approximate the measurement results as well as possible.

In a common project with John Deere the software was adapted to the special requirements for agricultural machines. TireTool makes a considerable contribution to the systematization of the simulation-supported development.

1 *John Deere farming tractor*

2 *Calculation results of the tractor tyre with vertical load: Total deformation and pressure distribution in the contact area (shown here without explicit modelling of the lugs)*

COMPETENCE CENTER HIGH PERFORMANCE COMPUTING

- MULTICORE INNOVATION CENTER
- HPC TOOLS
- SEISMIC IMAGING
- VISUALIZATION OF LARGE DATA SETS
- PERFORMANCE OPTIMIZATION
- E-ENERGY, SMART GRIDS

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Development and use of numerical simulation processes are the heart of the research at the Fraunhofer ITWM and the basis for all technically complex developments in industry. In many areas the computing power requirements of the simulations are high in order to either solve especially large problems (seismic exploration, molecular dynamics) or in order to develop interactively and thus more efficiently. High performance computing deals with the problems associated with the development and implementation software which is compute intensive and with its execution on HPC hardware. It is therefore positioned at the intersection between concrete computer hardware, software technology and numerical algorithms. In recent years a paradigm shift has taken place at this intersection, which has by and large still not entered into practice. Over more than 10 years the increase in compute speed was not an essential task for the software developers. The increase in clock speed from 20Mhz to 4 Ghz, improvements in the chip architecture together with a progress in compiler technology led to performance improvements by three orders of magnitude without dramatic changes in the software. The clock speeds have not changed since 2005, because the chips become too hot. At the same time, however, the number of transistors per surface can continue to be increased at the previous rhythm, so that an increase in the number of processors per chip became obvious. In the meantime this has turned into a competition for the highest number of cores. Graphics cards had already always been multi-core processes, even if the processors were greatly simplified. This change in direction on the hardware side has considerable consequences for the development of performance-hungry software. An increase in performance is now only to be attained through parallelization. Parallelization technology is not a new research topic – but research had been reduced in the years of continuous clock speed increase. Today parallelization always means re-analyzing and improving or redesigning the underlying algorithms, as necessary. Through this transition to multi-core technology, behaviour patterns of the past, which may have focused on the number of operations, can be abandoned and a new line of thinking must enter into the equation.

The Competence Center for High Performance Computing addressed this paradigm shift at an early stage and brought innovative new software tools to the market for the development of parallel software. The heart of these tools is an efficient library for the development of complex multi-thread programs (multi-core thread package MCTP) as well as the Fraunhofer Virtual Machine FVM, which replaces the previous MPI programming model. Expanding on this, new parallel programming platforms are currently being developed for large parallel computer systems. The Seismic Development and Processing Architecture SDPA implements a fault-tolerant system with which the application development happens on a graphical user interface and a semi-automatic parallelization takes place. The system is intended for large parallel systems and will be used initially in the oil industry and then later in other industrial sectors. In the BMBF project IMEMO the patented parallelization framework GraPA is being adapted to the requirements of future hardware systems including GPUs. GraPA automates the parallelization to the furthest degree and uses a graph-based approach. Since 2005 a new parallel file system has been under development at the ITWM. The development started from scratch, learning from the problems and hassles with existing systems. In 2008 the first official release was available from the website www.fhgfs.com. A series of smaller installations in the oil and gas sector has confirmed the reliability of the system in recent years and the first large installations have been implemented at various universities. The software packages for angle domain migration (GRT) and the visualization and analysis of pre-stack data (PreStack-Pro), which are under development since a few years, have fulfilled the qualitatively high demands of our industry partners and are now in productive use.

In the scope of the ITWM Future themes, activities of various departments which are involved with renewable energies are bundled under the ITWM Future "Renewable Energies". The focus of the work in the CC HPC are software systems which will manage distributed systems in electricity networks; see also www.mysmartgrid.de.

IMEMO PROJECT – INNOVATIVE HPC-METHODS AND APPLICATION TO HIGHLY SCALABLE MOLECULAR SIMULATION

Dr. Daniel Grünewald, Bernd Lörwald, Dr. Hendrik Adorf, Dr. Martin Kühn, Dr. Dominik Michel, Dr. Abel Amirbekyan, Dr. Dirk Merten, Dr. Norman Ettrich, Bernd Klimm, Dr. Carsten Lojewski, Alexander Petry, Dr. Tiberiu Rotaru, Dr. Dimitar Stoyanov, Dr. Mirko Rahn

Nikolai Ivlev, Benedikt Lehnertz, Alexander Neundorf, Tobias Götz, Ely Wagner Aguiar de Oliveira, Gvidas Dominauskas, Maxim Ilyasov, Mathias Dalheimer, Kai Krüger, Dr. Franz-Josef Pfreundt, Christian Mohrbacher, Frauke Santacruz, Sven Breuner, Jens Krüger, Rui Màrio da Silva Machado

The importance of molecular dynamics (MD) simulations is more and more increasing, especially in the fields of thermal and chemical process engineering, material sciences as well as the biomolecular sciences and technologies. Key points o f interest are, for example, the computation of thermodynamic properties and transport coefficients of real mixtures at arbitrary points in thermodynamic state space, the detailed study of transport processes across membranes or the dynamics of phase transitions.

However, compared to their enormous potential, molecular methods only find limited application in current industrial research and development. One of the major problems is that the relevant time and length scales over which phenomena of interest occur cannot be reached by todays MD simulations, even when employing massively parallel systems. In particular, they cannot be reached at a sufficiently high accuracy required for engineering purposes. Furthermore, response times lie at the scale of days and therefore not at the desired (semi-)interactive time scale. In order to tackle these challenges and push the state of the art one step further, the CC HPC has formed an alliance with the universities in Kaiserslautern (Chair of Thermodynamics), Paderborn (Chair of Thermodynamics and Power Engineering), Munich (Chair of Scientific Computing) and the High Performance Computing Center Stuttgart within the BMBF project IMEMO. Goal is to provide the next generation of highly scalable and functionally powerful MD codes as well as general programming tools for implementing molecular simulations. One of the main tasks is to reduce communications overheads in codes that are traditionally parallelized with MPI. It is achieved by making use of the FVM (Fraunhofer Virtual Machine) that was developed at the CC HPC and serves as a replacement of MPI. It realizes a PGAS (Partitioned Global Address Space) memory model and enables one to hide communications by employing DMA (Direct Memory Access). In this manner, scalability of codes is significantly increased.

Another important goal is to deliver programming tools for developers of MD simulations. They shall be enabled to write portable yet efficient code. Here, the CC HPC builds on its patented GraPA (Graph Parallel Architecture) framework. The framework is extended in order to allow for implementation and efficient execution of particle based simulations. Moreover, the range of supported platforms will be increased. The extended framework is employed in implementing a highly scalable MD kernel. The project IMEMO is funded by the Federal Ministry of Education and Research (BMBF) under grant 01IH08013C.

Fraunhofer FS

1

SCALABLE STORAGE WITH THE FRAUNHOFER PARALLEL FILE SYSTEM

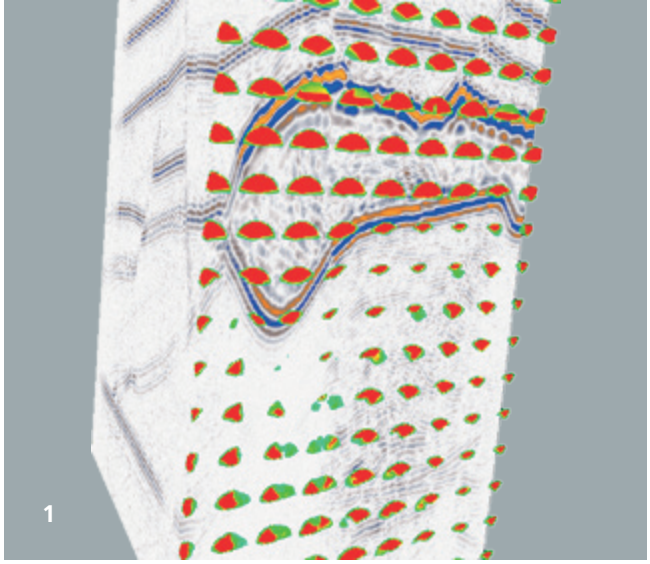
1 *Administration and monitoring of FhGFS are made very easy and intuitive through graphic tools*

With the constantly increasing performance of modern processors and network technologies, which enable integration with increasingly larger computer clusters, the demand for increasingly realistic and detailed simulation results is also growing. Such simulations also require work with large data sets which now often lie in the range of several hundred gigabytes or even in the terabyte range. In the process, however, it is problematic that the performance of hard discs lies significantly below that of the remaining system components, so that the run-time of a compute job is often primarily determined by the speed of the hard disc access.

In order to counteract this, the CC HPC has been working on the parallel file system FhGFS for several years now. With this file system, the individual files are distributed accross multiple servers chunk by chunk and, in doing so, can be read or written in parallel. This method enables the processing of data sets at many times the conventional speed and thereby has an immediate, positive effect on the length of time until reaching the calculation result. Along with a very good scalability of the system, the developer team placed major importance on uncomplicated use through the preparation of graphic management tools and a high degree of flexibility in the installation. In this way, FhGFS makes it possible to use separate servers as a shared parallel storage in a cluster as well as to connect the hard discs of the compute nodes themselves in this manner. In addition, the distribution pattern of the data can be flexibly adapted to the requirements of users, such as geographically separate data centers, in order to further reduce the access time to the data.

In recent years, cooperation with industry partners like SGI already showed that FhGFS can deliver a significantly better throughput rate for typical workloads than comparable commercial solutions. Therefore, the file system is also used to power the storage of the Fraunhofer Cell Cluster (until November 2008 in 1st place of the worldwide Green Top 500 List), where it enables a data throughput of several gigabytes per second. This year the system was presented live at workshops and trade fairs and sparked great interest in the HPC community.

Currently, the file system is already in use on diverse clusters with a size of several hundred compute nodes. Early next year, the work on a high-availability mode should be completed and support for Windows will follow. This will make the file system also attractive to users outside of the HPC area, for example as a fail-safe project storage or for home directories. FhGFS can be downloaded free of charge at http://www.fhgfs.com. Commercial support is also available.



SEISMIC PRE-STACK DEPTH MIGRATION PROCESSES

1 *GRT-migrated image of a salt dome structure, represented with information for the illumination of the subsurface (spherical segment)*

The group of processes of the seismic Pre-Stack Depth Migration (PSDM) carry over the measured and pre-processed seismic data to structural images of the subsurface, which are interpretable in regard to the position of the layer boundaries and the rock properties. In the meantime, there is an extensive range of software products in this area at the CC HPC. The processes based on ray-tracing offer the advantage of a higher computing speed and greater flexibility. Along with the standard process of Kirchhoff migration, the CC HPC has implementations of generalized radon transformation (GRT) and the ultra-fast beam migration. The advantages of GRT are based on the parameterization of the image problem through the angle of radiation at each point of the discretised subsurface. The result is high-quality subsurface images and reflection angle gather. The methodology does not allow pre-sorting of the seismic data, so that the implementation is only enabled by the CC HPC solution of the virtual machine. This year the significant acceleration of the extremely research-intensive methods were successful, so that the present GRT is probably the world's only productively usable implementation. Pursuing an entirely different objective, fast beam migrations, which are coarsened with interactive speed but deliver geometrically correct subsurface images, are used as a basis to determine the exact position and shape of salt rock bodies.

Through the generation and compression of so-called slant stacks, the speed-independent parts of the summations from the actual migration are extracted, whereby the migration percentage to be repeated with each change of the seismic speeds is currently twice as fast as with a conventional Kirchhoff migration. The CC HPC portfolio of radiation-based 3d processes is being expanded by reflection tomography, which – supported by massive, parallel implementation of all of its individual components and through the visualisation of intermediate and final results from PSPRO – should provide good depth speed models as input for the PSDM. The migrations directly triggering wave equation supply even better image qualities in many cases than the radiation processes discussed. However, they require significantly more computing time. A 2d implementation of the reverse time migration supplies very good results and forms the basis for enhancements to 3d and for the full waveform inversion (FWI). As the "core competency" the latter provides the best possible image qualities and precisions of the calculated speed models.

Based on the methodical problems and with data set sizes in the multiple TByte range for image depths up to 15 km and area expansions up to 1,000 km², FWI would be the most important theme in exploration seismology in the coming years.

