Professorship of Sport Equipment and Sport Materials

Anniversary publication
2002 – 2022

Professorship of Sport Equipment and Sport Materials
School of Engineering and Design
Technical University of Munich

Boltzmannstraße 15
85748 Garching

Tel.: 089 289 15366
Fax: 089 289 15389
kretsch@tum.de
http://www.spgm.tum.de

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Welcome Message

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

Today and 20 years later – the building and this room No. 6325 do not exist anymore – I am happy and also proud being able to say: "Dear colleague Melzer: Mission is successfully ongoing and TUM's network has been a major key for this success."

This booklet published in celebration of my professorship's 20th anniversary wants to tell the story of its continuous development and its integration into TUM's and also into the international research network.

It will not tell the story of the fascination and benefits of sports – much has been said about this.

It is also not on the emotions that sporting goods may induce. Instead, it tries to give an insight into the scientific attractiveness and the benefits of SPORTS ENGINEERING.

And it wants 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 our student's engineering education.

Moreover: It 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: 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 "Sports Science" faculty, which was newly founded in 2001, and filled by Senner, who was 42 at the time. In addition to a degree in mechanical engineering and a doctorate from TUM, Senner also is a graduate sports teacher, had 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 middle class 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 Sports Equipment and Materials has now been part of the TUM community for 20 years. Since 2009, it has been anchored in 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, what makes attractive sports products. The Chair of Sports Equipment and Materials has made valuable contributions to this and is therefore celebrating its 20th anniversary well deserved. 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

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 Materials, we are celebrating an academic achievement that has stood the test of time.

As its roots stem from the Faculty of Sports Science and, from 2009, based in the Faculty of Mechanical Engineering, the professorship has proved to be an interdisciplinary team player. This is particularly worthy of recognition, as the working method is very empirical, and thus sophisticated laboratories are operated at various locations and continuously expanded. Senner and his team's biomechanical expertise greatly enriches the research activities in the field of exoskeletons and robotics in the Department of Mechanical Engineering. Additionally, as a result of the sports equipment's field applications, many impulses have branched in 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 a another field of application. For instance, many activities that people perform and sometimes take on in their free time with sports equipment are extraordinarily demanding to model and sometimes go well beyond what would be permitted operationally. This results in valuable approaches to optimizing operational processes, designing aids, and looking at the concept of stress-strain.

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

As the department head 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 shared apartment Human Centered in Building 3, thank you for the refreshing collaboration in many ways.

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 professorship in the future.

Prof. Dr.
Klaus Bengler
Head of Chair of
Ergonomics

Harald
Böhm

Historical review

It was a start from the scratch – time zero, 2002. The EURO was just introduced and the Bologna process was still far away from its implementation.

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

THE FUTURE LOOKED BRIGHT…

Unskilful and Uneven First Steps

There seemed to be some reservations to establish a professorship for sport equipment and materials at TUM permanently – this may explain why it was given some kind of preliminary status: Five years to prove itself and myself. But: Five years to show … What? Which factors are considered crucial in terms of quality? Which strategy to follow? How do we use the existing resources optimally?

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

Important Milestones of SpGM	
2002-08-01	Inauguration Senner & start off SpGM
2004-09-30	Laboratory in Bavarian Research and Technology Centre for Sports Science (BFTS) allocated.
2005-10-01	Senner nominated Vice Dean of the 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 Master's course "Sports Engineering, M.Sc."
2009-06-01	SpGM transfer to the Department of Mechanical Engineering. Relocation to Research Campus Garching
2009-12-19	Adjunct professor (co-membership) Department of Sport Science
2011-10-12	New SpGM laboratory and offices in Garching – Hochbrück begin to operate.
2012-05-01	Launch of Master's course "Ergonomics -Human Factors Engineering".
2021-10-01	Inauguration TUM School of Engineering and Design
2022/01	Senner was nominated as Academic Program Director for all study 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 not being linked to an established chair. The positive circumstance of being an independent unit that is able to operate on its own cost center encountered on the other hand the negative aspect that it 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 took place and that good pieces of advice was missing. The entire department of Sport Science was founded only a few months ago and was much occupied with itself, trying to find the way from traditional physical education towards research-based educational programs and – even more important – towards an improved scientific output. Thus, being fully responsible and free to decide for my professorship was both a big chance and also a severe 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)

Today when looking back to these days, I cannot enough celebrate the moment when Dr. Harald BÖHM first started to work for SpGM on the 15th of January 2003 and four months later, 1st of April, Simona KRETSCH stepped into my life and became my secretary. She still is. It is not an exaggeration: Without her talent to organize the office, her unique way to communicate with administration, 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 (2004)

They both had experience with university administration and Harald brought valuable knowledge from his former time at the University of Tübingen. He developed our research concept very successfully, submitted the remarkable number of seventeen publications, and was particularly active as a lecturer throughout his 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-Karls-University Tübingen and the director of an orthopaedic gait lab in Aschau / Chiemsee.

