Professorship of Sport Equipment and Sport Materials

Anniversary publication
2002–2022

anniversary video:

Professorship of Sport Equipment and Sport Materials
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Welcome Message

On 1 August 2002, when starting my new job at TUM, standing in an empty room which was to become my office, I couldn't get them out of my mind—these words by professor Arnulf Melzer, the founding dean of the recently established Faculty of Sports Science: "Go for it and make use of TUM's network!"

Today, 20 years later—the building and this room no. 6325 no longer exist—I am happy and also proud to be able to say: "Dear colleague Melzer: The mission is successfully ongoing, and TUM's network has been a major part of this success."

The aim of this booklet, published in celebration of my professorship's 20th anniversary, is to tell the story of its continuous development and its integration into the TUM community and also into the international research network.

It does not tell the story of the fascination and benefits of sports—a topic about which much has already been said.

It is also not about the emotions that sporting goods may transport. Instead, it aims to give insight into the scientific attractiveness and the benefits of SPORTS ENGINEERING.

And it endeavors to give you an idea of what we have achieved and what we are still aiming to improve, namely to transfer our knowledge into other fields besides sport and also into the engineering education of our students. Moreover, the aim is to convince you that our research field is one of the best examples of human-centered engineering.

At this point, it is important to state that without the strategic vision of former TUM president Wolfgang A. Herrmann, without the help of many talented and ambitious young researchers, well-educated and motivated students, and—equally important—the perfect and loyal support of my secretary, this story could not be told.

Therefore: A very warm THANK YOU to all of you!

Prof. Dr.-Ing.
Veit Senner
Head of the Associate Professorship of Sport Equipment and Sport Materials

Welcome Message

by the Dean of TUM School of Engineering and Design

Prof. Dr. Christoph Gehlen

With the European Championships Munich 2022, the largest sporting event in Munich since the 1972 Olympic Games, the city is showing the world—as it did 50 years ago—that architecture and sport can be elegantly and timelessly linked. A similar synergy exists in the relationship between sports and technology, and TUM recognized this early on: A professorship of "Sport Equipment and Sport Materials" was established in the Faculty of Sports Science, which was newly founded in 2001, and filled by Senner, who was 42 at the time. In addition to holding a degree in mechanical engineering and a doctorate from TUM, Senner is also a qualified physical education teacher, has six years of experience in business, and has contacts in the sporting goods industry. This sent a clear signal: The Technical University of Munich offers research and teaching in the field of sports engineering, thus adding the technological component to classic sports science. The enormous sales generated worldwide in the area of sporting goods, German DAX companies in this industry, an extremely powerful community of small- and middle-sized companies for sports and wellness products, double-digit growth rates in the area of wearables, and, probably the strongest external impact, an outstanding level of competitive sports in Germany—all of this underscores the importance of research and development in the area of sports technology.

The Chair of Sport Equipment and Sport Materials has now been part of the TUM community for 20 years. Since 2009, it has been part of the Department of Mechanical Engineering and connects engineering not only through active secondary membership with the Faculty of Sport and Health Sciences but also through research collaborations with medicine, computer science, civil engineering, or the Straubing Science Center. With the founding of the TUM School of Engineering and Design in October 2021, what belongs together was unified. The school stands for human-centered engineering, which can be interpreted as emotionally evocative design, coupled with maximum functionality, ergonomics, and the intelligent use of innovative materials—namely, all that makes up attractive sports products. The Chair of Sport Equipment and Sport Materials has made valuable contributions to this and is therefore well deserving of celebrating its 20th anniversary.

I wish you a wonderful celebration and continued success in this field of research and application, which is particularly interesting both for students and in terms of external impact.

Prof. Dr.
Christoph Gehlen
Dean of TUM School of Engineering and Design

Simona Chiritescu-Kretsch 2002

Welcome Message

by the Head of the Chair of Ergonomics

Prof. Dr. Klaus Bengler

As we celebrate the 20th anniversary of the Professorship of Sport Equipment and Sport Materials, we are celebrating an academic achievement that has stood the test of time.

As it was originally part of the Faculty of Sports Science and has since 2009 been based in the Faculty of Mechanical Engineering, the professorship has proven to be an interdisciplinary team player. This is particularly worthy of recognition, as the chair has a very empirical method of working and thus operates and continually expands sophisticated laboratories at various locations. Senner and his team's biomechanical expertise greatly enriches the research activities in the field of exoskeletons and robotics at the Department of Mechanical Engineering. Additionally, as a result of the many applications of sport equipment, many impulses have branched out into the direction of technical devices for everyday use and rehabilitation.

As a point of ergonomics reference, the exchange with SpGM researchers not only broadens the perspective into another field of application. For instance, many activities that people perform with sport equipment, sometimes even in their free time, are extraordinarily demanding to model and sometimes go well beyond what would be permitted operationally. This results in valuable approaches to the optimization of operational processes, the design of aids, and the concept of stress-strain.

Since 2012, the professorship has enriched the master's program in Human Factors Engineering with its methodological expertise. The students receive excellent training in biomechanics, digital human modeling, and, above all, the creative procedures of concept development in engineering.

As head of the Department of Mechanical Engineering, I would like to thank Professor Senner for his commitment as chair, as well as for representing the study programs related to mechanical engineering in our school.

As a colleague and "roommate" of the Human Centered shared apartment in building 3, I would like to thank you for the refreshing collaboration of all kinds.

I wish the professorship and its staff all the best for the future in their research activities, and may many interested students continue to find their way to the chair in the future.

Prof. Dr.
Klaus Bengler
Head of the Chair of Ergonomics

Stefan Lehner 2002

Harald Böhm 2003

Historical review

It was a start from scratch—zero hour, 2002. The euro had just been introduced, and the Bologna process was still far away from its implementation.

On 1 July 2002, I found a letter in my mailbox, sent by the Bavarian Ministry for Science, Research, and Art, offering me the professorship at TUM. It took only four weeks, until 31 July, for me to be appointed. The fact that the term of this professorship was limited to five years did not bother me at the time.

THE FUTURE LOOKED BRIGHT…

Unskillful and uneven first steps

There seemed to be some reservations to establishing a professorship for sport equipment and sport materials at TUM on a permanent basis—this may explain why it was given a kind of preliminary status: five years to prove itself and myself. But five years to show … what? What factors would be considered crucial in terms of quality? What strategy should we follow? How could we make optimal use of the existing resources?

For someone with experience in industry but almost none in academia, this was not an easy choice to make. It also looked rather poor in terms of resources: The funding covered my position, a research vacancy yet to be filled, and a 50% position for a secretary.

Important Milestones of SpGM	
2002-08-01	Inauguration of Senner & establishment of SpGM
2004-09-30	Allocation of laboratory at Bavarian Research and Technology Centre for Sports Science (BFTS).
2005-10-01	Senner nominated vice dean of Department of Sport Science (staying in this position until 2009/05)
2007-08-01	SpGM receives permanent status at TUM
2008-07-01	Launch of “Sports Engineering, M.Sc.” master’s program
2009-06-01	Transfer of SpGM to Department of Mechanical Engineering; relocation to Garching Research Campus
2009-12-19	Adjunct professor (co-membership) Department of Sport Science
2011-10-12	New SpGM laboratory and offices in Garching-Hochbrück commence operation
2012-05-01	Launch of “Ergonomics—Human Factors Engineering” master’s program
2021-10-01	Inauguration of TUM School of Engineering and Design
2022/01	Senner nominated as academic program director for all degree programs in mechanical engineering.

And then there was an interesting administrative boundary condition: My professorship was one of the first C3-type professorships at TUM to not be linked to an established chair. On the other hand, the positive circumstance of being an independent unit capable of operating as its own cost center required full administrative and financial responsibility from the very first moment.

It also meant that no experienced colleague was there to cooperate, that no onboarding

Thomas Grund 2004

took place, and that good advice was hard to come by. The entire Department of Sport Science had been founded only a few months before and was very much occupied with itself, trying to find the way from traditional physical education toward research-based educational programs and—even more importantly—toward an improved scientific output. Thus, being fully responsible and free to make decisions for my professorship was both a big opportunity and also a great challenge.

So sitting in an empty room (in a building which today does not exist anymore) with no staff and—due to the August/September university lockdown—with almost no other employees around, the question was: What to do first? I decided to organize the necessary refurbishment of the room, buy furniture, and prepare for my first lecture. Good plan?