PHOTO-REALISTIC RENDERING: OFFLINE QUALITY – REAL TIME SPEED

1 & 2
Texture filtering and HQ Anti-aliasing (Lamborghini) 3D Object with ~ 2 Mio. triangles at a resolution of 2800×1050 pixels, with full ray differentials, HQ texture and normal-map filtering, un-compressed textures (up to 4,000×4,000 pixel), 16× anti-aliasing and Mitchell-Netravali reconstruction > 50 fps on average

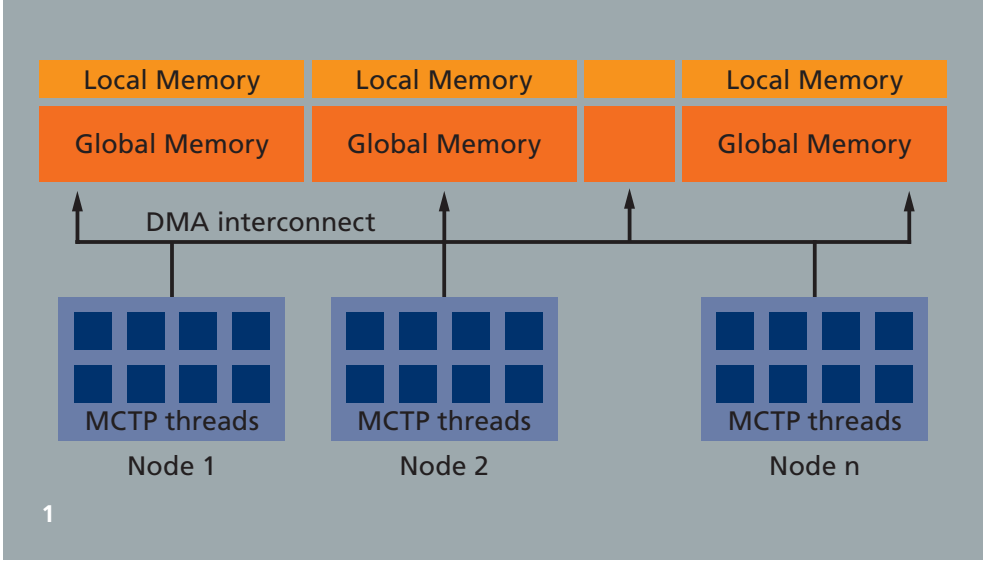
In diverse fields of production, ranging from the automotive industry through mechanical engineering to entertainment industry, the use of artificially generated, photorealistic images in recent years has steadily grown in importance. The capability to examine a future product virtually on a computer screen saves companies time and money for the production of prototypes. This is for example important for the development of new automobile models, where the costs for prototypes are immense. But this is only one kind of application. The consumers' expectations to special effects in new videogames or movies is constantly increasing the demand for better and more realistic images. But together with the requirements, calculation time for the desired degree of realism increases massively. Therefore the time for the calculation of a single image today ranges from a couple of minutes up to several hours. Up to now, there are no real-time algorithms, that enable a user to navigate interactively and smoothly through photo-realistically rendered, large 3d scenes.

The Competence Center for High Performance Computing (CC HPC) at the ITWM is dealing with CPU-based ray-tracing algorithms for large-scaled triangulated 3D scenes and objects for several years. Together with our ray-tracing algorithms and some powerful volume rendering algorithms, which also have been developed at the CC HPC, some successful commercial software products could be put on the market (including Pre-Stack PRO or modules for MAGMASOFT®).

The latest generation of the PV-4D PBRT Engine is now the first ray-tracing engine to bring production-quality rendered images in real-time on the screen, reducing the idle time for the user to some milliseconds. The rendering is so fast, the user can hardly recognize the calculation process between two images. So the PV-4D PBRT Engine defines entirely new standards for photorealistic ray-tracing engines and stands out clearly from all its competitors.

The procedures for geometry handling in the PV-4D PBRT Engine also correspond to the absolute latest in technology (i. e. traversal of the scene, intersection tests, ...). A full HDR-pipeline, HQ texture filtering and HQ anti-aliasing that measure up even with highest needs of the user, are also part of the engine's features.

With the use of CPUs instead of GPUs, additional benefits can be attained. Thus, there is no size limitation of models, scenes and textures, as in almost every GPU-based method. A special graphics hardware is not required.



SOFTWARE DEVELOPMENT FOR MULTI-CORE – MCTP AND FVM

1 *FVM- and MCTP-architecture*

Modern computer architectures are now multi-core: processing systems composed of two or more independent cores. This implies a paradigm shift on the development of software where developers must exploit the inherent parallelism of these architectures to be able to scale their applications. In the high-performance computing area, large computer systems are built with these modern architectures together with high-performance interconnects such as Infiniband. So programmability and scalability are some of the key points to take advantage of future HPC systems.

To tackle these key points, the CC HPC has developed the Fraunhofer Virtual Machine (FVM) and the Many-Core Threading Package (MCTP). The Fraunhofer Virtual Machine (FVM) is a communication library and runtime system for real-time parallel applications running on cluster systems. It provides a Partitioned Global Address Space (PGAS) to the application which in turn has direct and full access to a remote data location. The whole functionality includes communication primitives, environment runtime checks, synchronization primitives such as fast barriers or global atomic counters, all which allow the development of parallel programs for large scale. Focused on performance, by leveraging on the network interconnect hardware (wire-speed), it minimizes the communication overhead with overlap of communication and computation (asynchronous communications). The FVM provides a simple, reliable runtime system to handle large datasets, dynamic and irregular applications that are I/O and compute intensive. It has reached production quality for x86 and IBM Cell/B.E architectures.

Since software developers can no longer rely on increasing clock speeds alone to speed up single-threaded applications they must learn how to properly design their applications to run in a threaded environment and consequently attain peak performance. The MCTP is a threading package to make multi-threading programming slightly more programmer friendly. It abstracts the native threads of the platform and provides complete state-of-the-art functionality to work with threads, threadpools and related topics such as synchronization.

The FVM and the MCTP together allow the exploitation of parallelism at different levels – cluster and multi-core. They are the building blocks for the CC HPC parallel software development with which all parallel algorithms and applications such as Pre-Stack Pro are developed.

FRAUNHOFER-CHALMERS RESEARCH CENTRE FOR INDUSTRIAL MATHEMATICS FCC

- GEOMETRY AND MOTION PLANNING
- COMPUTATIONAL ENGINEERING
- RELIABILITY AND RISK MANAGEMENT
- SYSTEM BIOLOGY AND BIOIMAGING

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FCC has since start 2001 completed more than two hundred industrial and public projects. We have successfully cooperated with more than seventy companies from different branches. We have seen the power of our vision "Mathematics as Technology" and we are impressed and proud of the trust we enjoy from our founders Fraunhofer-Gesellschaft and Chalmers, from industrial partners, and from public research agencies.

Our mission is to undertake and promote scientific research in the field of applied mathematics to the benefits of Swedish and European industry, commerce, and public institutions. We do this as a business-making, non-profit, Swedish institution. From this perspective the year 2009 is by far our most successful year so far, with the turn-over increased by almost thirty percent.

We note a strong increase of public projects in absolute and relative numbers. At the same time the industrial income has dropped, while industry is to a large extent present as contracted partners in the public projects. We expect it will take two to three years to reestablish the normal level of an industrial income around forty percent through a campaign aiming at a broader base of industrial clients including small and medium-sized companies.

Together with our partners Chalmers and the Fraunhofer industrial mathematics institute ITWM we cover a wide range of applications. In 2009 we have intensified our cooperation further, including joint actions with all ITWM departments and with Chalmers Wingquist Laboratory, Chalmers Systems Biology, Chalmers Fluid Dynamics, and within the Gothenburg Mathematical Modelling Centre GMMC.

In 2008 we started the industrial partner group IPG as a successor of the former Swedish Association of Industrial Mathematics STM. The group meets two to four times a year in Kaiserslautern and in Gothenburg to define a research programme from research scenarios, industrial scenarios, and making a synthesis. The first year was on parameter identification and optimization resulting in a proposal on multi-scale, multi-objective simulation and optimization. In 2009 we addressed uncertainty, reliability, and quality with research scenarios presented by GMMC. The research proposal focused on variation mode and effect analysis VMEA.

The last year we were fortunate to recruit four new co-workers. Our staff of applied researchers is a mix of PhDs and Masters of Science, where about half have a doctor's degree. We believe in a model where an MSc first works in industrial and public projects for two to five years. In this period we encourage participating in conferences and submitting papers to get a research flavour. If a proper project then appears, which would naturally include a PhD student, we are well positioned to offer the project a candidate who would contribute significantly from start, and the interested staff member a possibility for bringing her or his education one step further. Seven of our employed MScs, five of them last year, have started PhD studies in this way: five at Chalmers and two on leave abroad.

In 2008 we initiated a campaign to offer an interesting option to Chalmers students while boosting our base for future recruitments. We invite master students from a handful of Chalmers and Gothenburg University international programs with a mathematical profile to information meetings "Earn Money on Mathematics". We describe FCC and our activities, including the possibilities for talented students to be contracted on ten percent of full time, or half a day per week, for work in the Centre, and to do master thesis projects at the Centre with joint supervision from Chalmers and FCC. In 2009 the volume of students doing contracted work and master thesis projects reached ten full-time equivalents.

The department Geometry and Motion Planning, working in close cooperation with the Chalmers Wingquist Laboratory, has entered the second phase of the ten-year Wingquist Laboratory VINN Excellence Centre for Virtual Product Realization 2007 – 2016. In 2009 the department started four three-year or longer public projects, including a project on virtual paint

and a project on intelligently moving manikins. The software platform IPS for rigid body motion planning, robotics path planning, and flexible cable simulation is recognized through licensing by industrial clients in Europe, United States, and Japan. The department has substantial joint development with the ITWM department Mathematical Methods in Dynamics and Durability.

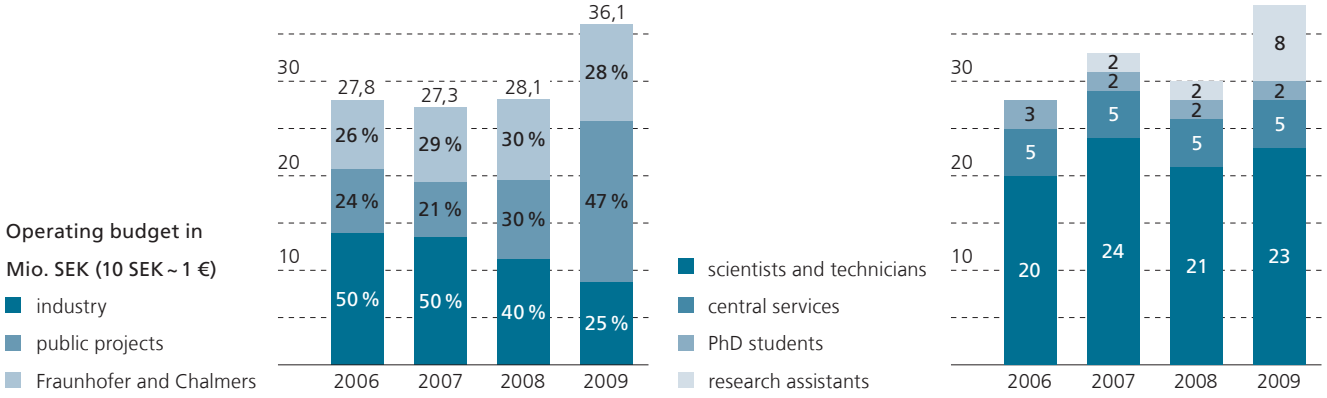
The department Computational Engineering and Design has expanded its work on multi-physics applications involving fluid-structure and fluid-electromagnetics interaction, in particular through projects with Swedish and other European industrial partners together with the ITWM departments Optimization, Flow and Material Simulation, and Transport Processes. In 2009, the department started a project on innovative simulation of paper with Swedish paper and packaging industry and a companion project on dynamic fiber network modeling in a finite element setting through the Gothenburg Mathematical Modelling Centre GMMC. The department is a key partner in the project on virtual paint mentioned above.

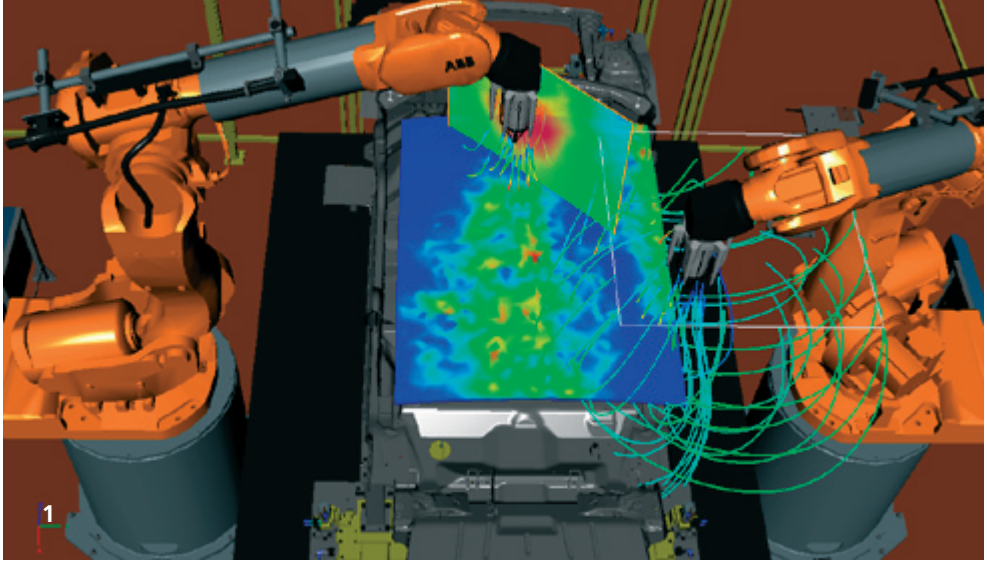
The department Reliability and Risk Management has its focus on fatigue life and load analysis of mechanical structures in, e. g., automation and automotive industry. In 2009 we successfully finished a four-year joint project "Guide to load analysis for automotive applications" with the Chalmers Stochastic Centre, Fraunhofer ITWM Dynamics and Durability, SP Technical Research Institute of Sweden, and six industrial partners from Germany, Italy, the Netherlands, and Sweden.

The department Systems Biology and Bioimaging, has continued to grow by adding substantial industrial (pharmaceuticals) and public (EU and GMMC) income to our long-term grant from the Swedish Foundation for Strategic Research SSF. In 2009 we submitted our final report to SSF, summarizing our research and describing the department built up as the result of this grant. Our cooperation with the ITWM department System Analysis, Prognosis and Control has intensified through a strategic project on integration of systems biology, biotechnology, mathematics, and image processing in fundamental animal cell protein production.

Since start the Centre has earned more than twenty million euro including forty percent industrial and thirty percent public income; we are well positioned for the challenges to come! Below we give a flavor of our activities through describing two profile projects and presenting our competences organized in four departments.