Finding a mission statement

Starting something new requires some kind of mission statement, preferably visualized by a respective logo. In these former 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 distinguishing from many others.

But at least it made clear what we did. Today after all institute, chair and department logos have been banned, we have come to a more sophisticated illustration specifying the scientific disciplines, we are focusing on. At least still 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 Campus Olympia-Park

One condition, the president of TUM and I agreed on before I started my new position, was the permission to continue with my company BASIS GMBH in secondary employment.

Dr. Stefan Lehner (2008)

Just to have a backstop in case the professorship was not renewed after five years. It soon became clear, that it was not possible to successfully run the company in addition to my obligations at SpGM. So luckily Stefan Lehner took over this responsibility and became the CEO. The company was given the Dean’s approval to rent a shared space in SpGM’s office room. Until 2006 he managed not only our company but also took work as consultatnt for another enterprise. Moreover, we used our common research interest in biomechanics, being thus able to exchange results and methods – especially musculo skeletal models to

simulate injury situations in sports. In order to avoid 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 had 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 important: It realized another 5 years of working together with a very great and 100% loyal person. It has become a fruitful time with 10 international publications as the visible scientific output.

SpGM receives the Permanent Status

In 2007, internal and external evaluators seem to have positively rated our scientific output throughout the past five years. And TUM presidency has judged in favor of my person. "… an active and highly dedicated colleague", as it was written in TUM president Wolfgang Herrmann's letter announcing SpGM's conversion to permanent status. I received this letter only three weeks before my contract at TUM would have expired – there was no indication in advance what the decision would be. Well, the past five years have turned my nerves into steel and optimism is a good friend of mine.

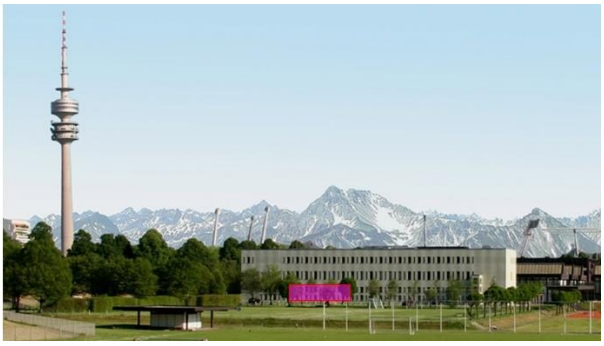
The letter has also honored my "… open attitude towards new developments" and, mentioned "…structural changes in the department of Sport Science". At that time, I did not read between the lines, but in May 2009, I fully understood the message:

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

We need room! - Developing infrastructure

January 2004: It was very cold in the former sports reporter cabin on the track and field tribune, fondly called "Aquarium". Three of my Ph.D. students tried to concentrate on their work – in vain with freezing feet and trembling fingers. Therefore, they started to isolate the walls, bought an electric heater, and put carpet on the floor.

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



Sport Equipment Development and Testing Laboratory in BFTS (2005-2009) – marked with pink color

For six(!) years until 2010 this “alternative office” has been used by SpGM – the Aquarium has been 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 common concept of 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 clear the lab in BFTS and were given a windowless room behind the faculty building, which formerly had been used for gas turbine testing.

At the same time, we received the confirmation, that our (small) Bicycle Test Lab on Campus Olympia Park also had to be emptied. No more bicycle testing facility at TUM? Not for department dean Peter KAU, who acted quickly. A short e-mail, sent by him on the 26th of January 2011, paved the way for the future of SpGM: 160 m^2 laboratory and 105 m^2 office space on the third floor of a new building on the business campus 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 on our costs, this solution made me happy.