Simona Kretsch (2022)

When I look back on those days today, I cannot stress enough what a relief it was when

Dr. Harald BÖHM first started to work for SpGM on 15 January 2003 and when, four months later, on 1 April, Simona KRETSCH stepped into my life and became my secretary. She still is. It is not an exaggeration: Without her talent for organizing the office, her unique way of communicating with administrators, students, colleagues, and also with me (“Herr Senner: Und wann machen wir die Mappe?”), and her precision with facts & figures, I would have been lost.

PD Dr. Harald Böhm

They both had experience with university administration, and Harald brought valuable knowledge from his time at the University of Tübingen. He developed our research concept very successfully, submitted the remarkable number of seventeen publications, and was

Sandra Huber 2004

particularly active as a lecturer throughout the six years until he left the professorship in 2009.

It was therefore logical that he received his habilitation—due to his other business obligations—several years later in August 2018. Today, Harald is a visiting professor at Eberhard Karl University of Tübingen and director of an orthopedic gait lab in Aschau on Chiemsee.

Finding a mission statement

Starting something new requires some kind of mission statement, preferably visualized by a logo. In these earlier times, the creativity of departments and units was not channeled by strict TUM corporate identity guidelines. Therefore, I did not hesitate to design a logo myself. It was inspired by a very early illustration from TUM (on the left in the picture below) which was used to show the four major disciplines medicine, life sciences, natural sciences, and engineering sciences. Our SpGM four-leaf clover stood for development, optimization, evaluation, and testing—hardly creative and not at all distinguishable from many others.

But at least it made it clear what we did. Today, after all institute, chair, and department logos have been banned, we have arrived at a more sophisticated illustration specifying the scientific disciplines we are focusing on. At least we still have four categories… And we have chosen our mission to be: “Understand the role and provide the technology for sustainable physical activity & health.”

Getting established at TUM Olympia Park Campus

One condition the TUM president and I agreed on before I started my new position was that I would be allowed to continue with my company BASIS GMBH in secondary employment.

Dr. Stefan Lehner (2008)

This gave me an alternative in case the professorship was not renewed after five years. It soon became clear that it was not possible to successfully run the company alongside my obligations at SpGM. So luckily, Stefan Lehner took over this responsibility and became CEO. The company was given the dean’s approval to rent a shared space at SpGM’s office. Until 2006, he not only managed our company but also worked as a consultant for another enterprise. Moreover, we used our common research interest in biomechanics, allowing us to exchange results and methods—especially musculoskeletal

models for simulating injury situations in sports. In order to avoid a conflict of interest, he submitted his doctoral thesis at the University of Koblenz-Landau and received his doctoral degree in 2008 (first examiner: Professor Karin GRUBER). In 2009, after Harald Böhm left SpGM, I took the opportunity to offer him the vacant position (he accepted on a 50% contract). This helped to conserve Stefan's valuable knowledge and especially his unique experience with the multi-body simulation package "Simpack" for SpGM. But even more importantly, it made it possible for me to work for another 5 years together with a very great person who is 100% loyal. It has been a fruitful time, with ten international publications as the visible scientific output.

SpGM receives permanent status

In 2007, internal and external evaluators evidently gave our scientific output throughout the past five years a positive evaluation. And the TUM presidency judged in favor of me. TUM president Wolfgang Herrmann's letter announcing SpGM's conversion to permanent status referred to me as "an active and highly dedicated colleague." I received this letter only

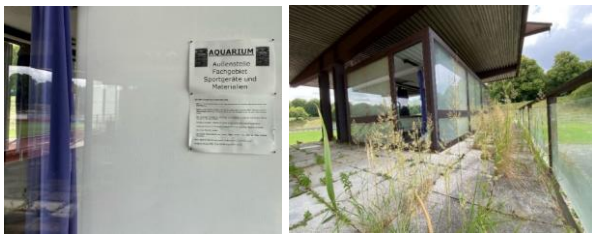
three weeks before my contract at TUM was to expire—and there was no indication in advance what the decision would be. Well, the past five years had turned my nerves into steel and optimism is a good friend of mine.

The letter also honored my "open attitude towards new developments" and mentioned "structural changes in the Department of Sport Science." At that time I did not read between the lines, but in May 2009 I fully understood the message.

The new development and structural changes concerned the SpGM and its future affiliation with the Department of Mechanical Engineering.

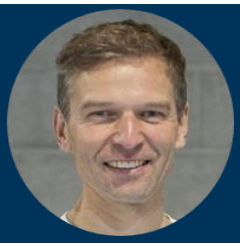
We need room!: Developing infrastructure

January 2004: It was very cold in the former sports reporter's cabin on the track and field grandstand, fondly called the "Aquarium." Three of my Ph.D. students tried to concentrate on their work—in vain, with freezing feet and trembling fingers. So they started to insulate the walls, bought an electric heater, and laid carpeting on the floor.



Interim office "Aquarium" from 2004 to 2010 (left) and shortly before its dismantling in 2021 (right)

This "alternative office" was used by SpGM for six (!) years, until 2010—the Aquarium was



Markus Rothermel 2005

Christoph Ebert 2005

dismantled in July 2021—confirming the saying that nothing lasts longer than interim solutions. The situation regarding laboratories was much better: In 2005, the new Bavarian Research and Technology Centre for Sports Science (BFTS) was inaugurated, offering broad laboratory space in a concept of joint usage with the other colleagues doing experimental work and testing. With the transfer of SpGM to the Department of Mechanical Engineering in 2011, we had to move out of the lab at BFTS and were given a windowless room behind the faculty building which formerly had been used for gas turbine testing.

Sport Equipment Development and Testing Laboratory in BFTS (2005–2009), marked in pink

At the same time, we received the confirmation that our (small) Bicycle Test Lab on the Olympia Park Campus also had to be vacated. No more bicycle testing facilities at TUM? Not for department dean Peter KAU, who acted quickly. A brief email, sent by him on 26 January 2011, paved the way for the future of SpGM: 160 m^2 of laboratory space and 105 m^2 of office space on the third floor of a new building on the business campus that had recently opened in Garching-Hochbrück. Even though this location was two subway stations away from my office and we had to install a compressed air supply and power current at our own cost, this solution made me happy.

SpGM's total office area in square meters thus fulfilled the standard density range defined by the department in 2017/18. The infrastructural foundation for both personnel and scientific growth was thus laid.

A new affiliation: SpGM transfers to the Department of Mechanical Engineering

The information came without any prior indications and was not announced beforehand by the head of department, Professor Jürgen Beckmann. Instead, I found an email dated 18 May 2009 in my inbox, sent from an unknown administrator, stating: "*The transfer of your professorship is imminent.*" The next day, I received a warm welcome email from my new colleague and dean of the Department of Mechanical Engineering.

I have to admit: The feelings were quite similar to when a partnership breaks up—maybe also due to the very short notice of this change. But looking back today, I can say without any hesitation:

This far-reaching decision of TUM president Herrmann has turned out to be a very lucky one for SpGM's development. And it still is…

Back to 2009: A letter and a serious discussion with TUM chancellor Albert Berger were necessary to preserve the 50% secretary position at SpGM. Even though this almost doubled Simona Chiritescu's commute to work, she decided to stay with SpGM. What a generous decision of hers!

Together with Professor Klaus Bengler, who started his job at TUM as the successor to Professor Heiner Bubb at the Chair of Ergonomics, we both found our new home on the third floor in the fancy Mechanical Engineering Building on the Garching Research Campus.

I am sure that the transfer to the Department of Mechanical Engineering would not have been realized if he had not strongly supported it. "He" refers to Professor Peter KAU, who had already helped in 2008 with the introduction of my "Sports Engineering" master's program at the Department of Sport Science (see more on this under "Teaching: What content and to whom?")

Prof. Dr.-Ing. Peter KAU (died 2013)

He passed away much too young, in 2013, but his work for the department is present and honored today in all of the colleagues' minds. He liked the idea of having someone in the department who dealt with sport on a scientific level. And YES, he sometimes brought in his latest race bike frames to perform stiffness measurements and to discuss technical details at the highest level. While mentoring SpGM, he signed my request to become an affiliated professor at the Department of Sport Science,

Ulrike Fontanari 2006

negotiating and realizing the allocation of lab and office infrastructure for SpGM in Hochbrück. I remain connected with him in great memories—we practice this by going on annual bike and skiing excursions with members of his family.