Dr. Uno Nävert
Director of FCC





VIRTUAL PAINT SHOP – SPRAY PAINTING

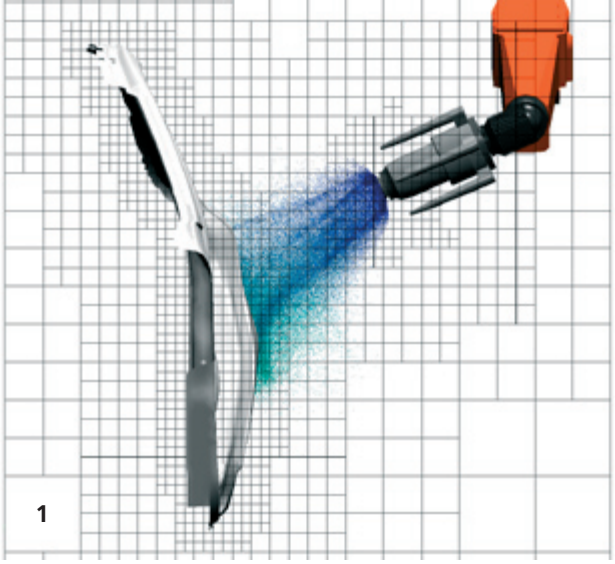
1 *Simulated flow field between applicator and target. Streamlines and colour on the cutting plane illustrate air velocity. The dots are paint droplets.*

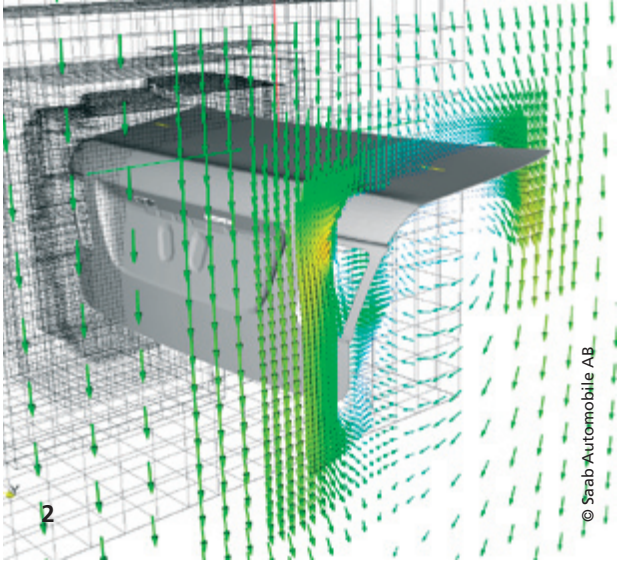
The goal of this ongoing project is to develop new simulation algorithms and tools for paint and surface treatment processes in automotive paint shops. The project is part of Vinnova's MERA and FFI programs that support the Swedish automotive industry and our research partners are Volvo Cars, Saab Automobile, Scania, Volvo AB and Swerea IVF. The researchers at FCC are responsible for the software and the development of new novel algorithms. The first version of the virtual spray painting tool was released in 2009 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.

Paint and surface treatment processes in the car paint shop are to a large extent automated and performed by robots. Having access to tools that incorporate the flexibility of robotic path planning with fast and efficient simulation of the processes is important since such tools will reduce the time required for introduction of new car models, reduce the environmental impact and increase quality. The key process in the paint shop, which is also the most demanding from a modelling point of view, is the spray painting of the car body. The combination of high physical complexity, large moving geometries, and demands on near real time results constitutes a big challenge. The current situation in the automotive industry is therefore to rely on individual experience and physical validation for improving their processes.

In spray painting paint primer, color layers and clear coating are applied through the Electrostatic Rotary Bell Sprayer (ERBS) technique. Paint is injected at the centre of a rotating bell; the paint forms a film on the bottom side of the bell and is atomized at the edge. The droplets are charged electrostatically and driven towards the target car body both by shaping air surrounding the rotating bell and by a potential difference in the order of 50-100 kV between paint applicator and target. An accurate prediction of the paint-film build-up therefore requires tracing the droplets, which are two-way coupled to the fluid flow and electrostatic field, from bell to target.

To efficiently simulate this demanding application we have developed an immersed boundary octree flow solver, IBOFlow, based on algorithms for coupled simulations of multiphase and free surface flows, electromagnetic fields, and particle tracing. In IPS Virtual Paint, the IBOFlow solver is included in the in-house package for automatic path planning, IPS. The first version of the software was released in 2009 and the major improvement of computational speed compared to other approaches is partly due to the use of grid-free methods which in addition simplifies preprocessing. In the software, an arbitrary geometry can be painted using a moving, pre-defined electrostatic rotary bell, where the user can set process conditions like paint flow,





air flow, electrostatic droplet charge and atomizer bell rotation speed. The process conditions are used to compute physical inlet conditions such as paint droplet size and velocity distributions and applicator inlet air flow. Validations using experimental data for test plates are excellent. Presently, we are working on further improvements of IPS Virtual Paint as well as tools for simulation of the other processes relevant to the automotive paint shop.

1 *Paint simulation in IPS Virtual Paint: Paint droplets are visualised and colored by mass, where blue is small and red is larger, as they impact on the target.*

2 *Geometry treatment in IPS Virtual Paint: The solver utilizes a Cartesian grid that can be arbitrarily refined around stationary as well as moving objects.*

GUIDE TO LOAD ANALYSIS FOR AUTOMOTIVE APPLICATIONS

1 The design specifications within the automotive industry are to a large extent based on testing and measuring loads on test tracks.

Transport vehicles are exposed to dramatically different operating conditions in different parts of the world and in different transport missions. Six leading European truck manufacturers: DAF, Daimler, Iveco, MAN, Scania, and Volvo, commissioned a research project to produce a guide to load analysis oriented towards fatigue design of trucks. The project was run by FCC, with Dr P Johannesson as the project leader, in collaboration with SP Technical Research Institute of Sweden, Chalmers Mathematical Sciences, Fraunhofer ITWM, and the industrial partners. The complete guide was available in 2009. In 2006 an initial investigation was carried out of current practice and future needs within load analysis, together with a survey of the state-of-the-art in load analysis for automotive applications. After this pre-study the parties agreed on the main project.

In 2007–2009, the Guide was developed in close collaboration between all parties, including regular meetings and annual seminars at each company. After the Introduction in the first part, the second part of the Guide presents Methods for load analysis, describing useful methods and how and when they should be used. The year 2009 was spent on the third part: Load analysis in view of the vehicle design process. Below we describe this part in somewhat more detail, starting with the philosophy of the load-strength model for reliability and robust design.

The ultimate goal for the manufacturer is to make a design that exactly meets the needs of the customers, neither too strong nor too weak. The requirements need to be converted into for example a certain small risk of failure, a proper safety factor, or an economical expected life. In order to make a robust design it is as important to have good knowledge of the properties of the customer loads, as it is to have good knowledge of the mechanical behaviour of the material and structure in question. To present load analysis in view of the truck design process, and describe what methods are appropriate in the different design stages, it is important to consider loads on different levels: system, sub-system, and component. Functional specifications and design goals are set on the different load levels. Here we are concerned with the durability demands in terms of reliability target for the truck, for sub-systems, and for components. It is important to follow these demands throughout the design process.

The task is to assess the customer load distribution. Apart from defining the load of interest (e. g. the load on the steering arm), it is important to define which population it represents, e. g. all potential customers, a specific application (e. g. timber trucks), or a specific market (e. g. the European market). Three strategies for estimating the customer load distribution are discussed:

1 *The durability specifications of trucks depend on the transport mission. The timber truck in the picture needs to be designed to sustain very high pay loads, as well as high dynamic loads.*

- Random sampling: Choose customers randomly, however, not necessarily with equal probabilities, and measure their loads.

- Customer usage and load environment: Estimate the proportion driven on different road types, and combine this with measurements from the different road types.

- Vehicle independent load description: Define models for customer usage, road types, driver influence, and legislation, which can then be combined with a model for the vehicle dynamics.

The topic is to derive loads for design and verification purposes. The basic specification is the severity of the load, which needs to be related to the design approach taken. Load time signals can be derived using simple synthetic loads, random load models, modification of measured signals, standardized load sequences, test track measurements, or can be defined through an optimized mixture of test track events.

The verification process is discussed; principles of verification, generation and acceleration of loads, and planning and evaluation of verification tests. Three verification approaches are presented:

- Highly Accelerated Life Testing, HALT, based on the idea that failures give more information than non-failures and give rise to improvements regardless severities that exceed what is expected.

- Load-Strength analysis based on characterizing tests. Strength and load properties are investigated by characterizing experiments. Scatter and uncertainties are analysed within a statistical framework to verify the design against reliability targets by means of established safety factors.

- Probability based formal procedures, with test plans based on formal consistent rules that, by experience, give safe designs. Typically, a low quantile in the strength distribution is verified by testing.

TALKS

Acar, Sarp Kaya; Lorenz, Stefan; Nögel, Ulrich
Heston Option Pricing Framework
Cambridge-Kaiserslautern Finanzmathematik Workshop, Fraunhofer ITWM Kaiserslautern, May

Altendorf, Hellen
3D Directional Mathematical Morphology for Analysis of Fiber Orientations
10th European Congress of Stereology and Image Analysis (ECS), Mailand, June

Altendorf, Hellen
Mathematical Morphology for Analysis of Fiber Networks
ESRF Seminar, Grenoble, January

Altendorf, Hellen
Morphologie Mathématique 3D Directionelle pour l'Analyse des Réseaux de Fibre
32ème Journée (International Society of Stereologie), Paris, February

Andrä, Heiko
Topology Optimization for Castings using a Level-set Method
Universität Graz, July

Andrä, Heiko et al
Domain decomposition for the computation of effective elastic moduli and Topology optimization for castings using a level-set method
Workshop Fraunhofer ITWM – Univ. Paris VI, Paris, July

Andrä, Heiko; Iliev, Oleg; Kabel, Matthias; Lakdawala, Zahra; Steiner, Konrad; Starikovicius, Vadimas
Interaction of Fluid with Porous Structure in Filtration Processes: Modelling and Simulation of Pleats Deflection
FILTECH 2009, International Conference & Exhibition for Filtration and Separation Technology, Wiesbaden, October

Andrä, Heiko; Kabel, Matthias; Rieder, Hans; Spies, Martin
Optimization of Multilayered Porous Acoustic Absorbers
NAG/DAGA 2009, International Conference on Acoustics, Rotterdam, March

Andrä, Heiko; Orlik, Julia; Zemitis, Aivars
Planungssystem für die Endoprothetik
Workshop "Simulation in der Biomaterial- und Medizintechnologie", Berlin, June

Becker, Jürgen
Determination of GDL Material Properties – Comparison of Experiment and Simulation
Hydrogen & Fuel Cells 2009: Conference and Trade Show, Vancouver, June

Becker, Jürgen; Wiegmann, Andreas; Steiner, Konrad
Numerical Determination of Effective Material Properties of Diffusion Media in Fuel Cells
ACHEMA 2009, Frankfurt, May

Becker, Jürgen; Wieser, Christian
Modelling of Microporous Layers
6th Symposium of Fuel Cell Modelling and Experimental Validation, Bad Herrenalb, March

Berger, Martin; Schröder, Michael; Küfer, Karl-Heinz
Multiobjective Optimization for Decision Support in Automated 2.5D System-in-Package Electronics Design
International Federation of Classification Societies 2009 Conference Dresden, March

Berndt, Dirk; Rösch, Ronald
Sicherstellung der Qualität durch optische Methoden
BME Forum: Einkauf von Gussteilen, München, January

Breuner, Sven
FhGFS – Das Fraunhofer Parallel File System
Parallel File Systems Workshop, HLRS Stuttgart, April

Burger, Michael; Dreßler, Klaus; Marquardt, Albert; Speckert, Michael
Calculating invariant Loads for System Simulation in Vehicle Engineering
Multibody Dynamics 2009, ECCOMAS Thematic Conference, Warschau, June

Cheng, Liping; Rief, Stefan; Wiegmann, Andreas
Nano Filtration Media – Challenges of Modelling and Computer Simulation
FILTECH 2009, Wiesbaden, October

Dalheimer, Mathias
Amazon EC2 als Teil der Virtualisierungsstrategie
IT-Virtualisierung, Köln, February

Dalheimer, Mathias
Cloud Computing – Eine Alternative für Enterprise HPC?
CloudConf 2009, Stuttgart, November

Dalheimer, Mathias
Cloud Computing im Unternehmenseinsatz
Stuttgarter Softwaretechnikforum 2009, Stuttgart, December

Dalheimer, Mathias
Financial Simulations on the Cloud
Open Grid Forum 27, Banff, Kanada, October

Dalheimer, Mathias
GenLM: Flexible License Management for Grids and Clouds", Grid License Management BoF
Open Grid Forum 25, Catania, March

Dalheimer, Mathias
Integrating EC2 services into the Fraunhofer PHASTGrid
Cloud Computing Workshop, Open Grid Forum 25, Catania, March

Dalheimer, Mathias
Lizenzen in D-Grid
D-Grid, All Hands Meeting, Göttingen, March

Dalheimer, Mathias
Multicriteria Scheduling in Grids & Clouds
Universität Leipzig, June

Dalheimer, Mathias
Virtualisierung im D-Grid
PT-Grid Workshop, Kaiserslautern

De Oliveira, Ely
Assessing Quality of Service in Production Grids,with respect to Middleware Systems
5° D-Grid Monitoring-Workshop, Jülich Supercomputing Centre, May