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

A New Affiliation: SpGM transfer to the Mechanical Engineering Department

The information came without any prior hints and was not announced beforehand by the Head of Department, Professor Jürgen Beckmann. Instead, I found an e-mail dated May 18th, 2009 in my inbox sent from an unknown administration person telling me “*The transfer of your professorship is imminent…”.* The next day I received a warm welcome e-mail from my new colleague and Department Dean 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 for Simona Chiritescu, the needed time to get to work almost doubled, she decided to stay with SpGM. What a generous decision of her!

Together with Professor Klaus Bengler, who started his job at TUM following 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 Research Campus Garching

I am sure that the transfer to Department Mechanical Engineering would not have been realized if he had not strongly supported it. "He" means Professor Peter KAU, who already in 2008 had helped with the introduction of my Master's course „Sports Engineering" in the Sport Science Department (see more on this

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

under the headline Teaching: Which content and to whom?). He died much too young 2013, but his work for the Department is present in all colleagues' mind and honoured until today. He liked the idea of having someone in the department who would be dealing with sport on a scientific level. And YES, he sometimes brought in his latest race bikes frames to perform stiffness measurements and to discuss technical details on their highest level. Mentoring SpGM he signed my request to become affiliated professor in the Department of Sport

Science, he negotiated and realized the allocation lab and office infrastructure for SpGM in Hochbrück. I remain connected with him in great memories – we practise this with annual bike and skiing excursions, together with members of his family.

Special staff, hard working people and excellent students

It is impossible to even give an overview of all the people who have made the wonderful development of SpGM become reality. Several hundreds of student qualification thesis and a huge number of student assistants should be mentioned in the first place. In these 20 years I have truly experienced Humbold's pleading for the unity of research and teaching: Being well educated in the latest research methods and on the current state of technology, our highly motivated students are the backbone of 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 the status of TUM employee and Ph.D candidate. Among of all of these marvellous people in my staff, I like to explicitly name two of them: My right hand, co-strategist and scientist from the heart for now almost 10 years (including his time as student): Aljoscha Hermann. He will finish his Ph.D in a few weeks and unfortunately leave academia to start a new career in industry. The other one is my friend and colleague since the early 90ties Dipl. Phys. Jürgen Mitternacht.

Aljoscha Hermann (2022)

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

Jürgen Mitternacht (2019)

Teaching: Which content and to whom?

A rocky start

Having been appointed despite of my missing experience in university teaching, a fast building-up of this experience seemed essential. This however faced two challenges, where the first – developing a course within a few weeks until the semester started – was the minor one. The real hurdle was the fact, that all curricula of the existing study programs did not contain or did not leave room for anything related to sport technology or sport engineering.

Nevertheless, I started the winter semester of 2002/03 with a seminar on *Biomechanical Methods in Sport Equipment Development*. I guess the wording "sport equipment" was the keyword that interested 11 students, no examination but regular attendance throughout the entire semester was the criteria to pass the course. Seven did – and left the question: Good or bad?

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

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

Looking back today, this was not surprising as the entire teaching program of the faculty was in an ongoing and longer-lasting transition phase from a traditionally designed Diplom study course towards modularised Bachelor- and Master's programs according to the Bologna guidelines.

[1] 19. Protokoll der AG Lehre vom 5.8.2003

Getting sport technology courses integrated into the department's curriculum

So it took until winter term 2008/2009 when the department's first bachelor program of science *Sportwissenschaftliche Basiskompetenz*

was launched and with this my course "*Competence in Sport Technology*" finally became a compulsory module. Today it is named *Sport Technology* and has become a mandatory module within the study program of Sport and Health Sciences. It has been improved over the years and since winter the semester 2016/17 it has been extended by a practical course *CAD Basics and the Evaluation of Innovations*. The credit for the big success of this course goes to my Ph.D. student and staff member Aljoscha Hermann, who managed to integrate the UnternehmerTUM Maker Space GmbH providing services for surface scanning and 3D printing.

However, it soon became clear: Developing and optimizing sporting goods at a high level would need profound engineering skills and also knowledge in information technologies, programming and simulation. More than the majority of sport science students were interested in 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 existing study programs of the department, the idea was born to establish an own master's program named *Sports Engineering*. Starting summer of 2007, my assistant Dr. Boehm and I both worked very hard to design this program. It should include not only teaching content from sport science but also teaching content from two other faculties, mechanical engineering, and computer science/informatics. It was clear that all teaching capacity had to be organized with no additional costs, by integrating the future students "cost –neutrally" into existing Bachelor's and Master's courses of the three faculties. This of cause required talking to many colleagues, however, all of thewereng very open-minded to our request, not only because of the small intended cohort of approximately 20-30 students per year. On the 5th of February 2008, I was proud and happy to be able to send a letter to the TUM presidency signed by the three study deans professor Schwirtz, Wachtmeister and Matthes who officially confirmed their department's teaching import. It took another few months of struggling with the details until the examination and study regulations were finalized and agreed upon the student advisory board and the university council.

