



Fraunhofer

ITWM

FRAUNHOFER INSTITUTE FOR INDUSTRIAL MATHEMATICS ITWM



ANNUAL REPORT 2017/18

Front page

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

ANNUAL REPORT

2017/18



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

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

A special highlight for the Kaiserslautern center last year was the successful bid submitted in the federal and state government initiative “Innovative Hochschule.” The collaborative project “Offene Digitalisierungsallianz Pfalz” was granted funding from the initiative for a 5-year period (2018 to 2022) as the result of a joint submission by ITWM, the University of Applied Sciences, and TU Kaiserslautern. The joint proposal addresses innovation in the areas of Education – Healthcare – Products – Vehicles. ITWM and the High Performance Center for “Simulation- and Software- based Innovation” contribute significantly to the research in the area of digital commercial vehicle technology, building on previous years of Fraunhofer-Gesellschaft sponsored cooperation with Kaiserslautern’s universities. This area is also being further developed through new technologies that simulate the vehicle-environment-human interaction. These technologies

are not only important for durability, energy efficiency, and emissions, but are also critical for the development of advanced vehicle assistance (ADAS), which includes autonomous driving.

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

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

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

PREFACE

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

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

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

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

In the context of the energy transition, the feed-in of alternative energies to the power grids is increasingly revealing previously

unknown interactions between electrical power grids and conventional power turbine generators. Our TorGrid software is a condition-monitoring-system that allows, for the first time, these interactions to be captured and analyzed by the TorGrid user.

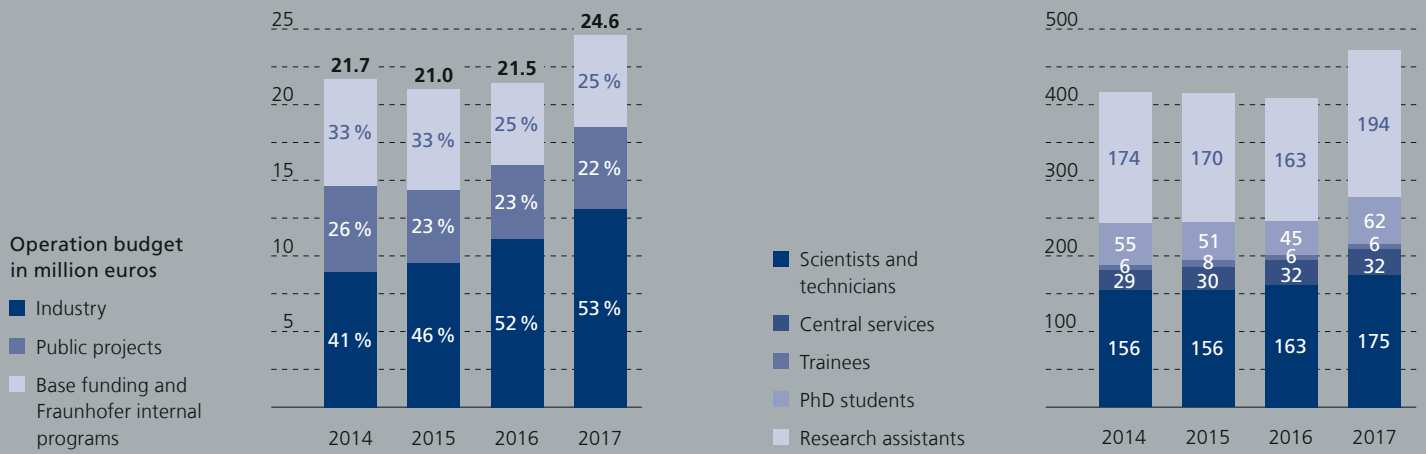
The effort made by our employees is what guarantees the continued scientific and economic success of the Institute. At this point, I take the opportunity to sincerely thank them for their commitment and high level of motivation as well as for their identification with the work and aims of ITWM. Their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

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

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



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



INSTITUTE PROFILE

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

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

Applied mathematics as an engine for success

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

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

Along with the implementation of this technology in application projects and its further development in research projects, the close collaboration with the Department of Mathematics at