Desmettre, Sascha
Own-company Stockholding and Work Effort Preferences of an unconstrained Executive
EURO 2009 – 23rd European Conference on Operational Research, Bonn, Juli, Fourth General Conference on Advanced Mathematical Methods in Finance, Aalesund, Mai, und Beyond Part III, Conference for Young Researchers, Centre for Mathematical Sciences, Cambridge, April

Didas, Stephan
Processing Tensor Data with Higher Order PDEs
New Developments in the Visualization and Processing of Tensor Fields, Dagstuhl, July

Dillhöfer, Alexander; Rieder, Hans; Spies, Martin
Roboterbasierte Detektion von Oberflächenstrukturen in komplexen Freiformflächen mittels Luftultraschall und Methoden der Bildverarbeitung
DGZfP-Jahrestagung 2009, Münster, May

Dimitroff, Georgi
Monte Carlo simulation in the Heston stochastic volatility model
Cambridge-Kaiserslautern Projektworkshop, Cambridge, February

Dimitroff, Georgi
Multi-asset Heston stochastic volatility model
Workshop Financial mathematics meets econometrics, Universität Bonn, November, und Workshop Moderne Finanzmathematik und ihre Anwendung für Banken und Versicherungen, Fraunhofer ITWM Kaiserslautern, December

Dimitroff, Georgi
Shinking and Expansion under Isotropic Brownian Flows
Monash University Melbourne, Monash Statistical Seminar, December

Dmitriev, Vitaly
Multiscale Finite Volume Method as Solver and as Preconditioner
Miniworkshop on Numerical Upscaling, Oberwolfach, March

Erlwein, Christina
A Regime-Switching Regression Model for Hedge Funds
EURO 2009, 23rd European Conference on Operational Research, Bonn, Juli, und BMBF-Meeting Alternative Investments, Fraunhofer ITWM, Kaiserslautern, July

Erlwein, Christina
Application of hidden Markov Models in Financial Modeling
Cambridge-Kaiserslautern Projektworkshop, Cambridge, June

Ettrich, Norman; Merten, Dirk; Foss, Stig-Kyrre
Seismic Trace Conversions by Sinc-function Based Interpolation
71st EAGE Annual Meeting, Amsterdam, June

Feßler, Robert
Muster, Logos und Schriftzüge aus Licht
MATERIALICA, Surface Kongress, München, October

Geiger, Ansgar
Optimization of Power Plant Investments using (Approximate) Dynamic Programming
EUROXXIII, Bonn, June

Geiger, Ansgar
Strategic Optimization of Power Plant Investments
Universität Karlsruhe, June

Glatt, Erik; Rief, Stefan; Wiegmann, Andreas
Microstructure Simulation of Virtual Woven Filter Media
FILTECH 2009, Wiesbaden, October

Godehardt, Michael
Microstructural Analysis of a C/SiC Ceramic based on 3d Image Data
20th International Congress on X-Ray Optics and Microanalysis, Karlsruhe, September

Godehardt, Michael; Altendorf, Hellen; Wirjadi, Oliver
Lokale Vermessung von Fasersystemen: Aktuelle Entwicklungen und offene Fragestellungen an der Schnittstelle zur Modellierung
15. QIA – Workshop Quantitative Bildanalyse, Bissersheim, May

Hansen, Neele; Krumke, Sven
Integrating Timetabling and Vehicle Scheduling
EUROXXIII, Bonn, June

Hansen, Neele; Krumke, Sven
The complexity of integrating timetabling and vehicle scheduling
MAPSP, Abbey Rolduc, The Netherlands, June

Hering-Bertram, Martin; Obermaier, Harald; Kuhnert, Jörg; Keller, Patric; Hagen, Hans
Feature-based Visualization of Point-based Data
Dagstuhl, June

Herkt, Sabrina; Dreßler, Klaus
Nonlinear Model Reduction in Structural Mechanics
GACM 2009, Hannover, September

Herkt, Sabrina; Dreßler, Klaus; Pinnau, Rene
Model Reduction of Nonlinear Problems in Structural Mechanics
ESMC EuroMech 2009, Lissabon, September

Hietel, Dietmar
Fiber Spinnng: Modeling, Simulation and Optimization
Polyester & Intermediates Conference, Frankfurt/Main, June

Hietel, Dietmar
Filaments & Nonwovens: Modeling, Simulation and Optimization
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Challenges in modelling and simulation of filtration processes
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Multiscale Problems and Upscaling. Simulation of Multiscale Filtration Processes
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Die Monte Carlo Methode: Klassisches und Neues
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Financial Mathematics: Between Stochastic Differential Equations and Financial Crisis
Conference in memory of Jürgen Lehn, METU Ankara, April

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The Decoupling Approach to Binomial Pricing of Multi-Asset Options
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Theoretical Advances with Practical Use in Finance
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Universität Bonn, November

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Veranstaltungsreihe zum Jahr der Wissenschaft, Fruchthalle Kaiserslautern, March

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Finite Pointset Method (FPM): Optimized Meshfree Solver in Gasdynamics
Fifth International Workshop on Meshfree Methods for Partial Differential Equations, Bonn, August

Kurz, Jochen; Rieder, Hans; Stoppel, Markus; Taffe, Alexander
Control and Data Acquisition of Automated Multi-Sensor Systems in Civil Engineering
NDTCE09 Non-Destructive Testing in Civil Engineering, Nantes, June

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A multibody System Modeling Approach to Geometrically Exact Rods using Geometric Finite Differences
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Monz, Michael
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Böhm, Martin
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Böhm, Martin
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University of Applied Sciences, Kaiserslautern

Dalheimer, Mathias
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Müller, Marlene; Ruckdeschel, Peter
Non- and Semiparametric Modelling and Programming in R (Doktorandenkurs)
University Göttingen, June 2009

Nickel, Stefan
Professur für Operations Research und Logistik
Saarland University, Saarbrücken (until March 2009)
Professur für Diskrete Optimierung und Logistik
University Karlsruhe (since April 2009)

Prätzel-Wolters, Dieter
Professur für Technomathematik
University of Kaiserslautern, Dept. of Mathematics

PUBLICATIONS

Rieder, Hans
Implementations of Signal Processing Algorithms based on embedded DSP Technology
HTW Saarland University of Applied Sciences, Saarbrücken, Winter term 2008/2009 and 2009/2010

Spies, Martin
Electromagnetic waves, their interaction with matter and some general principles used in NDT
Université Bordeaux I, Master CNDMS, November 2009

Acar, Sarp Kaya; Natcheva-Acar, Kalina
A guide on the implementation of the Heath-Jarrow-Morton Two-Factor Gaussian Short Rate Model (HJM-G2++)
Berichte des Fraunhofer ITWM 170, 2009

Ackermann, Heiner; Berenbrink, P.; Fischer, Simon; Hoefer, Martin
Concurrent imitation dynamics in congestion games
Proceedings of the 28th ACM Symposium on PODC, p. 63 - 72, 2009

Ackermann, Heiner; Fischer, Simon; Hoefer, Martin; Schöngens, Marcel
Distributed algorithms for QoS load balancing
Proceedings of the 21th SPAA, p. 197 - 203, 2009

Ackermann, Heiner; Röglin, Heiko; Vöcking, Berthold
Pure Nash equilibria in player-specific and weighted congestion games
Theor. Comput. Sci., 410 (17), p. 1552 - 1563, 2009

Ahmad, Kalimuddin; Knaf, Hagen; Lang, Patrick
A wavelet based technique to measure Heart Rate Variability
Sampling Theory in Signal and Image Processing 8 (2), 2009

Ahmad, M. K.; Didas, Stephan; Iqbal, J.
Using the sharp operator for edge detection and nonlinear diffusion
Berichte des Fraunhofer ITWM 176, 2009

Altendorf, Hellen; Jeulin, Dominique
3D Directional Mathematical Morphology for Analysis of Fiber Orientations
Image Analysis & Stereology 28, 143 - 153, 2009

Altendorf, Hellen; Jeulin, Dominique
Fiber Separation from Local Orientation and Probability Maps
ISMM 2009 Abstract Book, 45 - 48 University of Groningen, 2009

Andrä, Heiko; Kabel, Matthias; Spies, Martin; Rieder, Hans
Optimization of multilayered porous acoustic absorbers
Proc. NAG/DAGA 2009, International Conference on Acoustics, Rotterdam, 1679 - 1682, 2009

Attarakih, Menwer; Jaradat, Moutasem; Drumm, Christian; Bart, Hans-Jörg; Tiwari, Sudarshan; Sharma, Vikhash; Kuhnert, Jörg; Klar, Axel
Solution of the population balance equation using the one primary and One secondary method (OPOSPM)
In: Computer-Aided Chemical Engineering, 26, 1333, Eds: J. Jezowski, J. Thullie, Elsevier, 2009

Baydar, Evren;.di Graziano, Giuseppe; Korn, Ralf
Theoretical solution versus industry standard: Optimal leverage function for CPDOs
Blätter der DGVFM 30, 15 - 29, 2009

Becker, Jürgen; Flückiger, Reto; Reum, Mathias; Büchi, Felix N.; Marone, Federica; Stampanoni, Marco
Determination of Material Properties of Gas Diffusion Layers - Experiments and Simulations Using Phase Contrast Tomographic Microscopy
J. Electrochem. Soc. 156 (10), B1175 - B1181, 2009

Berger, Martin; Schröder, Michael; Küfer, Karl-Heinz
A Constraint-based Approach for the Two-dimensional Rectangular Packing Problem with Orthogonal Orientations
Operations Research Proceedings 2008, Part 9, Springer, p. 427 - 432, August 2009

Brandt, Achi; Iliev, Oleg; Willems, Jörg
A Domain Decomposition Approach for Calculating the Graph Corresponding to a Fibrous Geometry
In: Domain Decom-position Methods in Science and Engineering XVIII, M.Bercovier et al (Eds), Springer, LNCSE, 3 - 15, 2009

Brickenstein, Michael; Dreyer, Alexander
PolyBoRi: A framework for Gröbner basis computations with Boolean polynomials
Journal of Symbolic Computation, Volume 44, Issue 9 (2009), September 2009, pp. 1326 – 1345

Brickenstein, Michael; Dreyer, Alexander; Greuel, Gert-Martin; Wedler, Markus; Wienand, Oliver
New developments in the theory of Groebner bases and applications to formal verification
Journal of Pure and Applied Algebra, Special issue on Theoretical Effectivity and Practical Effectivity of Gröbner Bases, Volume 213, Issue 8, August 2009, pp. 1612 - 1635

Bügel, Ulrich; Knaf, Hagen; Laufs, Uwe
Technologieentwicklung: Theoretische; praktische Unterstützung mit Hilfe von Data Mining
HMD Praxis der Wirtschaftsinformatik, 268, 21 - 34, 2009

Burger, Michael, Dreßler, Klaus, Marquardt, Albert, Speckert, Michael
Calculating invariant loads for system simulation in vehicle engineering
Multibody Dynamics 2009, ECCOMAS Thematic Conference, 29th June - 2nd July 2009, Warsaw

Burgeth, Bernhard; Breuß, Michael; Didas, Stephan; Weickert, Joachim
PDE-based morphology for matrix fields: Numerical solution schemes
in: S. Aja-Fernandez, R. de Luis-Garcia, D. Tao, X. Li (Eds.): Tensors in Image Processing and Computer Vision, 125-150, Springer, London, 2009

Burgeth, Bernhard; Didas, Stephan; Weickert, Joachim
A general structure tensor concept and coherence-enhancing diffusion filtering for matrix fields
in: D. Laidlaw, J. Weickert (Eds.): Visualization and Processing of Tensor Fields: Advances and Perspectives. Springer, Berlin, 305-323, 2009

Cheng, Liping; Rief, Stefan; Wiegmann, Andreas
Nano Filtration Media – Challenges of Modelling and Computer Simulation

FILTECH, Wiesbaden, Vol. II, 2009, pp 413 - 419

Crauel, Hans; Dimitroff, Georgi; Scheutzow, Michael
Criteria for strong and weak random attractors
Journal of Dynamics and Differential Equations, 21 (2), 233 - 247, 2009

Dalheimer, Mathias
GenLM: License Management for Grid and Cloud Computing Environments
Proceedings of the 2009 9th IEEE/ ACM International Symposium on Cluster Computing and the Grid. Shanghai 2009

De Oliveira, Ely
Monitoring Service Level Agreements in Grids with support of a Grid Benchmarking Service
10th IEEE International conference on Grid Computing – Service Level Agreements in Grids Workshop, Banff, October 2009

Deines, Eduard; Michel, Frank; Hering-Bertram, Martin; Mohring, Jan; Hagen, Hans
Simulation and visualization of indoor acoustics using phonon tracing
In: Visualizing Sustainable Planning, 147 - 156, Springer, 2009

Didas, Stephan; Weickert, Joachim; Burgeth, Bernhard
Properties of higher order nonlinear diffusion fitlering
Journal of Mathematical Imaging and Vision 35 (3), 208 - 226, 2009

Dillhöfer, Alexander; Rieder, Hans; Spies, Martin
Roboterbasierte Detektion von Oberflächenstrukturen in komplexen Freiformflächen mittels Luftultraschall; Methoden der Bildverarbeitung
DGZfP Berichtsband BB 115-CD DGZfP-Jahrestagung (2009), P45

Dimitroff, Georgi; Scheutzow, Michael
Dispersion of volume under the action of isotropic Brownian flows
Stoch. Proc. Appl., 119 (2), 588 - 601, 2009

Dimitroff, Georgi; Szimayer, Alexander; Wagner, Andreas
Quanto option pricing in the parsimonious Heston model
Berichte des Fraunhofer ITWM 174, 2009

Dimitroff, Georgi; van Bargen, Holger
Isotropic Ornstein-Uhlenbeck flows
Stoch. Proc. Appl., 119 (7), 2166 - 2197, 2009