But finally, in the winter semester of 2008/09 the new Master of Science program Sports Engineering was launched – due to short notice of the announcement – with only three students enrolled. For the next term WS2009/10 again only seven students were enrolled, three of them in parallel to their still ongoing Diplom study course at TUM.

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

First: Intended as a consecutive Master it was focusing on the target group of those TUM students with a Bachelor's degree in mechanical engineering. In 2009 however, no such students were seen on the horizon. The reason was simple: At this time, the majority of the students in mechanical engineering were still enrolled in the traditional Diplom study course, which was not replaced by the Bachelor's program until 2008. In other words: The first TUM Bachelor's graduates could be expected winter semester of 2011/12, thus our new Master's program was established three years too early. Second: Even though there was an option for those sport science students with sincere interest and ambition for technology to get admission, the study course 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 preserve this master's course and voted 26th of March 2010 – only two cohorts after its launch – for stopping the program. Of course, all the students already in were able to finish.

Having stumbled and fallen: Regain upright position and start again…

With this popular maxim of sports in mind, it took only two years until in the winter semester of 2012/13 my colleague Klaus Bengler and I were able to start with a new Master's program "Ergonomie -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 – it is now open for TUM students with a Bachelor's degree in Sport and Health Science.

Teaching being well settled

Today SpGM's offered courses are fully established and well evaluated.

The obligatory teaching load of 19 SWS is entirely delivered, offering courses for TUM programs in M.Sc. in Mechanical Engineering, M.Sc. Human Factors Engineering and B.Sc. Sport Science.

More details on our entire SpGM teaching program showing also the teaching strategy and connection between the different offers can be read on page 35 of this booklet.

Circle completed

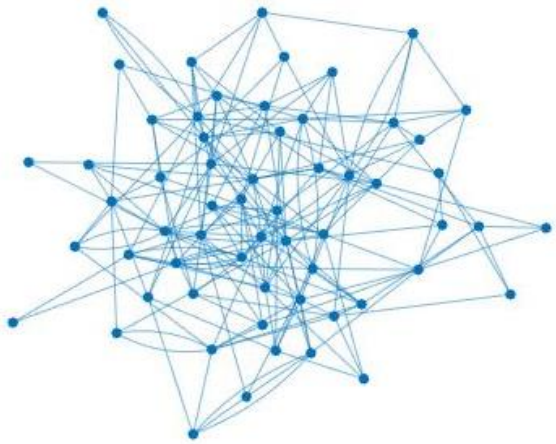
Having been nominated by our students, I have recently (01/2022) taken over the responsibility as Academic Program Director for all study programs in Mechanical Engineering. This honorable job, which I can successfully practise only with the help of many experienced colleagues and an equally capable administration, gives me the chance to get a deeper insight into TUM's concept for the future of teaching. And it intensifies the dialogue with our students

The Future

Michaela
Nusser

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.



As such, 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, clinics, and partners in the industry 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 sports equipment and sports materials engages in local and global research trends. The following pages are dedicated to our partners, who are crucial for the success of our organization.

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 am closely collaborating 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 funding for the upcoming 5 years!" – **Prof. Dr. Jan Kirschke - MRI**

Franz Höchtl

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 organisational 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

Clemens Burgardt

Network – Academia external

“I am very pleased to have the opportunity to celebrate the 20th anniversary of the Chair in Sports Equipment and Materials for the close collaboration and friendly relationship that we built in the past years. My knowledge with Prof. Veit Senner dates to the ISEA 2004 in Davis, California, when we first met and I soon realized how close were our interests to sports equipment, safety and performance analysis. Based on a strong mechanical engineering background, combined with detailed biomechanical experimental and numerical investigation, I always appreciated with admiration the achievement in the field of ski load collection, knee injury analysis and prevention, footwear and bicycle components, as well as in the support to 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 that we carried out in Cortina with enthusiasm and mutual esteem. We acknowledge the great contribution to science and education given Prof. Veit Senner and wish a successful continuation of the Chair”.
– **Prof. Dr. Nicola Petrone – University of Padova**