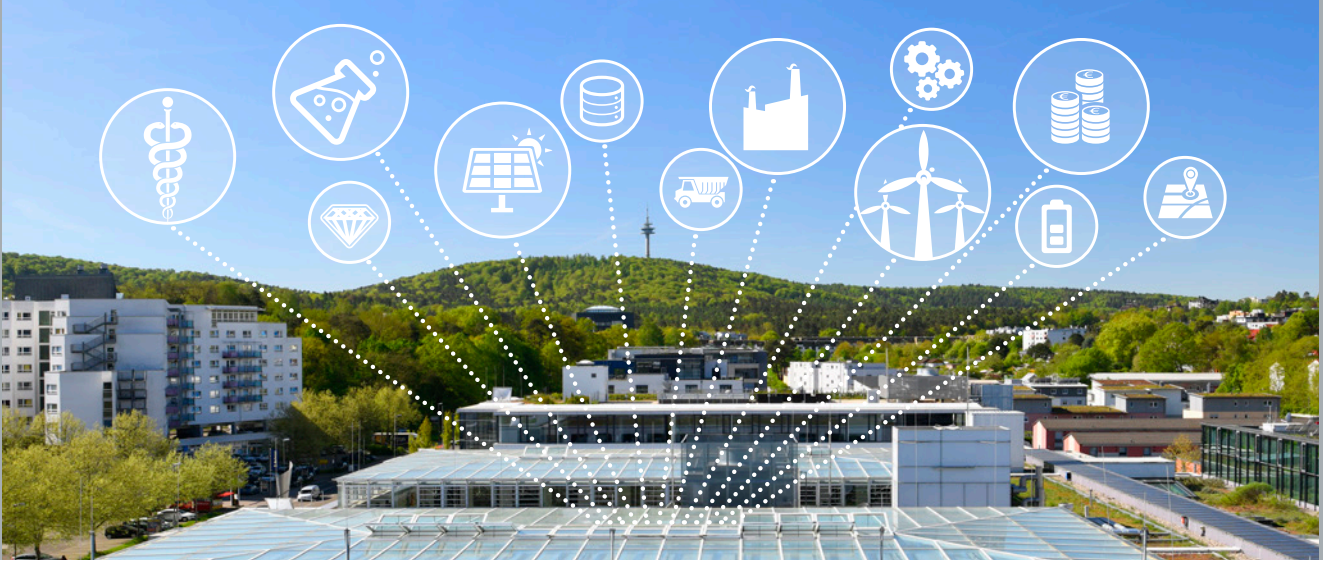
the University of Kaiserslautern is also a point of emphasis of the Fraunhofer ITWM.

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

The specific competencies of the ITWM are

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

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



INDUSTRIES – WHO DO WE WORK WITH?

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

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

and addresses companies and organizations in the sectors:

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

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



1

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2

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

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

2 *ITWM dissertation series established*

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

MORE AND MORE ITWM PhD CANDIDATES PUBLISHED BY FRAUNHOFER-VERLAG

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

ITWM SUCCESS IN THE INNOVATION FIELD “VEHICLE”

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



KAREMA DAYS – YOUNG SCIENTISTS VISIT FROM ABROAD

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

1 *Successful karema participants*

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

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

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



TALENTA – FRAUNHOFER SUPPORTS YOUNG FEMALE RESEARCHERS

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

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

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

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

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

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

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

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



FELIX-KLEIN ACADEMY: A COMPREHENSIVE VIEW OF APPLIED MATHEMATICS

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

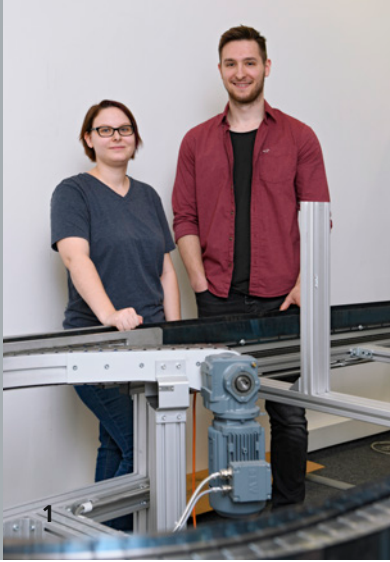
A highlight of the past fall was the international workshop “Networks and Uncertainty.” Experts from the USA, England, and Germany gave general lectures on current research about networks with a special focus on coping with uncertainties. In addition, the session last fall included topics from ITWM’s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

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

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

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

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



PERSONNEL RECRUITMENT AT TWO LABS: FROM APPRENTICE TO EMPLOYEE

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

2 *ITWM-Alumni*

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

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

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

We are very pleased that both are now ITWM employees!