Dittel, Agnes; Fügenschuh, Armin; Göttlich, Simone; Herty Michael
MIP presolve techniques for a PDE-based supply chain model
Optimization Methods and Software Volume 24, Issue 3, p. 427 - 445, 2009

Dreßler, Klaus; Speckert, Michael; Bitsch, Gerd
Virtual durability test rigs for automotive engineering
Vehicle system dynamics 47 (2009), No.4, pp.387 - 401

Ewing, Richard; Iliev, Oleg; Lazarov, Raytcho; Rybak, Iryna; Willems, Jörg
A simplified method for upscaling composite materials with high contrast of the conductivity
SIAM J. Scientific Computing, 31 (4), 2568 - 2586, 2009

Fery, Yvonne, Buschauer, Inga, Salzig, Christian, Lang, Patrick, Schrenk Dieter
Technical pentabromodiphenyl ether and hexabromocyclododecane as activators of the pregnane-X-receptor (PXR)
Toxicology. 2009 Oct 1;264 (1 - 2): 45 - 51

Georgi Dimitroff, Peter Baxendale
Uniform shrinking and expansion under isotropic Brownian flows
Journal of Theoretical Probability, 22 (3), 620 - 639, 2009

Glatt, Erik; Rief, Stefan; Wiegmann, Andreas; Knefel, Markus; Wegenke, Engelbert
Structure and pressure drop of real and virtual metal wire meshes
Berichte des Fraunhofer ITWM 157, 2009

Glatt, Erik; Rief, Stefan; Wiegmann, Andreas; Knefel, Markus; Wegenke, Engelbert
Struktur; Druckverlust realer; virtueller Drahtgewebe
Filtrieren; Separieren, Vol.23, No. 2, pp. 61 - 65, 2/2009

Gramsch, Simone; Hietel, Dietmar; Schäfer, Matthias
Optimierung von Nadelbildern in der Vliesstoffverarbeitung -Designmöglichkeiten durch Einsatz von Simulationstools
Proceedings 24. Hofer Vliesstofftage 2009

Grzhibovskis, Richard; Rjasanow, Sergey; Andrä, Heiko; Zemitis, Aivars
Boundary element method for calculation of effective elastic moduli in 3D linear elasticity
Mathematical Methods in the Applied Sciences, Published Online: Sep 11 2009

Hardt, S.; Tiwari, S.; Klar, A.
Momentum transfer to Nanoobjects between isothermal Parallel Plates
Microfluidics and Nanofluidics 6, 489 - 498, 2009

Hering-Bertram, Martin; Hagen, H.
Reducing interpolation artifacts by globally fairing contours
In: Mathematical Foundations of Scientific Visualization, Computer Graphics, and Massive Data Exploration, 257 - 269, Springer, 2009

Hering-Bertram, Martin; Reis, Gerd; Zeilfelder, Frank
Adaptive quasi-interpolating quartic splines
Computing, 86 (2 - 3), 89 - 100, 2009

Herty, Michael; Klar, Axel; Motsch, Sébastien; Olawsky, Ferdinand
A smooth model for fiber laydown processes and its diffusion approximations
Kinetic and Related Models, 2 (3), 489 - 502, 2009

Iliev, Oleg; Lakdawala, Zahra; Andrae, Heiko; Kabel, Matthias; Steiner, Konrad; Starikovicius, Vadimas
Interaction of fluid with porous structure in filtration process: Modelling and simulation of pleats deflection
Proceedings FILTECH Europa, Wiesbaden, 27 - 31, Volume II, 2009

Iliev, Oleg; Lakdawala, Zahra; Dedering, Michael; Ciegis, Raimondas; Starikovicius, Vadimas; Popov, Peter
Advanced CFD simulation of filtration processes
Proceedings FILTECH Europa, Wiesbaden, 440 - 444, Volume II, 2009

Iliev, Oleg; Lakdawala, Zahra; Starikovicius, Vadimas, Willems, Joerg, Popov, Peter
Multiscale problems and upscaling. Simulation of multiscale filtration processes
In: Oberwolfach Report 12/2009, A.Brandt et al (Eds), 694 - 696, 2009

Iliev, Oleg; Lazarov, Raytcho; Willems, Jörg
Fast numerical upscaling of heat equation for fibrous materials
Technical report 2009-049 of Inst. for Appl. Math. and Comp. Sci., Texas A&M University

Ilyasov, Maxim
Modeling Deep Geothermal Reservoirs: Recent Advances and Future Problems
Schriften zur Funktionalanalysis; Geomathematik, FB Mathematik, Bericht 47, December 2009

Jung, Pascal; Leyendecker, Sigrid; Linn, Joachim; Ortiz, Michael
Discrete Lagrangian mechanics and geometrically exact Cosserat rods
Multibody Dynamics 2009, ECCOMAS Thematic Conference, 29th June - 2nd July 2009, Warsaw

Kehrwald, Dirk; Latz, Arnulf; Rief, Stefan; Schmidt, Kilian; Wiegmann, Andreas
Virtual Diesel Particulate Filters: Simulation of the Structure, Exhaust Gas Flow and Particle Deposition
Filtration, No. 4, Vol. 9, 2009, pp. 315 - 320

Klar, A.; Reuterswaerd, P.; Seaid, M.
A Semi-Lagrangian method for a Fokker-Planck equation describing fibre dynamics
J. Scientific Computing 38 (3), 349 - 367, 2009

Klar, Axel; Marheineke, Nicole; Wegener, Raimund
Hierarchy of mathematical models for production processes of technical textiles
ZAMM, 89(12), 941-961, 2009

Klein, Peter; Pieper, Martin; Ewe, Hendrik
Heat Conductivity in Sintered Aluminum Fibers
Cellular Metals for Structural and Functional Applications, 2009

Kohl, Matthias; Ruckdeschel, Peter
R-Pakete distrEx 2.2, distrMod 2.2.1, RandVar 0.7, RobAStBase 0.7; ROptEst 0.7
Veröffentlicht auf CRAN, http://cran.r-project.org/

Korn, Ralf
Modern Mathematics for Finance and Economics: From Stochastic Differential Equations to the Credit Crisis
ERCIM News 78, 10-12, 2009

Korn, Ralf; Müller, Stefanie
Getting multi-dimensional trees into a new shape
WILMOTT 1(3), 145-153, 2009

Korn, Ralf; Müller, Stefanie
The decoupling approach to binomial pricing of multi-asset options
Journal of Computational Finance 12(3), 1-30, 2009

Korn, Ralf; Schäl, Manfred
The numeraire portfolio in discrete time: Existence, related concepts and applications
In: Radon Series for Computational and Applied Mathematics (eds. H. Albrecher, W. Runggaldier, W. Schachermayer), 303-326, 2009

Korn, Ralf; Seifried, Frank
A worst-case approach to continuous-time portfolio optimisation
In: Radon Series for Computational and Applied Mathematics (eds. H. Albrecher, W. Runggaldier, W. Schachermayer), 327-345, 2009

Korn, Ralf; Zeytun, Serkan
Solving optimal investment problems with structured products under CVaR-constraints
Optimization 58(3), 291-304, 2009

Kratt, Karin; Scherrer, Alexander
On the integration of DVH-based planning aspects into a convex intensity modulated radiation therapy optimization framework
Physics in Medicine and Biology 54 (2009) N239-N246

Krüger, Jens
Energy-Efficient Computing for Extreme-Scale Science
IEEE Computer, Volume 42, Nummer 11, November 2009

Kruse, Susanne; Müller, Marlene
Pricing American call options;er the assumption of stochastic dividends – An application of the Korn-Rogers model
Berichte des Fraunhofer ITWM 158, 2009

Kübel, Christian; Godehardt, Michael; Salz, D.; Rozefeld, S.; Cieslisnki, R.
Towards a Quantitative Understanding in Electron Tomography
Euromat 2009, Nürnberg

Küfer, Karl-Heinz; Süss, Philipp
Structure Optimization by Decision Support Systems
Emergence, Analysis and Evolution of Structures, pp. 63-73, Springer, 2009

Kuhnert, Jörg; Gerstenberger, R.
Finite Pointset Method (FPM): Meshfree Flow Solver with Applications to elasto-plastic material laws
Proceedings of the International Conference on Particle Based Methods and Applications, Eds: E.Onate, D.R.J. Owen, 2009

Kurz, Jochen; Rieder, Hans; Stoppel, Markus; Taffe, Alexander
Control and Data Acquisition of Automated Multi-Sensor Systems in Civil Engineering
in: O. Abraham, X. Dérobert (Eds.); Confédération Francaise pour les Essais Non Destructifs (COFREND): Non-Destructive Testing in Civil Engineering 2009: NDT-CE. Paris: Laboratoire Central des Ponts et Chaussées (LCPC), 433-439, 2009

Kurz, Martin; Oberschmidt, Dirk; Siedow, Norbert; Feßler, Robert; Jegorovs, Jevgenijs
Mit schnellem Algorithmus zur perfekten Freiformoptik
Mikroproduktion, 3, 10-12, 2009

Lakdawala, Zarah; Iliev, Oleg; Rief, Stefan; Wiegmann, Andreas
On Coupled Particle Level and Filter Element Level Simulation for Filtration Processes
Proceedings FILTECH Europa, Wiesbaden, 324-328, Volume I, 2009

Lang, Holger; Dreßler, Klaus, Pinnau René; Speckert Michael
Comparison of the solutions of the elastic and elastoplastic boundary value problems
Zeitschrift für angewandte Mathematik; Physik (ZAMP), DOI 10.1007/s00033-009-0042-y

Lang, Holger; Dreßler, Klaus; Pinnau, Rene; Speckert, Michael
Notes on Lipschitz estimates for the stop and play operator in plasticity
Applied mathematics letters 22 (2009), No.4, pp.623-627

Lang, Holger; Linn, Joachim
A second order semi-discrete Cosserat rod model suitable for dynamic simulations in real time
AIPConference Proceedings, Vol. 1168

Lang, Holger; Linn, Joachim; Arnold, Martin
Multibody dynamics simulation of geometrically exact Cosserat rods
Multibody Dynamics 2009, ECCOMAS Thematic Conference, 29th June - 2nd July 2009, Warsaw

Latz, Arnulf; Schmidt, Sebastian
Numerical Solution of Granular Hydrodynamics from Dilute to Quasi-Static Flow
AIP Conference Proceedings of the 6th International Conference on Micromechanics of Granular Media, 571-575, 2009

Lefteriu, Sanda; Antoulas, Athanasios C.
Modeling multi-port systems from frequency response data via tangential interpolation
Proceedings of the 13th IEEE Workshop on Signal Propagation on Interconnects, 2009

Lojewski, Carsten; Machado, Rui
The Fraunhofer virtual machine: a communication library and runtime system based on the RDMA model
Springer Berlin/Heidelberg, ISSN 1865-2034 (Print) 1865-2042 (Online), Juni 2009

Maag, Volker; Berger, Martin; Winterfeld, Anton; Küfer, Karl-Heinz
A novel non-linear approach to minimal area rectangular packing
Annals of Operations Research, Onlineversion unter doi: 10.1007/s10479-008-0462-7 (2009)

Maasland, Mark; Persson, Mikael; Sawilla, Stephanie; Gomm, Daniela; Hahn, Alfred; Schmidt, Martin; Stefan, Alfred; Mueller, Reinhold; Schoemaker, Hans; Summers, Jim; Garcia-Ladona, Francisco-Javier
A High Content Screening Assay for Discovery of Neurite Outgrowth-Inducing Principles in SH-SY5Y neuroblastoma cells using an automated object-based image analysis software
15th Annual SBS Conference Lille, Advances in High Content Screening, P10010, 2009

Maasland, Mark; Teutsch, Christian
Kombinierte optische Vermessung; Oberflächenprüfung von 3D-Objekten
Fraunhofer-Vision-Seminar "Inspektion; Charakterisierung von Oberflächen mit Bildverarbeitung", Erlangen, Tagungsband, 2009

Marburger, Jan
Optimisation using Particle Methods
Proceedings of the International Conference on Particle Based Methods and Applications, Eds: E.Onate, D.R.J. Owen, 2009

Marheineke, Nicole; Wegener, Raimund
Asymptotic model for the dynamics of curved viscous fibers with surface tension
Journal of Fluid Mechanics, 622, 345-369, 2009

Mickler, Matthias; Didas, Stephan; Rauhut, Markus; Bart, Hans-Jörg
In-Line-Bildanalyse von Blasen-, Tropfenströmungen
Chemie Ingenieur Technik 81(8), 1076 - 1077, 2009

Mohring, Jan
Interpolation von Zustandsraummodellen als Grundlage für parametrische Reduktion
Proceedings des GMA-Fachausschuss 1.30 Modellbildung, Identifikation; Simulation in der Automatisierungstechnik, 2009

Mohring, Jan; Wirsen, Andreas, Stoev, Julian; Lefteriu, Sanda; Kurch, Matthias; Mercan, Necati
Parametric Model Order Reduction of Systems for Active Noise Control
Proceedings of the 16th International Congress on Sound and Vibration, 2009

Mohring, Jan; Wirsen, Andreas; Stoev, J.; Lefteriu, S.; Kurch, M.; Mercan, N.
Parametric Model Reduction of Systems for Active Noise Reduction
Proceedings Sixteenth International Congress on Sound and Vibration, July 2009, Krakau

Mukherjee, Partha P.; Wang, C. Y.; Schulz, Volker; Kang, Q.; Becker, Jürgen, Wiegmann, Andreas
Two-Phase Behavior and Compression Effect in the PEFC Gas Diffusion Medium
ECS Transactions, 25(1) 1485-1494, 2009