Special staff, hard-working people, and excellent students

It is impossible here to mention all the people who have made the wonderful development of SpGM become a reality. Several hundreds of student qualification theses and a huge number of student assistants are first of all worthy of mention. In these 20 years, I have truly experienced Humboldt's appeal for a unity of research and teaching: Well educated in the latest research methods and on the current state of technology, our highly motivated students are the backbone of our research. The majority of my Ph.D. students are recruited from this cohort. It is enjoyable to observe the excitement they encounter when they switch from the status of student to that of TUM employee and Ph.D. candidate. I would like to explicitly name just two of these marvelous people in my staff: The first is Aljoscha Hermann, my right hand, co-strategist, and a dedicated scientist for almost 10 years now (including his time as student). He will finish his Ph.D. in a few weeks and unfortunately leave academia to start a new career in industry. The other is Dipl. Phys. Jürgen Mitternacht, my friend and colleague since the early 90s

Aljoscha Hermann (2022)

His extraordinary knowledge in almost everything, from physics to biology, his skills in programming, electronics, and data evaluation, and most of all his brilliant logic when it comes to the analysis of problems and the interpretation of data are beyond compare. Not only I and my staff but also numerous students and other colleagues have enjoyed his patient support.

Jürgen Mitternacht (2019)

Philipp Heimerl 2007

Teaching: What content and to whom?

A rocky start

Having been appointed despite my lack of experience in university teaching, I considered it essential to quickly build up this experience. However, there were two challenges, the first of which—developing a course within the few weeks remaining until the start of the semester—was the minor one. The real hurdle was the fact that all curricula of the existing degree programs did not contain or leave room for anything related to sport technology or sport engineering.

Nevertheless, I started the 2002/03 winter semester with a seminar on Biomechanical Methods in Sport Equipment Development. I guess the wording "sport equipment" was the keyword that interested the 11 students. The criterion for passing the course was not an examination but only regular attendance throughout the entire semester. Seven did—and left me with the question: Good or bad?

In the following summer we offered an advanced course on Biomechanical Methods in Sport Equipment Development II, and in the winter semester of 2003/04 we started a new seminar called Current Sport Trends and Material Developments. This reads better than it was in reality, because all these courses remained free electives, and thus only a few students made the effort to participate.

Realizing this unfavorable boundary condition, I used the 2003 working group meeting of the department's studies & teaching board[1] to propose the implementation of a "Sport and Technology" major in the existing undergraduate program. This proposal made it onto the group's brainstorming list—but not any further.

Looking back today, this was not surprising, as the entire teaching program at the faculty was in an ongoing and extended phase of transition from a traditionally designed diplom degree program towards modularized bachelor's and baster's programs in accordance with the Bologna guidelines.

Getting sport technology courses integrated into the department's curriculum

So it took until the 2008/2009 winter semester for the department's first bachelor of science program, *Sportwissenschaftliche Basis-kompetenz*, to be launched and my course *Competence in Sport Technology* to finally become a compulsory module. Today it is named *Sport Technology* and has become a mandatory module within the Sport and Health Sciences degree program. It has been improved over the years and extended since

[1] 19. Protokoll der AG Lehre vom 5.8.2003

the 2016/17 winter semester to include the practical course *CAD Basics and the Evaluation of Innovations*. The credit for the great success of this course goes to my Ph.D. student and staff member Aljoscha Hermann, who managed to integrate the UnternehmerTUM Maker Space GmbH to provide services for surface scanning and 3D printing.

However, it soon became clear that developing and optimizing sporting goods at a high level would require profound engineering skills and also knowledge in information technologies, programming, and simulation. The vast majority of our sport science students were interested and prepared to learn.

The rise and fall of a possible solution: Sports Engineering M.Sc.

To address this issue and to overcome the unsatisfying situation of not being well enough integrated into the department's existing degree programs, the idea was born to establish our own master's program named Sports Engineering. Starting in the summer of 2007, my assistant Dr. Boehm and I both worked very hard to design this program. It It was to include content not only from sport science but also from two other faculties, mechanical engineering and computer science/informatics. It was clear that we would have to integrate all of the teaching capacity with no additional costs by integrating the future students "cost-neutrally" into existing bachelor's and master's programs at the three faculties. This of course required talking to many colleagues. However, all of them were very open to our request, not only because of the small intended cohort of approximately 20–30 students per year. On 5 February 2008, I was proud and happy to be able to send a letter to the TUM presidency signed by the three academic deans Schwirtz, Wachtmeister and Matthes, who officially confirmed that their departments were prepared to participate in the program. It took another few months of struggling with the details for the examination and study regulations to be finalized and agreed upon by the student advisory board and the university council.

But finally, in the winter semester of 2008/09, the new master of science program in Sports Engineering was launched—with only three students enrolled due to the short notice of the announcement. For the next term, the 2009/10 winter semester, again only seven students enrolled, three of them in parallel to their still ongoing diplom course of study at TUM.

At this point, two major weaknesses of its design became evident.

First: Intended as a consecutive master's program, it was focusing on the target group of TUM students with a bachelor's degree in mechanical engineering. However, there were not yet any such students in 2009. The reason

Christian Krämer 2007

was simple: At this time, the majority of the students in mechanical engineering were still enrolled in the traditional diplom degree program, which had not been replaced by the bachelor's program until 2008. In other words, the first TUM bachelor's graduates could be expected in the winter semester of 2011/12, so our new master's program was established three years too early. Second: Even though there was an option for sport science students with sincere interest and ambition in technology to obtain admission, the course of study was not generally open for them.

So looking back on these days, it was not sensible but understandable that the Department of Sport Science did not defend and retain this master's course and voted on 26 March 2010 to terminate the program—only two cohorts after its launch. Of course, all the students already in were able to finish.

If you stumble and fall, get up and start again…

With this popular maxim of sports in mind, it took only two years, until the 2012/13 winter semester, for my colleague Klaus Bengler and I to introduce a new master's program, "Ergonomics: Human Factors Engineering." This program gives the students the possibility to choose from a list of electives to focus on "sports engineering." But additionally, they acquire an extended set of skills and more engineering methods and are thus able to find jobs in a much wider spectrum of industries than just at sporting goods companies. And—lesson learned—the program is now open to TUM students with a bachelor's degree in Sport and Health Science.

Teaching is fully established

Today, the courses offered at SpGM are fully established and receive positive evaluations.

Stefan Siebert 2008

The obligatory teaching load of 19 weekly hours per semester is delivered in full, including courses for the TUM programs M.Sc. in Mechanical Engineering, M.Sc. in Human Factors Engineering, and B.Sc. in Sport Science.

For more details on our entire SpGM teaching program, including our teaching strategy and the connection between the different offerings, see page 35 of this booklet.

Everything falls into place

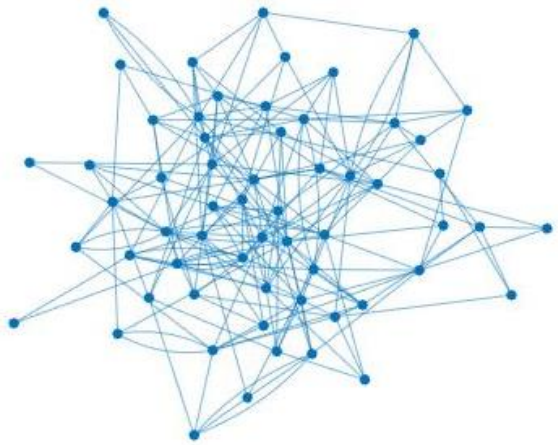
Having been nominated by our students, I have recently (01/2022) taken over responsibility as academic program director for all degree programs in mechanical engineering. This honorable job, which I can successfully practice only with the help of many experienced colleagues and an equally capable administration, gives me the chance to gain a deeper insight into TUM's concept for the future of teaching. And it intensifies the dialogue with our students.

The future

Michaela Nusser 2008

Network

Well-functioning networks are important for scientific success as they cross borders and break up supposedly closed entities. As such, networks create connections across disciplines, institutions, and nations. The resulting exchange with colleagues and collaboration partners from a variety of disciplines often leads to external impulses and innovation.



In this regard, the professorship has been an essential part of the research landscape on sports equipment and materials for 20 years and has maintained close connections and intensive cooperation with universities, hospitals, and industry partners on an international scale. From collaborations between researchers in individual projects to larger coalitions within the TUM organization, research centers, and industrial partners, the professorship of sport equipment and sport materials participates in local and global research trends. The following pages are dedicated to our partners, who are crucial to the success of our organization.