MEETING OF THE ALUMNI NETWORK: REMEMBERING PEOPLE AND IDEAS

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

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



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

OUR NETWORK

CUSTOMERS AND COOPERATION PARTNERS SELECTION 2017

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

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



SPIN-OFFS

Math2Market

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

fleXstructures

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

Sharp Reflections

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

ThinkParQ

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

Product information office for retirement planning PIA

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

ADVISORY BOARD OF FRAUNHOFER ITWM

August Altherr, JOHN DEERE European Technology Innovation Center

Prof. Dr. Nicole Bäuerle, Karlsruhe Institute of Technology

Dr.-Ing. Erwin Flender, MAGMA Gießereitechnologie GmbH

Dr. Werner Groh, Johns Manville Europe GmbH

Johannes Heger, HegerGuss GmbH

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

Dr. Wilhelm Krüger, Blue Order AG (Chairmen)

Prof. Dr. Volker Mehrmann, Technische Universität Berlin

Dr. Hannes Möller, Daimler AG

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

Barbara Ofstad, Siemens AG

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

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

Dr. Mattias Schmidt, Procter & Gamble Service GmbH

Prof. Dr. Wolfgang Wahlster, DFKI GmbH

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

NETWORKING AND COOPERATIONS OF FRAUNHOFER ITWM

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

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

Further cooperations

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

SUPRA-REGIONAL BRAND THANKS TO A STABLE NETWORK

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

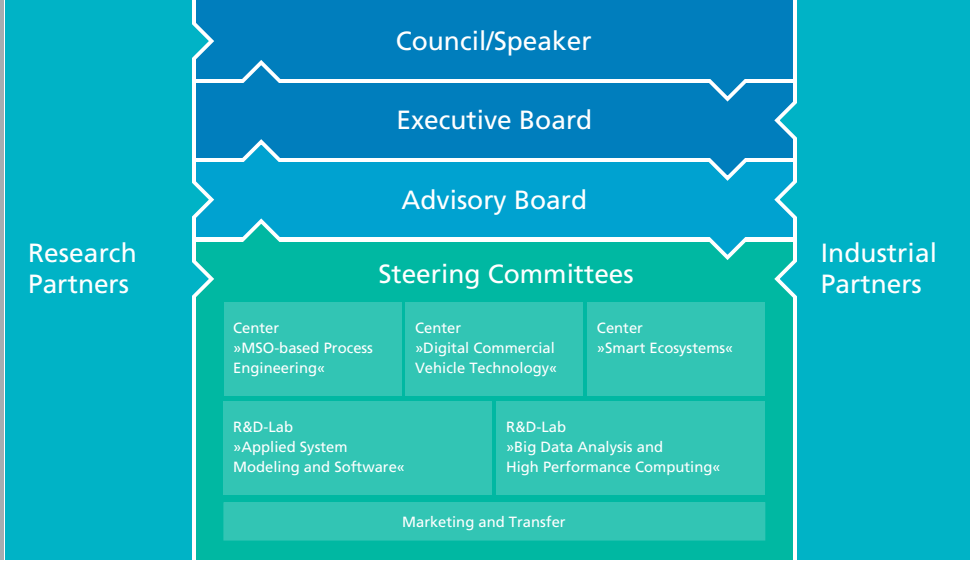
Two years after its establishment, it was subject to an external audit – which it passed with great success: the experts expressly recommended further funding and highlighted the excellent network available to the Kaiserslautern center. This network should experience greater use to increase visibility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

Efficient work in centers and labs

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

Center 1: MSO-based process engineering

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



Center 2: Digital commercial vehicle technologies

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

Center 3: Smart Eco-Systems

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

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

Transfer through the minds

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

Transfer path: IP-exploitation and spin-offs

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

Transfer path: Continuing industrial education

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



FRAUNHOFER-CHALMERS RESEARCH CENTRE FOR INDUSTRIAL MATHEMATICS FCC

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

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

- “Geometry and Movement Planning” works in close cooperation with Chalmers Wingquist Laboratory to develop simulations for automated path planning, sealants, flexible materials (e. g., cables and hoses) and human movement models. This last area is important for the ergonomic design of assembly processes.
- “Computational Engineering and Design” works on innovative numerical methods, fast algorithms, and engineering support tools for virtual product and process development. Applications include fluid dynamics, structural dynamics, and electromagnetism.
- “System and Data Analysis” supplies expertise in dynamic systems, forecasting and controls, image and video analysis, statistics, and quality engineering, in addition to technical, biological and biomedical applications.

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

THE FRAUNHOFER-GESELLSCHAFT AT A GLANCE

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

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

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

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

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

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