Müller, Marlene
Balancing Theory and Practice: Modern Financial Mathematics at Fraunhofer ITWM
ERCIM News 78, 14 - 16, 2009

Natcheva-Acar, Kalina; Acar, Sarp Kaya; Krekel, Martin
Modeling credit spreads with the Cheyette model and its application to credit default swaps
Journal of Credit Risk, 5(1), Spring Issue, 2009

Nickel, Stefan; Hanne, Thomas; Melo, Teresa
Bringing robustness to patient flow management through optimized patient transports in hospitals
Interfaces, 39(3), 241 - 255, 2009

Nickel, Stefan; Melo, Teresa; Saldanhada-Gama, F.
Facility location and supply chain management – A review
European Journal of Operations Research, 196(2), 401 - 412, 2009

Niedziela, Dariusz; Latz, Arnulf; Moritz, Tassilo
On numerical simulation of powder injection molding
NAFEMS Seminar "Simulation of Complex Flows - Applications and Trends" 16 - 17 March 2009, Wiesbaden

Obermaier, Harald; Hering-Bertram, Martin; Kuhnert, Jörg; Hagen, Hans
Volume deformations in gridless flow simulations
Computer Graphics Forum, 28(3), 879 - 886, 2009

Ohser, Joachim; Nagel, W.; Schladitz, Katja
Miles formulae for Boolean models observed on lattices
Image Analysis & Stereology 28, 77 - 92, 2009

Ohser, Joachim; Redenbach, Claudia; Schladitz, Katja
Mesh free estimation of the structure model index
Image Analysis & Stereology 28, 179 - 185, 2009

Ohser, Joachim; Schladitz, Katja
3d Images of Materials Structures – Processing and Analysis
Wiley-VCH, 2009

Orlik, Julia
Asymptotic Homogenization Technique for Stress and Strength for Some Non-Linear Elastic Problems with Near Periodic Structure
Journal of the Mechanical Behavior of Materials, Vol. 19, NOs. 2 - 3, 133 - 142, 2009

Orlik, Julia
Existence and stability estimate for the solution of the ageing hereditary linear viscoelasticity problem
Abstract and Applied Analysis, Vol. 2009, Article ID 828315, 2009

Orlik, Julia; Zhurov, Alexey
Homogenization of Contact Problems with Known Mikroroughness of the Contacting Surfaces
Journal of the Mechanical Behavior of Materials, Vol. 19, NOs. 2 - 3, pp 143 - 150, 2009

Page, Yves; Cuny, Sophie; Zangmeister, Tobias; Kreiß, Jens-Peter; Hermitte, Thierry
The evaluation of the safety benefits of combined passive and on-board active safety applications
Association for the Advancement of Automotive Medicine (AAAM), Proceedings zur 53. AAAM-Konferenz in Baltimore 2009

Persson, Mikael; Schilder, Andreas; Maasland, Mark; Meyer, Axel; Gomm, Daniela; Otterstätter, Bernd; Hahn, Alfred; Schmidt, Martin; Stefan, A.; Schoemaker, H.; Summers, Jim; Garcia-Ladona, F.-J.
RNA interference of the AARF domain containing kinase gene family modulates neurite outgrowth in SH-SY5Y neuroblastoma cells
RNAI Europe, Berlin, P23, 2009

Popov, Peter; Efendiev, Yalchin, Gorb, Yulia; Iliev, Oleg
Multiscale modeling and simulation of flow in deformable porous media
In: Oberwolfach Report 12/2009, A. Brandt et al (Eds), 706 - 710, 2009

Raillon, Raphaele; Mahaut, Steve; Leymarie, Nicolas; Lonné, Sébastien; Spies, Martin
Results of the 2008 UT Modeling Benchmark Obtained with Two Semi-Analytical Models: Responses of Flat-bottom Holes;er Surfaces of Different Curvatures
in: Review of Progress in QNDE, Vol. 28, AIP Conference Proceedings CP1096, 1938 - 1945, 2009

Rauhut, Markus
Typischer Aufbau eines Online-Oberflächeninspektionssystems
Fraunhofer Vision Seminar "Inspektion; Charakterisierung von Oberflächen mit Bildverarbeitung", Erlangen, Tagungsband, 2009

Redenbach, Claudia
Microstructure Models for Cellular Materials
Computational Materials Science 44(4), 1397 - 1407, 2009

Redenbach, Claudia; Särkkä, A.; Freitag, Johannes; Schladitz, Katja
Anisotropy analysis of pressed point processes
Advances in Statistical Analysis 93(3), 237 - 261, 2009

Rieder, Hans; Spies, Martin
Entwicklung, Anwendung eines leistungsfähigen Ultraschallverfahrens zur zerstörungsfreien Prüfung von komplexen Bauteilen aus schwerprüfbaren Werkstoffen am Beispiel von Schiffspropellern – von der Simulation über die Prüfung bis zur Bewertung
ZfP-Zeitung No. 116, Oktober 2009. DGZfP, Berlin, 48 - 51

Rief, Stefan; Glatt, Erik; Wiegmann, Andreas
Microstructure Simulation of Virtual Woven Filter Media
Proceedings FILTECH Europa, Wiesbaden, 231 - 238, Volume 1, 2009

Rösch, Ronald; Berndt, Dirk
Vorteihaft kombiniert – 3D-Messung; Oberflächeninspektion in einem System
QZ Qualität; Zuverlässigkeit, 12 2009

Ruckdeschel, Peter
R-Pakete startupmsg 0.7, Sweave ListingUtils 0.4, distrEllipse 2.2
Veröffentlicht auf CRAN, http://cran.r-project.org/

Ruckdeschel, Peter; Kohl, Matthias; Stabla, Thomas; Camphausen, F.
R-Pakete distr 2.2, distrDoc 2.2, distrTeach 2.2, distrSim 2.2, distrTEst 2.2
Veröffentlicht auf CRAN, http://cran.r-project.org/

Ruckdeschel, Peter; Spangl, B.
R-Paket robKalman 0.3
Published on r-forge, http://r-forge.r-project.org/

Scheben, Rolf; Götz, Siegbert; Spies, Martin; Rieder, Hans
Schnelle Ultraschallsimulation mittels eines Hybridverfahrens aus der Punktquellensynthese; der Elastodynamischen Finiten Differenzen Methode
DGZfP Berichtsband BB 115-CD DGZfP-Jahrestagung, 2009, P46

Schmidt, Kilian; Rief, Stefan; Wiegmann, Andreas
Simulation of DPF Media, Soot Deposition and Pressure Drop Evolution
Proceedings FILTECH Europa, Wiesbaden, 74-80, Volume II, 2009

Schmidt, Oliver; Halfmann, Thomas; Lang, Patrick
Coupling of numerical and symbolic techniques for model order reduction in circuit design
Springer Lecture Notes in Electrical Engineering, 2009

Schüle, Ingmar; Dragan, Anca Diana; Radev, Alexander; Schröder, Michael; Küfer, Karl-Heinz
Multi-criteria optimization for regional timetable synchronization in public transport
Operations Research Proceedings 2008, Part 6, Springer, pp. 313-318, August 2009

Schüle, Ingmar; Ewe, Hendrik; Küfer, Karl-Heinz
Finding tight RLT formulations for Quadratic Semi-Assignment Problems
Proceedings Cologne Twente Workshop 2009

Schüle, Ingmar; Schröder, Michael; Küfer, Karl-Heinz
Synchronization of regional public transport systems
Proceedings Urban Transport 2009

Serna, Jorge Ivan; Monz, Michael; Thieke, Christian; Küfer, Karl-Heinz
Trade-off bounds for the Pareto surface approximation in multi-criteria IMRT planning
Physics in Medicine and Biology 54 (2009), pp. 6299-6311

Sharma, Vikhash; Tiwari, S.; Attarakih, M.; Jaradat, Moutasem; Klar, Axel; Kuhnert, Jörg; Bart, H.-J.
Simulation of two-phase flow with incorporated Population Balance Equation using a Meshfree Method
In: Computer-Aided Chemical Engineering, 26, 1345, Eds: J. Jezowski, J. Thullie, Elsevier, 2009

Speckert, Michael; Ruf, Nikolaus; Dressler, Klaus
Undesired drift of multibody models excited by measured accelerations or forces
Multibody Dynamics 2009, ECCOMAS Thematic Conference, 29th June - 2nd July 2009, Warsaw

Spies, Martin; Rieder, Hans
Dreidimensionale Ultraschall-Tomographie an schwer prüfbaren strukturellen Werkstoffen
DGZfP Berichtsband BB 115-CD DGZfP-Jahrestagung, 2009, Mi.2.A.1

Spies, Martin; Rieder, Hans
Enhancement of the POD of Flaws in the Bulk of Highly Attenuating Structural Materials by Using SAFT Processed Ultrasonic Inspection Data
in: Proceedings of the 4th European-American Workshop on Reliability of NDE, Berlin, Germany; DGZfP Berichtsband BB 116-CD, 2009, 172-179

Spies, Martin; Rieder, Hans
Quantitative Fehlercharakterisierung aus Ultraschall-HF-Daten mittels simulationsgestützter Auswerteverfahren
MP Materials Testing 51 (10), 717-722, 2009

Spies, Martin; Scheben, Rolf
Ultraschallsimulation durch Überlagerung transienter Punktquellen-Wellenfelder – Neue Möglichkeiten mit der Punktstrahlersynthese
DGZfP Berichtsband BB 115-CD DGZfP-Jahrestagung, 2009, P40

Stephani, Henrike; Herrmann, Michael; Wiesauer, Karin; Katletz, Stefan; Heise, Bettina
Enhancing the Interpretability of Hyperspectral Terahertz Data Through Unsupervised Classification
Proc. IMEKO XIX World Congress, Fundamental a. Applied Metrology, Lissabon, 634, 2009

Streit, Anja; Dreßler, Klaus; Speckert, Michael; Lichter, Jörg; Zenner, Timo; Bach, Peter
Anwendung statistischer Methoden zur Erstellung von Nutzungsprofilen für die Auslegung von Mobilbaggern
VDI-Berichte Nr. 2065, VDI-Verlag GmbH Düsseldorf, 2009, pp. 65-77

Szimayer, Alexander; Dimitroff, Georgi; Lorenz, Stefan
A parsimonious multi-asset Heston model: calibration and derivative pricing
Berichte des Fraunhofer ITWM 171, 2009

Thömmes, Guido; Becker, Jürgen; Vaikuntam, Ashok Kumar; Kehrwald, Dirk; Klar, Axel; Steiner, Konrad; Junk, Michael; Wiegmann, A.
A Lattice Boltzmann Method for immiscible multiphase flow simulations using the Level Set Method
Journal of Computational Physics, 228, pp. 1139-1156, 2009

Tiwari, S.; Klar, A.; Hardt, S.
A particle-particle hybrid method for kinetic and continuum equations
JCP 228, 7109-7124, 2009

Trinkaus, Hans L.
Innovation Play/Board – Knowledge, Project and Process Management
Geteiltes Wissen ist doppeltes Wissen, Kongressband zur KnowTech 09, October 2009, Bad Homburg

Trinkaus, Hans L.
SACA: Software Assisted Call Analysis – Structuring, Extraction and Storage of Contents; Retrieval, Exploration, Comparison and Clustering of Phone Dialogues
Proceedings of I-KNOW'09, Journal of Universal Computer Science, September 2009, Graz

Uhlmann, Eckart; Gerstenberger, Robert; Graf von der Schulenburg, Matthias; Kuhnert, Jörg; Mattes, Alexander
The Finite-Pointset-Method for the Meshfree Numerical Simulation of Chip Formation
Proceedings 12th CIRP Conference on Modelling of Machining Operations, 2009

Velichko, Alexandra; Mücklich, Frank; Wiegmann, Andreas
Estimation of the conductivities of complex cast iron microstructures using FIB-tomographic analysis
Acta Materialia, Vol. 57, 2009, pp. 5023-5035

Velten, Sebastian; Nickel, Stefan,; Puerto, J.; Marin, Alfredo
A flexible model and efficient solution strategies for discrete location problems
Discrete Applied Mathematics, 157 (5), pp. 1128-1145, 2009

Velten, Sebastian; Nickel, Stefan; Marin, Alfredo
An extended covering model for flexible discrete and equity location problems
Mathematical Methods of Operations Research, pp. 1-39, 2009

Wagner, Björn; Dinges, Andreas; Müller, P.; Haase, G.
Parallel volume image segmentation with watershed transformation
Salberg, A.-B.: Image analysis. 16th Scandinavian Conference, SCIA 2009: Oslo, June 15-18, 2009; proceedings. Berlin: Springer, 2009. (Lecture Notes in Computer Science 5575), 420-429, 2009

Wagner, Björn; Godehardt, Michael
Cell reconstruction on stream computing architectures
ISMM 2009 Abstract Book, 45-48, University of Groningen, 2009

Wiegmann, Andreas; Cheng, Liping; Glatt, Erik; Iliev, Oleg; Rief, Stefan
Design of Pleated Filters by Computer Simulations
Proceeding of the Annual Meeting of the American Filtration & Separation Society 2009, Minneapolis und Berichte des Fraunhofer ITWM 155, 2009

SCIENTIFIC GRADUATION THESES

Wiegmann, Andreas; Rief, Stefan; Latz, Arnulf; Iliev, Oleg
Toward Predicting Filtration and Separation: Progress & Challenges
Proceedings FILTECH Europa, Wiesbaden, 48 - 63, Volume I, 2009

Wildhagen Michael, Bitsch Gerd, Dreßler Klaus
Systemsimulation; Versuch in der Trailerentwicklung
VDI-Berichte Nr. 2068, VDI-Verlag GmbH Düsseldorf, 2009, pp. 145 - 156