Franz Höchtl 2009

Our TUM-internal Network

SG

Department of Sport and Health Sciences

- Associate Professorship of Didactics in Sport and Health
- Chair of Human Movement Science
- Lehrstuhl für Angewandte Sportwissenschaft
- Chair of Preventive Pediatrics
- Professorship for Neuromuscular Diagnostics
- Associate Professorship of Biomechanics in Sports
- Chair of Performance Analysis and Sports Informatics

MED

TUM School of Medicine

- Department and Outpatient Clinic for Preventive Sportsmedicine
- Department of Orthopaedics and Sports Orthopaedics
- Neuro-Kopf-Zentrum
- Body Magnetic Resonance Research Group

"I have closely collaborated with the Professorship of Sport Equipment and Sport Materials with great pleasure since 2015. I esteem the open and fruitful mind of the people and their deep scientific knowledge in biomechanics and simulations. This helped us to acquire another €2Mio in funding for the upcoming 5 years!" – **Prof. Dr. Jan Kirschke - MRI**

Clemens Burkardt 2009

ED

TUM School of Engineering and Design

Institute for Computational Mechanics

Chair of Automatic Control

Chair of Metal Forming and Casting

Chair of Applied Mechanics

Institute of Micro Technology and Medical Device Technology

Professorship of Laser-based Additive Manufacturing

Institute of Automotive Technology

Chair and Testing Institute of Soil Mechanics and Foundation Engineering, Rock Mechanics and Tunneling

Chair of Aerodynamics and Fluid Mechanics

Institute for Carbon Composites

Chair of Medical Materials and Implants

Laboratory for Product Development and Lightweight Design

Professorship for Green Technologies in Landscape Architecture

Professorship of Biomechanics

Chair of Ergonomics

UMWELT FORSCHUNGSSTATION SCHNEEFERNERHAUS

"For several years now, the team at the environmental research station has been pleased to welcome the sports science groups to the Schneefernerhaus. The organizational cooperation has always been uncomplicated and smooth. Both the professional and the personal exchange are a benefit for our house." – **Team of the environmental research station Schneefernerhaus**

TUMCS

Technische Universität München
Campus Straubing für Biotechnologie und Nachhaltigkeit

Chair for Biogenic Polymers

UNTERNEHMER TUM

MAKERSPACE

CIT

TUM School of Computation, Information and Technology

Research group Augmented Reality

Chair of Cognitive Systems

MRM

Munich Institute of Robotics and Machine Intelligence

MGT

TUM School of Management

Chair of Psychology

Maximilian Hainz 2009

Network – Academia external

"I am very pleased to have the opportunity to celebrate the 20th anniversary of the Chair of Sport Equipment and Sport Materials for the close collaboration and friendly relationship that we have built up in the past years. My acquaintance with Prof. Veit Senner dates back to ISEA 2004 in Davis, California, where we first met and I soon realized how close our interests were in sports equipment, safety, and performance analysis. On the basis of a strong mechanical engineering background, combined with detailed biomechanical experimental and numerical

investigation, I always had great admiration for his achievements in the field of ski load collection, knee injury analysis and prevention, footwear and bicycle components, and support for the progress of international standards. In addition, our common approach to project-based learning allowed us to share a precious and unforgettable experience during 5 years of ISEA Winter School, which we carried out in Cortina with enthusiasm and mutual esteem. We acknowledge Prof. Veit Senner's great contribution to science and education and wi a successful continuation of the chair." – **Prof. Dr. Nicola Petrone – University of Padova**

Max Müller 2009

The Professorship of Sport Equipment and Sport Materials has been undertaking pioneering work in the field of sports engineering and technology for over 20 years. I have had the pleasure of collaborating with Professor Veit Senner and his team on many occasions, and the experience has always been enjoyable. Our interactions have been varied and fulfilling, taking place at international conferences and meetings, spanning sports engineering and snow sport safety, and even at winter schools testing sports equipment with students on the slopes in ski resorts! – **Dr. Thomas Allen – Manchester Metropolitan University**

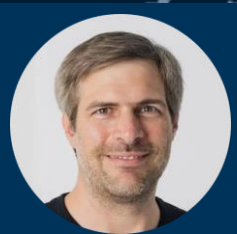
Robert Vilzmann 2009

Network – business partners

“The project work with the Chair of Sport Equipment is always inspiring for us and challenging in a positive sense. The discussions and conversations result in new ways of thinking and the motivation to critically examine one's own way of working, to be open to new things and not to stick too much to the status quo. Thank you for the enriching collaboration.” – **Michael Knye, Marker**

"For over 20 years I have known Veit as an author of scientific papers, and in 2008 I finally had the privilege of meeting Veit personally. In these "last" 14 years we realized exciting and successful projects together for adidas, the bfu, Scott, and Vaude. But what is much more important than the business relationship for me is the development of a friendship in which I could always count on the support and help of Veit and his team. THANK YOU—also for the unforgettable converence evenings!" – **Frank Michel, Vaude**

What I remember very clearly and positively from my time as a student were the field studies that we carried out as part of the sports technology lectures. These were always a highlight, because despite the professional scientific project implementation, fun was never neglected—for both students and lecturers. I always really appreciated the relaxed atmosphere! – **Kerstin Salmen, researcher at Adidas and former HFE student**



Florian Zierer 2009

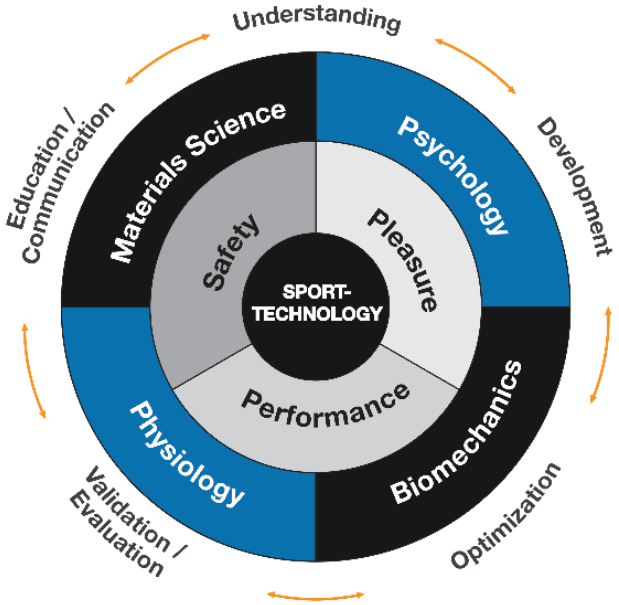
"A research and development project is always particularly exciting and a particularly important investment for us as a start-up. At SHER, we are very grateful to have found an outstanding team in the Professorship of Sport Equipment and Sport Materials with Dr. Senner and M.Sc. Nispel, who have met our requirements with passion, empathy, expertise, experience, and outstanding project planning. We have thus come a long way towards realizing our strategic goals. " – **Sara Canali**, **Sheer**

Marius Janta 2009

Matthias Blümel 2010

Research Projects

Materials—Psychology—Biomechanics—Physiology



Our mission is to understand the role of technology and to provide that technology for sustainable physical activity and health.

Sports technology can range from wearables tracking athletes' movement, heart rate, or blood pressure to sports equipment that improves athletes' performance, comfort, and security. Whether it's everyday activities, the rehabilitation sector, amateur sports, or competitive sports at a professional level, such appropriate equipment can only be developed on the basis of extensive research. Modern technologies, combined with a profound knowledge of physiological and psychological processes, can provide the ability to support the athlete at various levels.

Broken down to its essence, our research can be defined by three main goals: maximization of safety, improvement of comfort and pleasure, and optimization of performance during physical activity.

We achieve these goals through human-centered engineering. This approach increases effectiveness and efficiency, improves human well-being, user satisfaction, and accessibility, and counteracts possible negative effects of use on health, safety, and performance.

We focus on the four main research fields we consider to be the most crucial for meaningful innovation in sports engineering: materials science, psychology, physiology, and biomechanics. The following pages provide an overview of past and ongoing projects in these areas at the chair of sport equipment and sport materials.

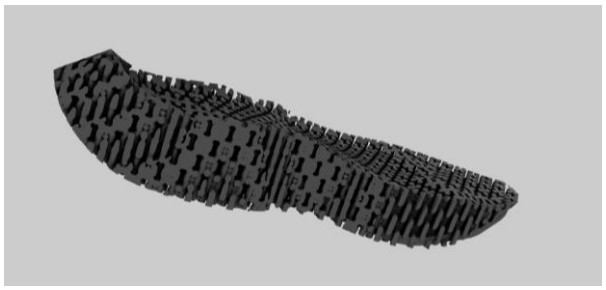
Christin Hölzel 2011

Materials

New materials and manufacturing processes lead to customized and ecological sporting goods

In the development of new sporting goods, two key parameters influence the mechanical properties: the design and the material. These parameters are mutually dependent. The choice of material also limits the possible manufacturing processes and thus the designs that can be achieved. New manufacturing processes, such as 3D printing, open up new possibilities for individualization. At the same time, sporting goods are becoming increasingly ecological through the use of sustainable polymers. The professorship works on numerous research projects in this field.