universität wien
Deutscher Skilehrerverband
TECHNISCHE UNIVERSITÄT IN DER KULTURHAUPTSTADT EUROPAS CHEMNITZ
Bayerisches Kuratorium für alpine Sicherheit
OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG
DITF DEUTSCHE INSTITUTE FÜR TEXTIL+FASERFORSCHUNG
UNIVERSITY OF OSLO
UNIVERSITÀ DEGLI STUDI DI PADOVA
TD Textil & Design Hochschule Reutlingen
UNIVERSITÄT SALZBURG
THE UNIVERSITY OF SYDNEY
RUHR UNIVERSITÄT BOCHUM RUB
technische universität dortmund
The University Of Sheffield.
DAV Deutscher Alpenverein
UNIVERSITÄT KOBLENZ · LANDAU
universität innsbruck
ETH zürich
DSV DEUTSCHER SKIVERBAND
Manchester Metropolitan University
University of Ljubljana

Maximilian Hainz


The Professorship of Sports Equipment and 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**
UNIVERSITÄT BAYREUTH
Technische Hochschule Ingolstadt
BLSV
BAYERISCHER LANDES-
HM
Hochschule München University of Applied Sciences
RUSH
ATOS
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Klinik für Gelenkersatz
im Klinikum Garmisch-Partenkirchen
THE UNIVERSITY OF MELBOURNE
Universität Hildesheim
2003
DEUTSCHER EISHOCKEY-BUND
Universiti Malaysia PAHANG
Deutsche Sporthochschule Köln
German Sport University Cologne
Loughborough University
Deutsche Hochschule
für Prävention und Gesundheitsmanagement
University of Applied Sciences
ISPO Munich
UNIA
Universität Augsburg University
Bayerische Forschungsstiftung
BGU Murnau
Berufsgenossenschaftliche Unfallklinik Murnau
Bundesinstitut für Sportwissenschaft

Max Müller

Network – business partners

“The project work with the Chair of Sports Equipment is always inspiring for us and challenging in a positive sense. 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 emerge from the discussions and conversations.
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 was finally allowed to meet Veit personally. In these "last" 14 years we realized exciting and successful projects together for adidas, the bfu, Scott and Vaude. But, much more important than the business relationship, is for me 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 congress 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**

Robert
Vilzmann

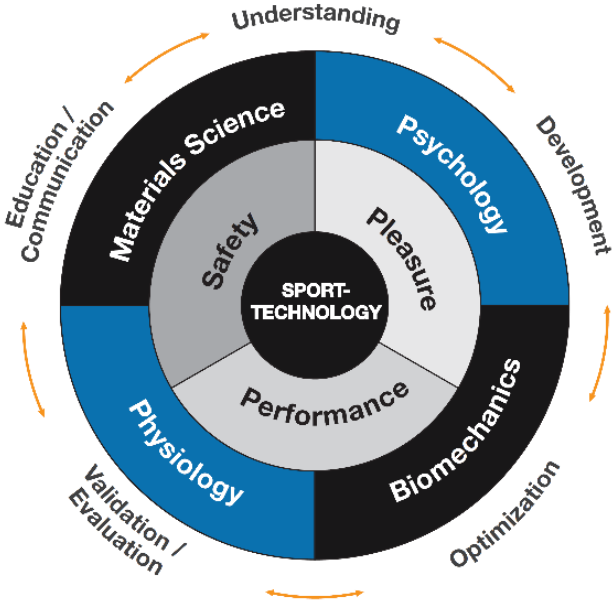
"A research and development project is always particularly exciting and a particularly important investment for us as a start-up. At SHER, we are very grateful to have found an outstanding team in the Professorship of Sports Equipment and Materials with Dr. Senner and M.Sc. Nispel, who have met our requirements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

Florian Zierer

Marius
Janta

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 the 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 based on extensive research. Modern technologies combined with a profound knowledge of physiological and psychological processes can provide the ability to support the athlete on various levels.

Broken down to its essence, we can define three main goals of our research: 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.