Willems, Jörg
A numerical subgrid approach for the Brinkman problem
In: Oberwolfach Report 12/2009, A.Brandt et al (Eds), 714 - 717

Wirjadi, Oliver, Breuel, Thomas
A Branch and Bound Algorithm for Finding the Modes in Kernel Density Estimates
Int. J. Computational Intelligence and Applications 8(1), 17 - 35, 2009

Wirjadi, Oliver; Kim, Yoo-Jin; Breuel, Thomas
Spatial Statistics for Tumor Cell Counting and Classification
In: Joachim Denzler, Gunther Notni, Herbert Süße (Eds.): Pattern Recognition - Proc. 31st DAGM Symposium, 492 - 501, Springer, 2009

Wirjadi, Oliver; Schladitz, Katja; Rack, Alexander; Breuel, Thomas
Applications of anisotropic image filters for computing 2D and 3D-fiber orientations
in: Stereology and Image Analysis - Proceedings of the 10th European Conference of ISS, Mailand, Juni 2009, The MIRIAM Project Series, Vol. 4, 107 - 112

Zangmeister, Tobias; Kreiß, Jens-Peter; Page, Yves; Cuny, Sophie
Evaluation of the safety benefits of passive and/or on-board active safety applications with mass accident data-bases
Proceedings zur 21. Enhanced Safety of Vehicles (ESV) Konferenz in Stuttgart, 2009

Arne, Walter
Dynamik viskoser Jets
Diploma thesis, University Kassel, Dept. of Mathematics

Barf, Robert
Finite-Element-Methode im Designprozess
Student research project, Berufsakademie Mannheim

Bartsch, Daniel
Parallelisierte Erzeugung von Voronoi-Diagrammen mit Hilfe des CUDA-Frameworks
Diploma thesis, University of Applied Sciences Iserlohn, Dept. of Mechanical Engineering

Becker, Urs
Iterativ lernende Regelung und invariante Anregung
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Berger, Martin
Bicriteria Optimization in Electronic Design Automation
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Berndt, Thilo
Implementierung von Middleware-Komponenten zur automatischen Code-Parallelisierung auf Cell-Prozessoren
Diploma thesis, University of Applied Sciences, Applied Computer Science

Blaj, Markus
Ermittlung der Steifigkeit einer integrierten Lagestelle im Abdampfgehäuse
Bachelor thesis, Duale Hochschule BW Mannheim

Blaj, Markus
Finite-Element-Berechnung eines Lagerbocks mit ABAQUS
Student research project, Berufsakademie Mannheim

Boytsova, Tatiana
Credit Quality Correlation Structure in the Emerging Markets
Master thesis, Humboldt-Universität zu Berlin, Dept. of Econonomics and Business Engineering

Calim, Ali-Zengin
Optimierung des Prozesses zur Erstellung von numerischen Spannungsanalysen mit ANSYS
Bachelor thesis, Duale Hochschule BW Mannheim

De Kock, Johan
Volatilitätsarbitrage und ein Markoff-Modell für CDOs
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Deitrick, Mira
Navigation of VOI-related and DVH-based criteria in multi-criteria IMRT planning
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Dillhöfer, Alexander
Entwicklung eines Luftschallprüfsystems für die Roboterbasierte Konturvermessung und Erfassung von Kerbzahlen in Oberflächen von Walzstahl mittels Signal- und Bildverarbeitung
Diploma thesis, Saarland University of Applied Sciences, Dept. of Electrical Engineering

Dmitriev, Vitaly
On certain approaches for solving multiscale elliptic problems
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Feth, Sascha
Partially Passed Component Counting for Evaluating Reliability
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Geiger, Ansgar
Strategic Power Plant Investment Planning under Fuel and Carbon Price Uncertainty
Doctoral thesis, University Karlsruhe, Dept. of Economics and Business Engineering

Groß, Matthias
Towards Scientific Applications for Interactive Ray Casting
Doctoral thesis, University Kaiserslautern, Dept. of Computer Sciencse

Hamann, Kai Uwe
3D-Rekonstruktion von Oberflächen aus 2D-Bilddaten mittels Maximum-Likelihood-Parameterschätzung
Diploma thesis, University Kaiserslautern, Dept. of Computer Sciences

Hansen, Neele
Integrating Timetabling and Vehicle Scheduling
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Hauser, Matthias
Identification of Reduced Systems from Data
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Jung, Pascal
A Discrete Mechanics Approach to Cosserat Rod Theory – Static Equilibria
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Keller, Patric
Adaptive extraction and representation of geometric structures from unorganized 3D point sets
Doctoral thesis, University Kaiserslautern, Dept. of Computer Sciences

Kenfack Tontsop, Pierre Marie
Implementierung und Vergleich von verschiedenen Algorithmen zur Bildsensorkalibrierung
Diploma thesis, University of Applied Sciences Kaiserslautern, Dept. of Applied Engineering Sciences

Krengel, Annette
Clustering of High-Volume Gene Expression Data from Time Course Microarray Experiments
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Leidheiser, Madeleine
Using Interlace Effects for 2,5D System-In-Package Design Size Minimization
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Leithäuser, Christian
Shape Design for Stokes Flows
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

PARTICIPATION ON FAIRS AND CONFERENCES

Lorenz, Stefan
Neue Methoden zur Lösung von Vorwärts-Rückwärts-Stochastischen-Differentialgleichungen
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Maag, Volker
Multikriterielle globale Optimierung des Designs von Gusform-Kühlsystemen
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Proll, Sabine
Matching and Alignment Methods for Three-Dimensional Objects Applied to the Volume Optimization of Gemstones
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Schmele, Timothy
Discretized wave equation for triangulated scenes
Bachelor thesis, University Kaiserslautern, Dept. of Computer Sciences

Schmidt, Sebastian
On numerical simulation of granular flow
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Schwarz, Heinrich Jonathan
Zuverlässigkeitsanalyse in Softwaresystemen mittels autoregressiven Zustandsraummodellen
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Shankar, Maddu
Asymptotic analysis and applications of boundary conditions for lattice Boltzmann methods
Doctoral thesis, IIT Madras, Department of Mathematics

Sitaru, Illinca
The Potential Approach to Interest Rate Modelling
Masterarbeit, University Kaiserslautern, Dept. of Mathematics

Stahl, Dominik
PF-MPC: Particle Filter – Model Predictive Control
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Tarin, Omar
Portfolio Optimierung nach Markowitz und Softwareentwicklung
Diploma thesis, University of Applied Sciences, Gießen-Friedberg, Dept. MND

Todorov, Yavor
Structural risk minimization based model selection using neural networks
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Vecchio, Irene
Stochastic fiber processes for modelling and simulation in materials science
Master thesis, Universita degli Studi di Milano, Facolta di Scienze Matematiche, Fisiche e Naturali

Wagner, Andreas
A Multidimensional Heston Model and Applications
Diploma thesis, University Augsburg, Dept. of Mathematics

Willems, Jörg
Numerical upscaling for multiscale flow problems
Doctoral thesis, University Kaiserslautern, Dept. of Mathematics

Wirjadi, Oliver
Models and Algorithms for Image-Based Analysis of Microstructures
Doctoral thesis, University Kaiserslautern, Dept. of Computer Sciences

Wojtek, Thaddäus
Alternative DAE-Ansätze zur Berechnung invarianter Anregungen im Fahrzeugbau
Diploma thesis, University Kaiserslautern, Dept. of Mathematics

Yaneva, Filka
Modelling and navigation of tumor conformality in IMRT planning
Master thesis, University Kaiserslautern, Dept. of Mathematics

Zarkova, Elena
A Vehicle-Independent Model for Lateral Excitations
Masterarbeit, University Kaiserslautern, Dept. of Mathematics

Achema 2009
Frankfurt/Main, May, Exhibitor

Annual Meeting American Filtration Society
Minneapolis, May, Exhibitor and lecture

Annual Meeting of International Society for Porous Media
Kaiserslautern, March, Exhibitor and lectures

15th Annual SBS Conference
Lille, April, Poster

Anuga FoodTec 2009
Köln, March, Exhibitor

Bildungsmesse des Akademischen Bildungszentrums e.V. Kaiserslautern "Mathematik im Alltag – Wir knacken jede Nuss"
Kaiserslautern, June, Workshops

39. Bildverarbeitungsforum: "Moderne Beleuchtungstechniken"
Mannheim, March

40. Bildverarbeitungsforum: "Bildfolgenanalyse und Dynamische Prozesse"
Stuttgart, July

41. Bildverarbeitungsforum: "Neue Methoden der Oberflächeninspektion"
Darmstadt, October

CeBIT 2009
Hannover, March, Exhibitor

12. Chemnitzer Textiltechnik-Tagung
Chemnitz, September/October

Composites Europe 2009
Stuttgart, October, Exhibitor and lecture

CONTROL – Internationale Fachmesse für Qualitätssicherung
Stuttgart, May, Exhibitor

CVC – Jahrestagung
Mannheim, October, Exhibitor

31. DAGM Symposium
Jena, September, Lecture

Deutsches Museum, Zentrum "Neue Technologien", Fraunhofer-Materialbank
München, since November, Exhibit

DGZfP-Jahrestagung 2009
Münster, May Lectures and poster

EAGE 2009
Amsterdam, June, Exhibitor

ESMC EuroMech 2009
Lissabon, September

10th European Congress of Stereology and Image Analysis
Mailand, June, Lectures

4th European-American Workshop on Reliability of NDE
Berlin, June, Lecture

FILTECH 2009
Wiesbaden, October, Exhibitor and lectures

Fraunhofer-Symposium "Future Security"
Karlsruhe, September, Poster

Fraunhofer-Vision Seminar "Inspektion und Charakterisierung von Oberflächen mit Bildverarbeitung"
Erlangen, December, Exhibitor and lectures

Fraunhofer-Vision Technologietag 2009
Kaiserslautern, October, Exhibitor and lectures

Fraunhofer-Truck "60 Jahre im Auftrag der Zukunft"
Alzey, June, Exhibitor

GACM 2009
Hannover, September

HANNOVER MESSE 2009
Hannover, April, Exhibitor

24. Hofer Vliesstofftage
Hof, November, Exhibitor and lectur

Hydrogen & Fuel Cells 2009: Conference and Trade Show
Vancouver, June

XIX. IMEKO World Congress: "Fundamental and Applied Metrology"
Lissabon, September, Lecture

OWN EVENTS

7th International Conference on Numerical Analysis and Applied Mathematics (ICNAAM)
Rethymno, Kreta, September

International Symposium on Mathematical Morphology ISMM 2009
Groningen, August, Poster

ISC'09 – International Supercomputing Conference
Hamburg, June, Exhibitor

JEC Composites Show
Paris, March, Exhibitor

32. Journée ISS France (International Society of Stereologie)
Paris, February, Lecture

Kaiserslautern – Jahr der Wissenschaft, Abschlussveranstaltung
Kaiserslautern, December, Exhibitor

Miniworkshop on Numerical Upscaling
Oberwolfach, March

Models and Images for Porous Media (MIPoM)
Paris, January, Poster

Multibody Dynamics 2009, ECCOMAS Thematic Conference
Warschau, June

NAG/DAGA 2009 International Conference on Acoustics
Rotterdam, March, Lecture

NDTCE09 Non-Destructive Testing in Civil Engineering
Nantes, June/July, Lecture

New Developments in the Visualization and Processing of Tensor Fields
Dagstuhl, July, Lecture

NUMDIFF Conference
Halle (Saale), September

PSPRO User Group Meeting
Houston, November

15. QIA Workshop "Quantitative Bildanalyse"
Bissersheim, May, Lectures

RNAI Europe 2009
Berlin, September, Poster

SC'09 – Supercomputing
Portland (USA), November, Exhibitor

SEG 2009
Houston (USA), Oktober, Exhibitor

Special Session on Industrial and Biomedical Multiscale Problems at Conf. Large Scale Scientific Computation
Sozopol, June

TechTextil 2009
Frankfurt/Main, June, Exhibitor

VDI-Tagung "Erprobung und Simulation in der Fahrzeugentwicklung"
Würzburg, June, Exhibitor

VDI-Tagung "Nutzfahrzeuge 2009"
Neu-Ulm, May, Exhibitor

VDI-Tagung "Technische Zuverlässigkeit"
Leonberg, April, Exhibitor

VDMA-Kongress "Intelligenter Produzieren"
Mannheim, June, Exhibitor

Vision 2009
Stuttgart, November, Exhibitor

VW – Konzerntagung "Corporate Conference on Virtual & Augmented reality"
Braunschweig, September, Exhibitor

Workshop "Detektionssysteme für CBRNE-Gefahrstoffe"
Karlsruhe, September, Poster

15. Workshop Farbbildverarbeitung
Berlin, October

Workshop Fraunhofer-Innovationscluster DNT "Bemessungsgrundlagen und Simulation"
Kaiserslautern, March and October

Workshop Fraunhofer-Innovationscluster DNT "Boden und Wechselwirkungssimulation"
Kaiserslautern, March

15th Workshop on Stochastic Geometry, Stereology, and Image Analysis
Blaubeuren, March, Lecture

Exhibition "Begegnungen – Licht & Malerei von Ingo Bracke und Jochen Dewerth"
November – January 2010

1st International Conference on "Challenges of Porous Media"
March

Seminar "Lastdaten – Analyse, Bemessung und Simulation"
Kaiserslautern, January and November; Stuttgart, December

Seminar "Statistische Methoden in der Betriebsfestigkeit"
September

Tag der offenen Tür im Fraunhofer-Zentrum Kaiserslautern
Oktober (in collaboration with Fraunhofer IESE)

Workshop "Bildverarbeitung im Bauwesen"
Januar (in collaboration with TU Kaiserslautern)