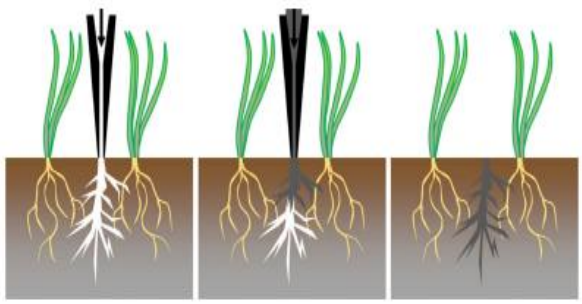
As part of the ZIM project ***IndiSports***, we are developing a highly individualized, additively manufactured midsole for the realization of a cushioning-optimized running shoe. Thanks to a change in grid structure and material composition, the shoe can be optimally adapted to the area of use and runner-specific orthopedic problems. This requires the development of new materials and 3D printing processes.



Automatically designed individualized midsole with varying grid density

In collaboration with the Italian brand for women's cycling clothing SHER, we are investigating ***the pressure conditions*** of female road cyclists on their saddles. The pressure distributions are analyzed and digitized with the help of a special measuring device. They are then used as a basis for modeling and simulating the human–sports equipment interface. 3D printing is used to develop a new type of insert pad for women's cycling shorts that achieves an ergonomic load distribution. Sensitive regions can thus be relieved and the health risks reduced in ambitious women's road cycling.

The goal of the ZIM project ***SuPer (Sustainable Polymer) Hybrid Turf*** is the development of a compostable hybrid sports turf with an ideal biomechanical loading profile to minimize non-contact injury risk in professional turf sports. For this purpose, a sustainable polymer is introduced into the soil in a liquefied state.



Lukas Sporer 2011

From left to right: Generation of air pores in the soil, injection of liquid biopolymer, curing and stabilization of the biopolymer

In addition to the ongoing projects, the professorship has numerous test stands for testing various materials—especially in the shoe sector.

The **TrackTester** is a test stand for measuring the traction of shoes. The central element is an artificial foot model. The foot model, including the shoe to be tested, is pressed onto the ground. The ground is then moved translationally or rotationally. The force or torque required for this corresponds to the translational or rotational traction, which is significantly influenced by the design and material of the shoe's outsole.

A traction measurement for trail running shoes is performed on the TrackTester

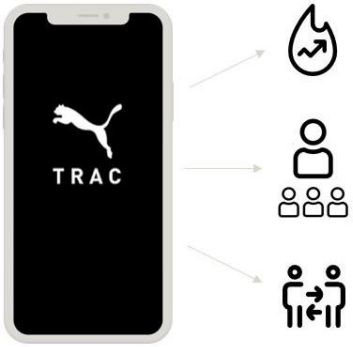
The ***TUM DIN test*** is a supplement to the TrackTester. It is a pure material test rig for determining the friction coefficient of rubber samples. In contrast to the TrackTester, it tests material samples of the outsole which always have the same shape. This means that the measurements are independent of the design of the outsole.

The Impactor is a test stand for characterizing the damping behavior of the midsole and insole of the footwear. Here, a ball with a defined weight is dropped onto the sample from a defined height. The acceleration with which the ball bounces off the sample is then measured.

Psychlogy

Health, wellness, and more fun through technical support

Sports and physical activity are often considered to be the “preventive medicine not taken.” This emphasizes the “self-management of health,“ since people are individually responsible for their physical activity and well-being. However, people often lack the long-term motivation to exercise regularly. We have conducted several research projects regarding this topic throughout the years to support people in attaining motivation.



App prototype for Puma TRAC app

uThe goal of the PUMA—Designing the Future of Wearables project was to develop significant design variables for future wearables. A user experience and usability study was conducted alongside a KANO analysis of product characteristics of wearables. The aim was to investigate users’ individual implicit and explicit motive dispositions and their effect on long-term usage.

The Sustainable Fitness Service project aimed to analyze the motivational structure of fitness customers, identify motivational aspects of the fitness industry, and conceptualize motivational workouts for the promotion of a lifelong active lifestyle. Instruments for a practicable yet scientifically validated recording of customer profiles were developed.

In the ongoing ZIM project MotiTRAIN, the aim is to develop an interactive fitness coach that can significantly increase the user's motivation and success in fitness training through innovative approaches and novel technologies. With the help of optimal training and adapted rewards, this will be controlled in such a way as to create long-lasting customer loyalty to the fitness studio. We aim to achieve this through an innovative combination of gamification approaches, extensive and precise data acquisition, intelligent evaluation, and a combination of individualized visual and haptic feedback.

Gamification approach to Qigong with interactive avatar

Besides the psychology of motivation and volition, what also plays an important role in the development of sports equipment is perception and subjective measurements.

In the ***Sky-Running*** project, subjective measurements of the form factors of shoes, such as traction, stability, weight, comfort, and cushioning, were compared among amateur trail-runners in different surface conditions.

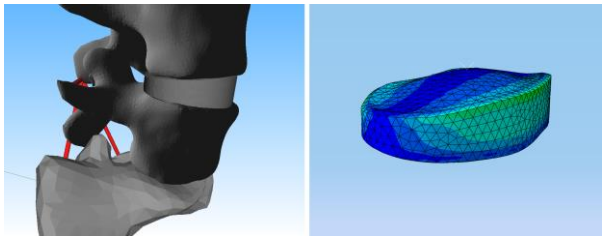
Trail running experiment with different trail running shoes

The ***PAHaM (perception and adaption of human movement)*** project investigated the interaction between perception and kinematic and neuromuscular parameters. In running, shoe mass and inclination were investigated as perturbation factors in different ranges. Perceived discomfort was measured subjectively via a questionnaire. The aim was to determine the threshold of subjective assessment and to evaluate neuromuscular and kinematic behavior in the upper and lower range of the perception threshold.

Biomechanics

Mechanics of all living beings

Biomechanics is a highly technical field whose research methods are changing rapidly, as is the technology. New techniques are regularly replacing old research methods as faster and more sophisticated software and hardware become available. Biomechanics in sports engineering is concerned with the muscular, joint, and skeletal actions of the body during athletic movement and interaction with sports equipment. Through our research, we aim to contribute to the development of new methods to positively impact athlete performance, improve rehabilitation, and prevent injury.



Individualized biomechanical multi-body model of the spine (left) coupled with a finite element model of the intervertebral disc (right)

Collaborating with the Klinikum Rechts der Isar in the context of the ERC-funded research project iBack, we quantify spinal loads using individualized biomechanical models. For these models, individual factors such as spinal alignment, body weight, and mass distribution of the soft tissue of the torso are taken into account. This helps us to better understand the pathobiomechanics of the disease and to find the optimal treatment approach for each patient and draw a direct correlation between chronic back pain and biomechanical and anthropometric parameters. Using bidirectional co-simulation, we couple individualized multi-body models with finite element models of the intervertebral discs to determine effects of disc degeneration on spinal kinematics and kinetics.

The systematic analysis of injury situations led us to understand that new technologies in ski safety are necessary to prevent knee injuries. Mechatronic ski bindings can be the solution to reducing ligament injuries. Our innovative project Mechatronic Ski Binding (funded by the Bayerische Forschungsstiftung) integrates different types of sensors into skis, bindings, ski boots, and ski clothing. The sensors continuously measure the skier's speed, knee angle, the loads on the foot, and even the activity of important leg muscles. Based on this data, an algorithm predicts the probability of injury in real-time, allowing the ski binding to react and reduce the risk of injury.

Specially built measuring ski binding for recording all forces and moments that occur during skiing.

Jürgen Mitternacht 2013

A detailed assessment of the human neuromuscular control can drastically improve the prediction of the injury risks for a healthy athlete, as well as the evaluation of the readiness to return to sports for an injured one. The **ArNeMuCo** (artificial neuromuscular control) project aims to build a digital twin of the human neuromuscular control and improve the personalization and efficiency of neuromuscular training. The project leverages the latest breakthroughs in reinforcement learning and estimates muscle activations from captured movements.