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

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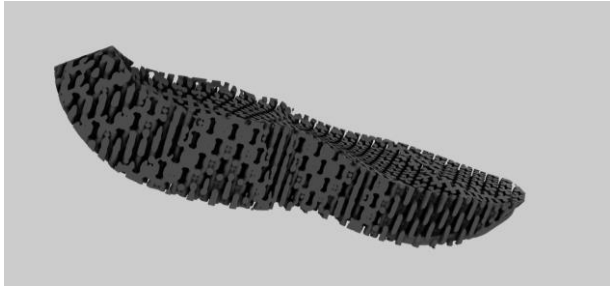
Materials

New materials and manufacturing processes lead to customized and ecological sporting

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 in this field on numerous research projects.

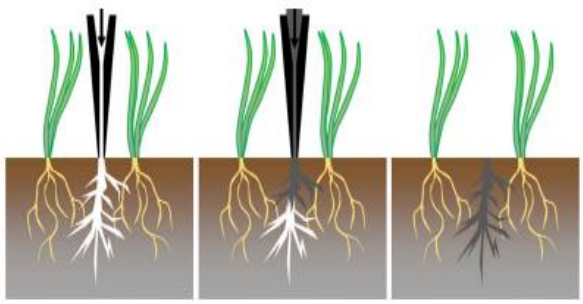
As part of the ZIM project ***IndiSports***, a highly individualized additively manufactured midsole is developed for the realization of a cushioning-optimized running shoe. By changing the grid structure and material composition, the shoe can be optimally adapted to the area of use and runner-specific orthopedic problems. New materials and 3D printing processes have to be developed for this.



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. Using a special measuring device, the pressure distributions are analyzed and digitized. 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 in ambitious women's road cycling can be reduced.

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.



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 to test 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

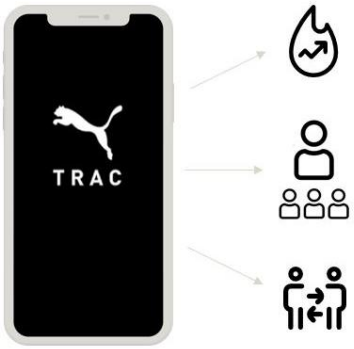
The ***TUM DIN test*** is a supplement to the TrackTester. It is a pure material test rig for determining the coefficient of friction of rubber samples. In contrast to the TrackTester, material samples of the outsole are tested, which always have the same shape. This means that the measurements are independent 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 and from a defined height is dropped onto the sample. The acceleration with which the ball bounces off the sample is then measured.

Psychology

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 long-term motivation to exercise regularly. To support people in attaining motivation several research projects regarding this topic have been conducted throughout the years.



App prototype for Puma TRAC app

The 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 were conducted alongside a KANO analysis of product characteristics of wearables. Users’ individual implicit and explicit motive disposition and their effect on long-term usage were investigated.

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 to promote a lifelong active lifestyle. Instruments for a practicable, yet scientifically validated recording of customer profiles were developed.

In the currently running 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. Using optimal training and adapted rewards, this should be controlled in such a way that long-lasting customer loyalty to the fitness studio is created. This should be achieved 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

Tim Nebas
Max Jagsch

Not only the psychology of motivation and volition plays an important role in the development of sports equipment but also 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 armature trailrunners in different surface conditions.

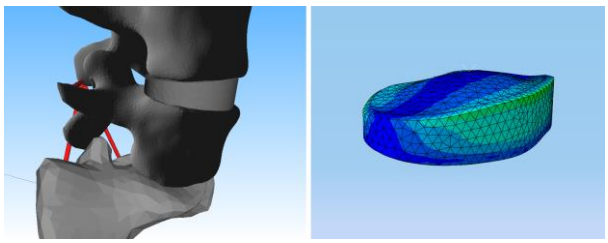
The ***PAHaM (Perception and adaption of human movement)*** project investigated the interaction between perception and kinematic and neuromuscular parameters. In running, shoe mass and inclination as the perturbation factors are investigated in different ranges. The perceived discomfort was measured subjectively through 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.

Trail running experiment with different trail running shoes

Biomechanics

Mechanics of all living beings

Biomechanics is a highly technical field whose research methods are changing rapidly, as is 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 *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 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 reduce ligament injuries. Our innovative project ***Mechatronic Ski Binding*** (funded by 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 to record all occurring forces and moments during skiing.