Workshop "Cambridge – Kaiserslautern Financial Mathematics
Mai

Workshop "Computertomografie und Analyseverfahren für industrielle Anwendungen"
Kaiserslautern and Saarbrücken, Oktober (in collaboration with Fraunhofer EZRT)

Workshop "Guide to Load Data Analysis"
Eindhoven, Göteborg, Södertälje, Stuttgart, München, October

Workshop "Moderne Finanzmathematik und ihre Anwendungen für Banken und Versicherungen"
December

Workshop: Cambridge-Kaiserslautern Finanzmathematik
May

Workshop: Moderne Finanzmathematik und ihre Anwendungen für Banken und Versicherungen
December

GUESTS

Antoulas, Athanasios C. (International University Bremen)
Reduktion großer dynamischer Systeme
May

Arbenz, Peter (ETH Zürich)
Grid partioning on bone structure analysis
February

Arnold, Martin (University Halle)
Numerik für DAE
June and September

Attarakih, Menwer (Al-Balqa Applied University Amman, Jordanien)
Populations Bilanz Gleichungen
October

Becker, Christoph (Frankfurt School of Finance & Management)
State dependent dependencies - A continuous-time dynamics for correlations
October

Brüning, Ulrich (University Mannheim)
Virtual Machine
September

Ciegis, Raimondas (Technical University of Vilnius)
Flows in porous media and parallelization
March and December

Dempster, Michael (University of Cambridge (GB) and Cambridge Systems Associates Ltd.)
A Preliminary Analysis of the Credit Crisis
May

Deshpande; Saresh (Indian Institute of Science, Bangalore, Indien)
Kinetic Schemes
August

Eberhard, Peter (University Stuttgart)
Kontaktmechanik und Wechselwirkungssimulation
January

Efendiev, Yalchin (Texas A&M University)
Multiscale problems, Numerical Methods For PDEs, Uncertainty
March

Fuhrmann, Juergen (WIAS, Berlin)
Numerical methods, electrochemistry simulation
November

Geißler, Johannes (Johannes University of St. Andrews (GB))
Inflation Linked Bond from a Central Banks Perspective
June, September – February 2010

Gerds, Matthias (University Würzburg)
Kontrolltheorie, Optimalsteuerung
September

Godsill, Simon (University of Cambridge (GB))
Sequential Monte Carlo
June

Hofstee, Peter (IBM Austin Research Laboratory, Austin, Texas)
Entwicklung der Hardware bei Cellprozessoren
December

Hoppe, Roland (University Augsburg and University of Houston)
Numerical analysis, optimization, multiscale
July

Horbach, Jürgen (DLR Köln)
Molecular dynamics vs. Lattice Boltzmann for flow in porous media
November

Jasak, Hrvoje (University of Zagreb und Wikki Ltd, London)
CFD software/OpenFOAM Seminar
December

Kalimuddin, Ahmad (Department of Mathematics, Aligarh Muslim University, Aligarh (INDIA))
Using the sharp operator for edge detection and nonlinear diffusion
May – July

Kloeden, Peter E. (Goethe-University, Frankfurt/Main)
Pathwise convergence of numerical schemes for random and stochastic differential equations
January

Kraft, Holger (Goethe-University, Frankfurt/Main)
Optimal Housing, Consumption, and Investment Decisions over the Life-Cycle
May

Landstorfer, Manuel (University Ulm)
Derivation of Model Equations for a Solid Electrolyte Battery Cell
October

Lazarov, Raytcho (Texas A&M University)
Numerical Methods For PDEs
June – July

Liu, Mario (University Tübingen)
The Physics of Granular Mechanics, Granular Solid Hydrodynamics
December

Mai, Jan (TU München)
Marshall-Olkin distributions and portfolio credit risk
December

Margenov, Svetozar (Bulgarian Academy of Sciences)
Multilevel preconditioners, numerical upscaling, numerical analysis
September

Medova, Elena (University of Cambridge (GB) und Cambridge Systems Associates Ltd.)
Individual Asset Liability Management
May

Meister, Andreas (University Kassel)
Dynamik viskoser Jets
July

Mikelic, Andro (Universite Lyon)
Poro elastic beam theory
February

Moreno-Bromberg, Santiago (Humboldt-University, Berlin)
Derivative Design in Principal-Agent Games
July

Naess, Arvid (NTNU, Trondheim)
Pricing of discretely monitored exotic options under NIG dynamics
April

Nögel, Ulrich (DEVnet GmbH & Co KG, Kaiserslautern)
Variable Annuities: The new complexity of insurance contracts
December

Ortiz, Michael (CALTECH, Pasadena)
Diskrete Mechanik
June

Platen, Eckard (UTS Sydney)
A Variance Reduction Technique Based on Integral Representations
January

Popov, Peter (Bulgarian Academy of Sciences)
Multiscale problems, numerical upscaling, CFD
September

Prieto Honorato, Carlos (Institute of Industrial Automation (IAI), CSIC, Madrid)
Kalman filtering for robust ultrasonic localization
May – July

Rogers, Chris (University of Cambridge)
Optimal and Robust Contracts for a Risk-Constrained Principal
May

Rusche, Henrik (Wikki GmbH, Braunschweig)
CFD software / OpenFOAM Seminar
December

Scherer, Matthias (TU München)
Sampling hierarchical Archimedean copulas and an application to CDO pricing
December

Spangl, Bernhard (Universität für Bodenkultur, Wien)
Robust Kalman filtering
July

Starikovicius, Vadimas (Vlinius Technical University)
Numerics for CFD and for flow in porous media
April – June

Sven-Joachim Kimmerle (Humboldt University, Berlin)
Macroscopic diffusion models for precipitation in crystalline GaAs - Modelling, analysis and simulation
September

Szimayer, Alexander (University Bonn)
Executive Stock Options
August – September

Vabishchevich, Peter (Inst. Math. Modeling, Russian Academy of Sciences)
Computational Mathematics, Computational Physics, Numerical Analysis, CFD
August

Zagst, Rudi (TU München)
Crash-NIG copula models: Pricing of CDOs under changing market conditions
December

Zeytun, Serkan (Middle East Technical Universtiy (METU), Ankara)
Portfolio optimization under CVaR constraints
August

COLLABORATION IN BOARDS, EDITORSHIP

Didas, Stephan
- Signal Processing (Appraiser)
- IEEE Transactions on Pattern Analysis and Machine Intelligence (Appraiser)
- Image Processing Letters (Appraiser)
- Image and Vision Computing (Appraiser)
- International Journal on Computer Vision (Appraiser)
- SIAM Journal on Imaging Sciences (Appraiser)
- Asian Conference on Computer Vision (Appraiser)
- IEEE Transactions on Image Processing (Appraiser)
- Pattern Recognition (Appraiser)

Erlwein, Christina
- IMA Journal of Management Mathematics (Reviewer)

Ettrich, Norman
- Geophysics (Appraiser)
- Geophysical Prospecting (Appraiser)

Gerwalin, Elmar
- Wissenschaftlich-technischer Rat der Fraunhofer-Gesellschaft (WTR)

Hering-Bertram, Martin
- EuroVis 2009 (Programmkomitee)
- Topo In Vis 2009 (Programmkomitee)
- IEEE Visualization 2009 (Reviewer)
- Computer Aided Design (Reviewer)

Iliev, Oleg
- President-Elect of the International Society for Porous Media
- J. Comp. Meth. Appl. Math. (Editor)
- Math. Modelling and Analysis (Editor)
- Mathematisches Forschungsinstitut Oberwolfach, Report 12/2009 (Editor)
- LNCS, Springer (Appraiser)
- SIAM Multiscale Modeling and Simulation (Appraiser)
- Physica A (Appraiser)
- Numerical Methods for Partial Differential Equations (Appraiser)
- SIAM J. Sci. Comp. (Appraiser)
- Tranport in Porous Media (Appraiser)
- Advanced Water Research (Appraiser)

Korn, Ralf
- Dekan, FB Mathematik, TU Kaiserslautern
- Senat, TU Kaiserslautern
- Speaker Research Center $(CM)^2$, TU Kaiserslautern
- 1+1+1 Lehrexzellenzkommission, TU Kaiserslautern
- Stellv. Vorsitzender der Deutschen Gesellschaft für Versicherungs- und Finanzmathematik (until April 2009)
- Mathematical Finance (Associate Editor)
- Blätter der DGVFM (Associate Editor)
- Mathematical Methods of Operations Research (Associate Editor)
- Finance and Stochastics (Guest Editor)
- ERCIM News (Guest Editor)
- BMBF-Mathematik-Programm (Commssision of consultants)
- SIAM Journal on Control and Optimization (Appraiser)
- SIAM Journal on Financial Mathematics (Appraiser)

Küfer, Karl-Heinz
- Mathematics of Operations Research (Appraiser)
- Medical Physics (Appraiser)
- Zentralblatt für Mathematik (Reviewer)
- Mathematical Programming (Appraiser)

Kuhnert, Jörg
- Scientific Committee, ESI Group (Member)

Maasland, Mark
- Fraunhofer Allianz Vision (Member)

Mohring, Jan
- GMA-Fachausschuss 1.30 Modellbildung, Identifikation und Simulation in der Automatisierungstechnik (Member)
- Advances in Acoustics and Vibration (Appraiser)

Müller, Marlene
- Computational Statistics (Associate Editor)
- Elected Member of the International Statistical Institute (ISI)
- Mitglied des Ausschuss für Ökonometrie des Vereins für Socialpolitik
- Computers & Operations Research (Appraiser)

Neunzert, H.
- Fraunhofer-Chalmers Research Centre for Industrial Mathematics FCC (Vice Chairman of the Board)
- Monte Carlo Methods and Application (Associate Editor)
- Technologie-Botschafter der Stadt und des Landkreises Kaiserslautern
- Hochschulrat der FH Aschaffenburg
- Ausschuss Fraunhofer-Carnot
- Scientific Board des Winquist-Laboratoriums, Göteborg

Nickel, Stefan
- Computers & Operations Research (Editor-In-Chief)
- Mitglied des Vorstands der GOR (Gesellschaft für Operations Research)
- Health Care Management Science (Mitglied des Editorial Board)
- Speaker of the Board European Working Group on Locational Analysis (EWGLA)

Prätzel-Wolters, Dieter
- Resaerch Center "Center of Mathematical and Computational Modeling CM^2" der TU Kaiserslautern (Member)
- Fraunhofer-Chalmers Research Centre for Industrial Mathematics FCC (Boardmember)
- GAMM-Fachausschuss "Dynamik und Regelungstheorie (Member)
- Graduiertenkolleg "Mathematik und Praxis" der Technischen Universität Kaiserslautern (Member)
- Präsidium und Senat der Fraunhofer-Gesellschaft (Member)
- Rheinland-pfälzischer Landesforschungsschwerpunkt "Mathematik und Praxis" (Member)
- Stiftungsrat "Fraunhofer-Zukunftsstiftung" (Member)
- Wissenschaftlich-technischer Rat und Hauptkommission der Fraunhofer-Gesellschaft (Chairman)

Redenbach, Claudia
- Image Analysis & Stereology (Appraiser)
- Communications in Statistics - Theory and Methods (Appraiser)

PATENTS

Rieder, Hans
- VDE/VDI-Fachausschuss "Nichtlineare Systeme"

Rösch, Ronald
- Fraunhofer Allianz Vision (Coordination Board)
- Fraunhofer-Innovationsthema Leichtbau (ILBS)
- Commercial Vehicle Cluster (CVC)
- DGM-Arbeitskreis "Tomographie"
- DGM-Arbeitskreis "Quantitative 3D-Mikroskopie"
- DGM-Fachausschuss "Strahllinien"
- Heidelberger Bildverarbeitungsforum (Advisory Board)
- Deutsche Gesellschaft für Materialkunde e.V. (DGM, Member)
- Deutsche Gesellschaft für Zerstörungsfreie Prüfung e. V. (DGZfP, Member)
- IOP electronic Journals (Appraiser)
- GACR (Appraiser)

Ruckdeschel, Peter
- Computational Statistics (Appraiser)
- Journal of the American Statistical Association (Appraiser)

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

Schladitz, Katja
- Leichtbau-Cluster (Member)
- Journal of Microscopy (Appraiser)
- Image Analysis & Stereology (Editorial Board and Appraiser)
- Journal of the Royal Statistical Society (Appraiser)

Schröder, Michael
- Computers & Operations Research (Appraiser)

Siedow, Norbert
- Beraterkreis des AiF-Projekts"Verteilerrinne" der HVG

Spies, Martin
- IEEE Transactions on Ultrasonics, Ferroelectrics & Frequency Control (Appraiser)
- Journal of the Acoustical Society of America (Appraiser)
- Journal of Computational Acoustics (Appraiser)
- Materials Evaluation (Appraiser)
- NDT&E International (Appraiser)
- Wave Motion (Appraiser)
- Ultrasonics (Appraiser)
- Acustica (Appraiser)
- Deutsche Gesellschaft für Zerstörungsfreie Prüfung e.V. (DGZfP, Member, Advisory Borad)
- Mitglied des DGZfP Fachausschusses "Ultraschall"
- Mitglied des DGZfP Fachausschusses "Hochschullehrer"

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

Wirjadi, Oliver
- IEEE Transactions on Image Processing (Appraiser)
- Journal of Computational Statistics (Appraiser)

Zemitis, Aivars
- Mathematical Modelling and Analysis, The Baltic Journal on Mathematical Applications, Numerical Analysis and Differential Equations (Editor)

Linn, Joachim; Moog, Mathias (MAGMA GmbH)
Method and apparatus for describing the statistical orientation distribution of particles in a simulation of a mould filling process
Int. Patent WO002009003677A1, published January 8th 2009