Learning to walk—simulation of human movement using artificial intelligence and motion capturing

Inverse dynamic musculoskeletal models can help gain information on muscle activity and joint loads. Such a model is the main framework of the ZIM project ***TheraTrain***. The goal is to create a simulation environment that includes the gait-training device acting on the patient. Our task is to quantify the necessary external support forces/moments to reproduce normal gait as realistically as possible, depending on the limitations of the individual patient. To optimize the training results, the training device will try to keep the support forces as low as possible.

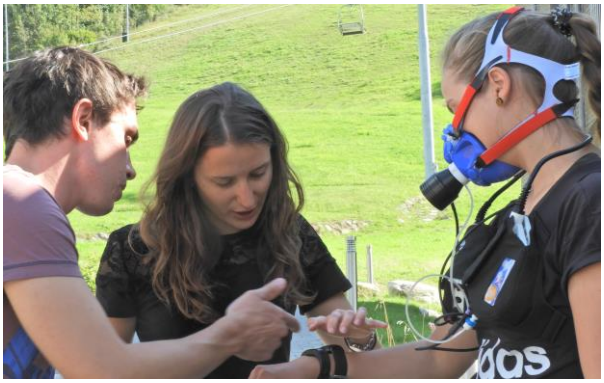
Bahador Keshvari 2013

Physiology

Fitness trackers, feedback systems, athlete-equipment interaction

The human body is a complex system of cells, tissues, organs, hormones, and other systems that are constantly communicating with each other to maintain physiological functions of the body. Even under resting conditions, the body actively maintains physiological functions. Under physical stress, these systems become even more active. This response of the human body to activity can be recorded via various sensors, and the recordings can then be used for training guidance, performance measurement, feedback systems, or monitoring of athletes to prevent overload. Today, the accelerated progress of sensing technologies, embedded systems, wireless communication, nano-technologies, and miniaturization potentially make it possible to develop smart systems for monitoring activities and vital parameters. Even devices with sensors attached to or implanted in the body are within grasp. Sports engineering not only takes part in developing these systems or improving their accuracy and usability but is also in charge of validating them against gold standards. Besides measuring physiological parameters, sports engineering can also influence them by carefully designing sports equipment.

To improve the estimation of the physiological parameters of ***future wearable devices***, we conducted extensive studies to determine how accurately various fitness trackers (GARMIN vivosmart® HR, TOMTOM Touch, Fitbit Charge 2, Withings Pulse Ox) estimate certain physiological parameters. These parameters include heart rate, energy consumption, body fat percentage, and cardiorespiratory fitness level.



Investigating the accuracy of various fitness wearables

The ***Biofeedback System for Thermal Strain*** (BIOSS) developed by the professorship non-invasively determines heat stress and possible dehydration states of the human body. The incorporation of multiple relevant parameters, such as skin and core temperature, sweat rate, and heart frequency, enables a reliable prediction of thermal strain, which, in turn, can be used to take reasonable counteractions to prevent harm.

In a collaboration with ***Busch PROtective***, we investigated the impact of helmets on the body's thermoregulation and possible solutions to related problems. Due to their properties and the closed surface, safety

Kilian Rauner 2014

Helmet (left) and measuring system (right) that can be worn underneath the helmet

helmets act as an insulation layer and hinder heat transfer from the head to the environment. In the case of excessive heat, thermoregulation can get off balance and lead to health problems. To determine the microclimate (temperature and humidity) between the head and helmet objectively, we developed a measuring system in cooperation with Reutlingen University's Faculty of Textile & Design and manufactured an active helmet cooling system. In accompanying tests, the system proved to significantly reduce thermal discomfort caused by the helmet.

"One of the most interesting seminars of my master's degree program" – participant of the Methods Seminar Sports Engineering

"The course and learning the related programs is a lot of fun. There is a pleasant learning atmosphere that is open to questions." – Student from the course CAD Basics

"Very competent guidance through the seminar from the lecturers, while at the same time you can show your own initiative. A highlight of the Master's program, which gives very good insights into the process, preparation and follow-up of a field study."
– On the Methods Seminar Sports Engineering

The concept of lecture, exercises and subsequent project is very well thought out and helps with understanding and internalizing the course content. –
Participant of the course of Digital Human Modeling: Advanced

The exercises work great and I feel very well taken care of. The hybrid format is technically very well implemented and the material is very practice-oriented. I think it's great that you can choose the topics yourself.
–
Participant on the course of Digital Human Modeling: Fundamentals

"I never thought I would get so enthusiastic about the subject of CAD!" – Student from the course CAD Basics

The lecturer is very eager to teach the students the material in an understandable way. Well done!
–
Student on the lecture Sports Technology

"The content was very interesting, especially the ski self-build exercise. I found Valentin's experience in the area particularly interesting. Cool hobby!" – Participant of the lecture Sports Engineering

I really enjoyed the relaxed but thoroughly successful teaching style.
–
Participant on the course of Digital Human Modeling: Fundamentals

I liked the course very much. Especially the "hands on" work on my own model was a great change from other courses.
– student on the course of Digital Human Modeling: Advanced

"Working in the interdisciplinary team was a lot of fun and we all learned a lot during the work. Thank you for providing the IDP – during my master program this was the lecture that was most worthwhile for me." – Student on the interdisciplinary project

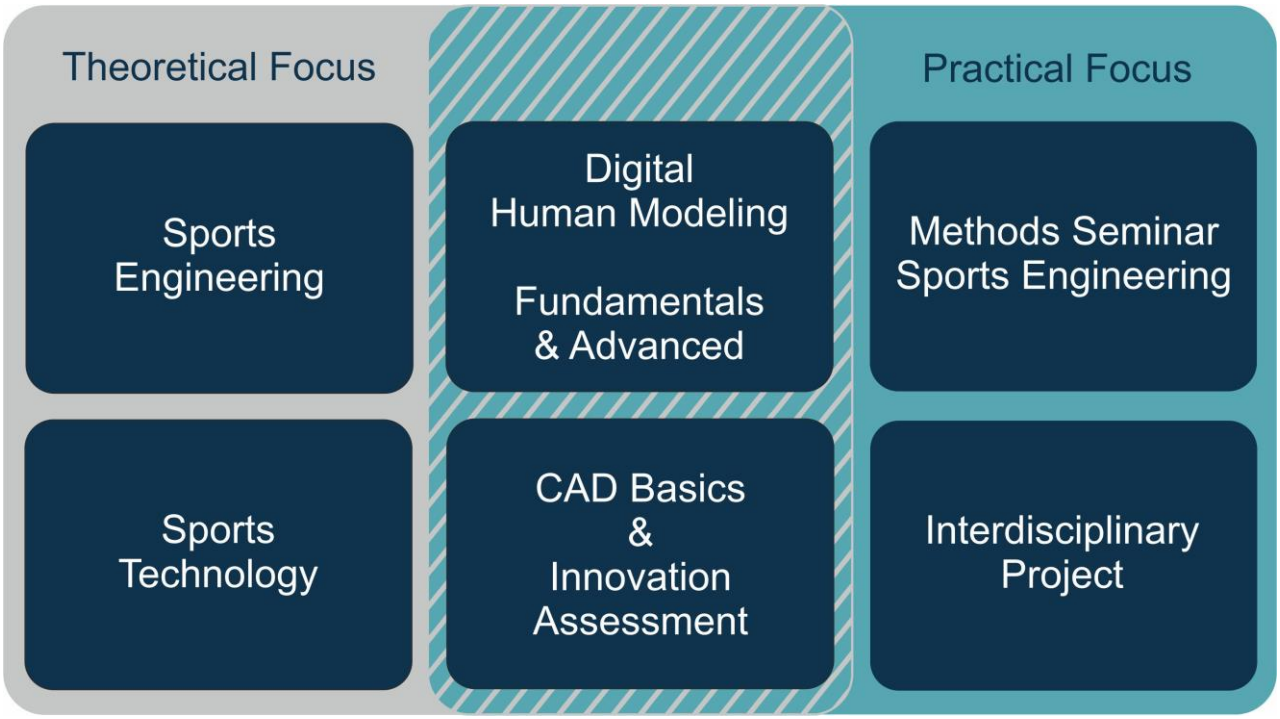
The three-day stay at the Schneefernerhaus on the Zugspitze was probably the coolest university event I have experienced in my 5 years of study so far. Above all, the relaxed but nevertheless goal-oriented working atmosphere and the fantastic group dynamics are worth mentioning. – participant of Methods Seminar Sports Engineering

Philipp Kopp 2015

Teaching

High-quality teaching is a priority at our professorship. We are convinced that the practical application of theoretical principles not only improves learning success in the long term but above all significantly increases the motivation and enjoyment of learning. Therefore, in addition to classic theory-based courses, we offer our students various opportunities to apply previously learned concepts in their own projects. We cover a broad spectrum of scientifically relevant content and tasks, place particular emphasis on interdisciplinarity and teamwork, and always strive to support our students with competent supervision, thus maximizing learning success.