Jürgen Mitternacht

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

Learning to walk – Simulation of human movement using artificial intelligence and motion capturing

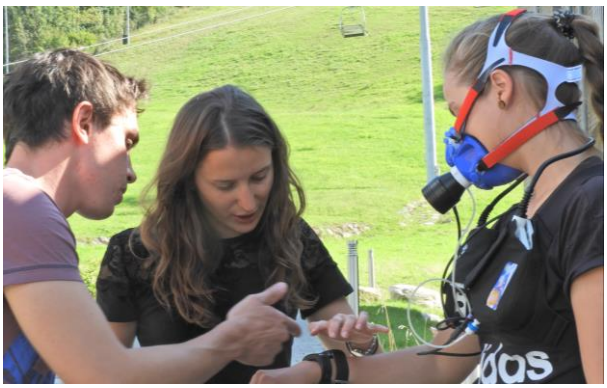
Inverse dynamic musculoskeletal models can help gain information on muscle activity and joint loads. Such a model is the main framework of the ZIM-project ***TheraTrain***. The goal is to create a simulation environment that includes the gait-training-device acting on the patient. Our task is to quantify the necessary external support forces/moments to reproduce normal gait as realistic 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.

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 is active to maintain 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 the development of smart systems for monitoring activities and vital parameters possible. Even devices with sensors attached to or implanted in the body are a reality. Sports engineering not only takes part in developing those systems or improving their accuracy and usability, but it also is in charge of validating them against gold standards. Besides measuring physiological parameters, sports engineering can also influence these by carefully designing sports equipment.

To improve the estimation of 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 as well as 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. By incorporating multiple relevant parameters like skin and core temperature, sweat rate, and heart frequency, a reliable prediction of thermal strain can be made, which, in turn, can be used to take reasonable counteractions to prevent harm.

Kilian Rauner

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

In a collaboration with ***Busch PROtective,*** we investigated the impact of helmets on the body's thermoregulation and possible solutions for related problems. Due to their properties and the closed surface, safety 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, a measuring system was developed in cooperation with Reutlingen University – Faculty of Textile & Design, and an active helmet cooling system has been manufactured. 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 that the subject of CAD would excite me so much" –
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 area. 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 never thought that the subject of CAD would excite me so much" –
Student from the course CAD Basics

"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

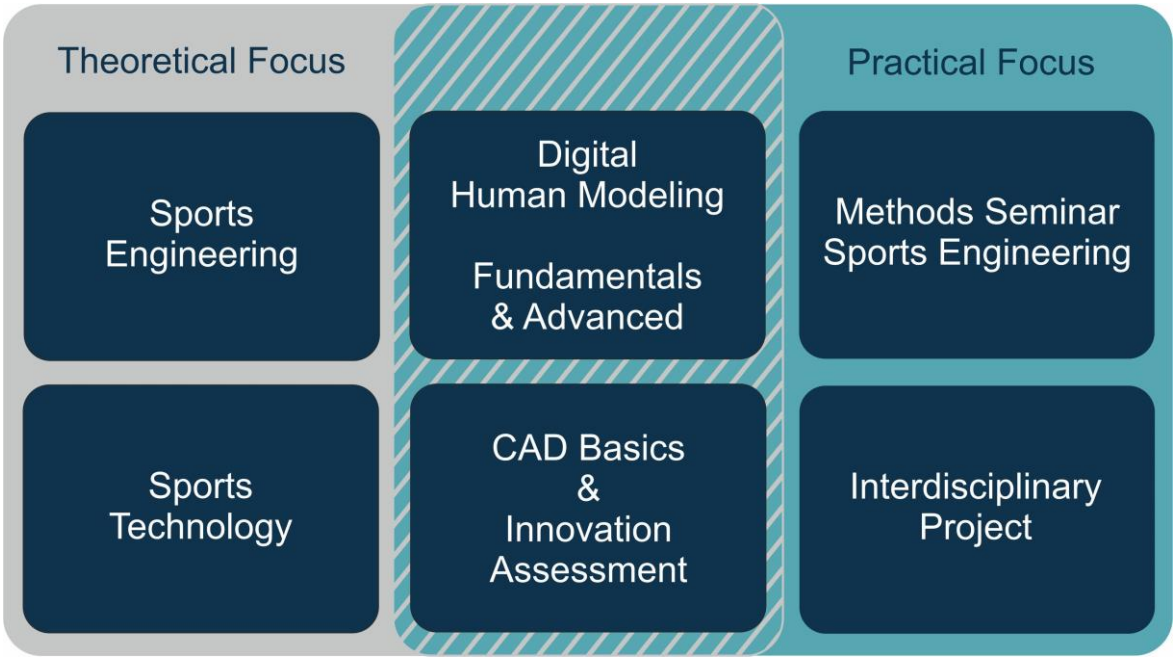
The three-day stay at the Schneefernerhaus on the Zugspitze was probably the coolest university event I have experienced in my 5 years of study so far. Above all, the relaxed but nevertheless goal-oriented working atmosphere and the fantastic group dynamics are worth mentioning. – participant of Methods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