Our teaching program includes courses from different areas in biomechanics and anatomy, construction, measuring technologies, and numerical simulation. The underlying overall concept thus provides our students with a comprehensive toolbox for various stages of research and development processes in sports engineering, medical engineering, and biomechanics.



Aljoscha Hermann 2015

The development, optimization, and evaluation of sports articles require methods and measurement procedures originating from sports sciences and engineering as well as from the behavioral sciences and psychology. The **Sports Engineering** module conveys a basic understanding of these methods and uses numerous examples to connect them to sports practice, both for recreational and competitive sports. The principles of scientifically oriented work in the field of sports engineering are illustrated and selected papers from journals and conferences discussed. Particular attention is paid to the need to combine different methods and to know sensible selection criteria for this.

The **Sports Technology** course provides technical and engineering basics to supplement the education of students in the Department of Sport and Health Sciences. It addresses the importance of sports science in the development of sports technology and thus highlights the important role of sports scientists. One focus of the lecture is on selected topics of materials science and strength-of-materials theory, which are worked out both theoretically and with simple calculation examples.

Digital Human Modeling: Fundamentals provides an explanation of the principles and methodical procedures in the modeling process of multi-body simulation (MBS). The course covers mechanical basics from the field of kinetics and kinematics as well as rheological models for simulation of viscoelastic behavior, taking into account related biomechanical and histological characteristics. Parallel to the theoretical content of the lectures, students build their own MBS models to address research questions from biomechanics in sports, medicine, or everyday life. Focusing on inverse dynamic simulation, students are encouraged to analyze the plausibility and sensitivity of their models using model parameter variations, thus enabling them to develop an understanding of the possibilities and limitations of multi-body systems.

Following on from the **Fundamentals** course, **Digital Human Modeling: Advanced** covers the principles and methodological approach to the modeling process of forward dynamic biomechanical MBS with a focus on muscle modeling. Students build corresponding models by coupling the MBS software with MATLAB and thus learn not only common methods of muscle force modeling but also how to deal with software-related limitations. As a complement, students gain insight into scientific and economic perspectives on the use of numerical simulations via guest lectures from various fields.

The focus of the **Methods Seminar in Sports Engineering** is a three-day series of experiments conducted on the glacier of the Zugspitze in the winter semester and the

Joaquin Parodi 2015

Stefan Klare 2015

Bavarian Alpine region in the summer semester. In preparation for this excursion, students work out and develop a methodology for addressing various research questions of limited scope on the topic of outdoor sports (especially cycling, skiing, or mountain sports). Students can use prototypes of sports equipment as well as measuring instruments and/or evaluate new products from the sports equipment market in scientifically oriented practical tests. This must involve the use of both objective data (material characteristics, biomechanical or physiological parameters) and subjective evaluations.

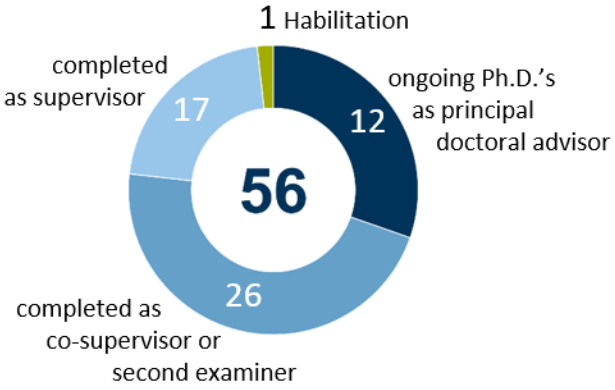
In the **Interdisciplinary Project**, students from different disciplinary backgrounds carry out project work. A seminar accompanies the actual project work and primarily serves to provide background information and recommendations for working in interdisciplinary teams. This also includes an introduction to project management. On the other hand, students learn special procedures and methods for collecting and evaluating data. This includes an introduction to MATLAB. Following the introduction of topics, the actual prelude to the IDP is an approximately four-hour block course in the second week of lectures for "teambuilding" and "team-briefing." A second block course at the end of the semester (milestone 2) serves to present what has been achieved so far and to reflect together on the experiences with interdisciplinary teamwork.

The aim of **the CAD Basics and Innovation Assessmen**t exercise course is to introduce students without an engineering background to the use of CAD software (computer-aided design). Students are introduced to CAD-based product development processes with rapid prototyping methods. In doing so, they are familiarized with the way of thinking and working in engineering and learn how to contribute their subject-specific knowledge from the various previous courses of study. This therefore strengthens interdisciplinary thinking.

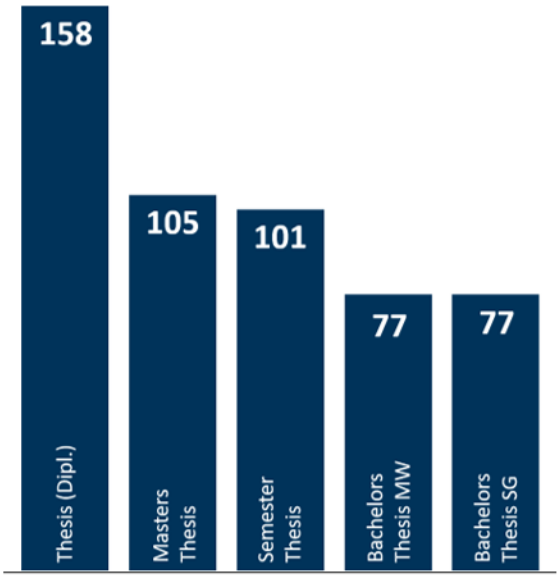
In the process, the students learn how a 3D scanner can be used to capture a body and how the scan can be processed in CAD. A customized product is then designed for the scanned object. Finally, the object is 3D printed. The students learn how to design according to standards and how to create technical drawings. In addition, the basics of innovation assessment are taught.

Achievements

Dissertations



Student research projects



Projects

Scientific talks & presentations:

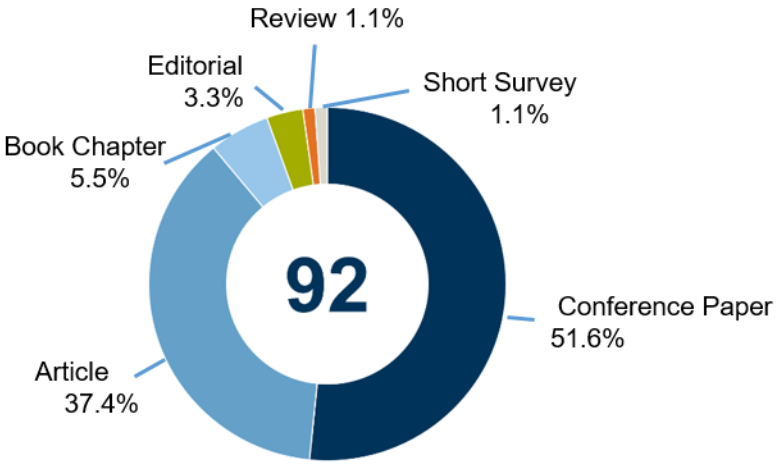
234

Raised funding:

4,189,233.72 €

Daniela Schranner 2016

Scopus listed publications

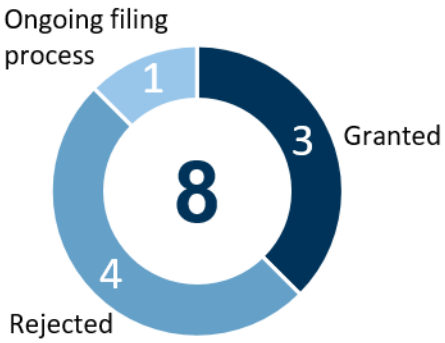


Spin-offs

Exist-Program supported by BMWi

evoha Electrolyte TRIPSTIX SURFBOARDS MOTICON

Patent applications



All numbers as of July 22, 2022

Tanja Lerchl 2017

Interviews
Research Associates

Christian Fritzsche

Started in 2022 with a focus on biomechanical modeling in the domain of footwear science

What is the attraction of a position at the professorship for SpGM?

What I like most is that there is so much exchange of information with other faculties as part of the work, such as medicine, sports science, or computer science. This means that the work is not limited to engineering-related topics but includes interdisciplinary interaction.

Where do you see the relevance of your research in general and for your personal everyday life?

From my own experience, I know how much foot pain can limit one's overall well-being and, in general, one's entire everyday life—especially when the simplest tasks, like "going shopping," become a challenge or you can no longer give 100% when doing sports. This makes it all the more motivating for me to research a topic where this pain will be alleviated and/or prevented.

How would you characterize the community structure at the professorship?

I have only been at the professorship for a few months, but I felt welcome immediately. The joint activities outside working hours have also strengthened the sense of belonging.

What have you gotten out of your time at the SpGM?

I have only been at SpGM for a few months, but as of now, only positive things ;-)

Melanie Baldinger

Research associate since 2021 in the field of motivational psychology and biomechanics with a focus on kinematics

What is the attraction of a position at the professorship for SpGM?

At the professorship for SpGM, I can pursue my passion for sports at an engineering level and thus ideally combine my two disciplines, sports science and mechanical engineering. I really enjoy working in a team with people from various disciplines, like sports science, mechanical engineering, computer science, or even (sports) medicine. Getting involved in different topics and areas and learning from others is a major attraction for me and challenges and encourages me every day. And the great thing about it is that it never gets boring and you never stop learning!

Where do you see the relevance of your research in general and for your personal everyday life?

I find it particularly exciting when technical products and, in particular, sports products are made for (and not only by) people. Individualization and digitalization are certainly the keywords of our time, and we also encounter and shape them in our everyday research. Making sports products more individual for people is one of our main tasks. The future products should help people to have more fun and motivation in sports, but also to be safer. Digital sports products will also be in great demand in the future, and we have the opportunity to help shape them and set new standards.

How would you characterize the community structure at the professorship?

It is never boring in our small but very nice SpGM team. Different characters and competencies are represented, which is very rewarding both professionally and personally. You can find a competent person to ask almost any important question, whether it's about research-related topics or woodworking, DIY craft projects, the latest gadgets on the sports market, or even music. And of course—despite a sometimes stressful everyday life—our almost exclusively athletic team events are never neglected.

What have you gotten out of your time at the SpGM?

In my personal everyday life, my view of sports equipment and products has changed a lot through my work and research. I see things with different eyes and have a much greater understanding of how much research and development work goes into even the smallest components, sensors, and products, which I find incredibly exciting. But I also try to see potential for improvement everywhere ;-)

Above all, I've gained a diverse spectrum of methods, a lot of knowledge about many different sports products, and a lot of joy in this work

Valentin Wohlgut

Valentin has been a member of the SpGM team since 2020 and focuses mainly on multi-body simulation and footwear science.

What is the attraction of a position at the professorship for SpGM?

My work at the professorship allows me to combine my hobby with my profession. In my spare time, I am passionate about trail running. In my research, I focus on designing the perfect trail running shoe outsole. I am fascinated by the interaction between shoe and human. To make the whole thing tangible, I use different methods, which makes it varied and challenging. I conduct everything from subject tests to test stand development and computer simulations

Where do you see the relevance of your research in general and for your personal everyday life?

Kati Nispel 2020

Optimizing the outsole of trail running shoes is about two key elements that are absolutely relevant for both amateurs and professional athletes: The risk of injury should be minimized. At the same time, performance should be increased. I hope that I can benefit from this in future trail running competitions ;-)

How would you characterize the community structure at the professorship?

Everyone has their own projects and needs to move them forward. Nevertheless, everyone helps everyone. It is simply fun.

What have you gotten out of your time at the SpGM?

I am still working on the professorship ;-) I am definitely gaining a great deal of expertise in the field of sports equipment development. By working with external companies, colleagues, and also students, I have also learned a lot of project management and interpersonal skills, and also how to present complicated issues in a way that is understandable to the general public.

Gheorghe Lisca

Gheorghe has been part of the professorship since 2022. His main research topic is the use of deep reinforcement learning in muscle force estimation

What is the attraction of a position at the professorship for SpGM?

I am delighted to have the particular opportunity which the professorship for SpGM offers to study human movement from a holistic perspective. In this regard, I am building up a solid foundation for researching the emergence of movement within the human body and its mechanical properties in interaction with the environment. More specifically, I can solidly validate the results of the artificial intelligence algorithms I am leveraging in order to gain a deeper understanding of human movement.

Where do you see the relevance of your research in general and for your personal everyday life?

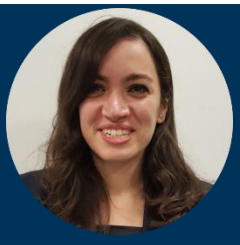
On the one hand, for neuroscientists it is still an enigma how the human brain triggers and controls the movement of the body. On the other hand, artificial intelligence algorithms are becoming increasingly better at generating anthropomorphic movements on biomechanical models in neuromechanical simulations. In this context, these algorithms are becoming increasingly relevant for the understanding and modeling of human neuromuscular control. Furthermore, for my personal life, researching how movement arises within the human body helps me to better know how my body functions.

How would you characterize the community structure at the professorship?

Wonderful! The openness of my colleagues makes me feel welcome in the group, and the faith of Professor Senner in my research questions keeps me motivated to move forward. I feel lucky and grateful to be part of the SpGM professorship

What have you gotten out of your time at the SpGM?

A lot! ... inspiration, new know-how, support, fun, a load of memories, and wonderful friends



Interviews
Alumni

Prof. Dr. Harald Böhm

Prof. Dr. Harald Böhm was a team member at the SpGM from 2003 to 2009

Where are you employed now and what is your position?

I have two positions. I am head of the gait lab at the Aschau Children's Hospital and professor in the orthobionics course at the pfh in Göttingen University Medical Center.

How would you characterize your time at SpGM in a few words?

We always had exciting projects in various fields with new challenges every day.

What impact did your time have on your career?

I took my first steps in 3D motion analysis during my time at the SpGM.

Bonus question: Was there a ritual that characterized your everyday life at the professorship?

I can't remember a specific ritual.

Dr. Marius Janta

Dr. Marius Janta was a team member at the SpGM from 2009 to 2017

Where are you employed now and what is your position?

acatech – Deutsche Akademie der Technikwissenschaften
Manager Strategische Projekte

How would you characterize your time at SpGM in a few words?

Diverse, Instructive, Active, Valuable, Happy, Funny

What impact did your time have on your career?

It built the foundation and solidified interdisciplinary areas that I would like to work on in my future career. Yet, it is not foreseeable what impact the time at SpGM will actually have. But I am sure it will be good!

Bonus question: Was there a ritual that characterized your everyday life at the professorship?

Lovely reoccurring discussions on travel expenses with Mrs. Kretsch :).

Interviews
Athletes

Anna Schaffelhuber

successful former para-alpine skier, Photo: Andreas Panzenberger

What role does sport play in your life?

A very big role. Through and in sport, I have built myself up a lot and made myself into the person I am today. Sport taught me so many values at a young age that I would otherwise have learned much later and to a different extent. In addition, sport is still a great counterbalance to my job today.

How has sport changed during your career due to technological innovations?

The changes have been very, very rapid. Many new technologies in the field of handbike sport are making the environment more and more accessible to me and giving me the opportunity to discover it more. In the field of skiing, the technological innovations have contributed enormously to the professionalization of the whole competitive sport.

If you could push ahead one technological development in sport, what would it be and why?

Actually, the BikAble is one of my great passions. I really enjoy being in the mountains and in nature. The BikAble will give me even more freedom. For the winter, I would like to see a development that would allow me to go on a ski tour in a sitting position.

Where do you see the opportunities and risks of sports technology development in your sport?

The opportunities of sports technology developments are enormous, because they improve the quality of life of people with a disability in and outside of sport. For example, I believe that a large part of "inclusion" will and even must work through sport. For this, however, you need more barrier-free sports facilities and then suitable equipment to be able to participate well in sport. However, I see a big problem in providing affected people with the new sports equipment. This equipment is very expensive, and many people with disabilities cannot afford it. Unfortunately, the health insurance companies hardly pay anything or even less and less in this respect

Time flies: The team of the Associate Professorship for Sport Equipment and Sport Materials almost 20 years after its foundation.

Christian Fritzsche 2022

Kevin Lippmann 2022

Technical University of Munich
School of Engineering and Design
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