Philipp Kopp

Teaching

High-quality teaching is a priority at our professorship. We are convinced that the practical application of learned theoretical principles not only improves learning success in the long term but above all significantly increases 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 and thus maximize 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
Joaquin Parodi

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. In the module ***Sports Engineering***, a basic understanding of these methods is conveyed and the reference to sports practice, both for recreational and competitive sports, is established through many examples. The principles of scientifically oriented work in the field of sports engineering will be illustrated and selected papers from journals and conferences will be discussed. Particular attention is paid to the need to combine different methods and to know sensible selection criteria for this.

The course ***Sports Technology*** supplements the education of students in the departments of Sport and Health Sciences with technical and engineering basics. The importance of sports science in the development of sports technology is addressed and thus the important role of sports scientists is presented. 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.

In ***Digital Human Modeling: Fundamentals*** principles and methodical procedures in the modeling process of Multi-Body Simulation (MBS) are explained., In this course, mechanical basics from the field of kinetics and kinematics, as well as rheological models for simulation of viscoelastic behavior are discussed considering related biomechanical and histological characteristics. Parallel to the theoretical content of the lectures, students will build their own MBS models to address research questions from biomechanics in sports, medicine, or everyday life. Focussing on inverse dynamic simulation, students are encouraged to analyze the plausibility and sensitivity of their models using model parameter variations to develop an understanding of the possibilities and limitations of Multi-Body Systems.

Following on from the ***Fundamentals*** course, the content of ***Digital Human Modeling: Advanced*** is the explanation of the principles and methodical 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. Complementary, insight in scientific and economic perspectives on the use of numerical simulations is an integral part of the course, which students will gain via guest lectures from various fields

.

The focus of the ***Methods Seminar Sports Engineering*** is a 3-day series of experiments conducted on the glacier of the Zugspitze in the winter semester and the Bavarian Alpine region in the summer semester. Various research questions, limited in scope, on the topic of outdoor sports (especially cycling, skiing or mountain sports) will be worked out together in preparation for this excursion and made methodologically accessible. Prototypes of sports equipment as well as measuring instruments can be used and/or new products of the sports equipment market can be evaluated in scientifically oriented practical tests. For this purpose, both objective data (material characteristics, biomechanical or physiological parameters) and subjective evaluations must be included

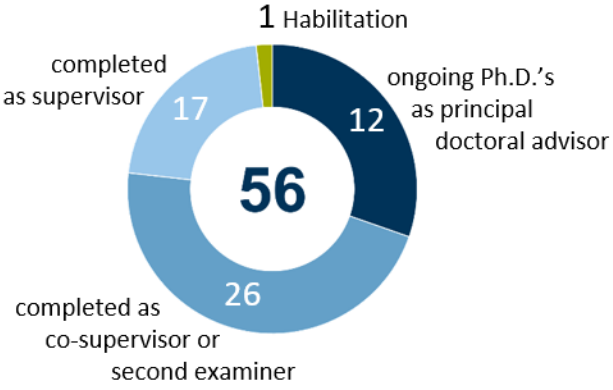
In the course ***Interdisciplinary Project***, students from different disciplinary backgrounds carry out project work. A seminar accompanies the actual project work and primarily serves to provide background information and recommendations for working in interdisciplinary teams. This also includes an introduction to project management. On the other hand, special procedures and methods are presented that help to collect and evaluate data. This includes an introduction to MATLAB. After introducing offered topics, the actual prelude to the IDP is an approx. 4-hour block event in the second week of lectures for "teambuilding" and "team-briefing". A second block event 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 exercise ***CAD Basics and Innovation Assessment*** 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 should get to know the way of thinking and working in engineering and learn how they can contribute their subject-specific knowledge from the various previous courses of study. A strengthening of the interdisciplinary way of thinking is thus to be promoted.

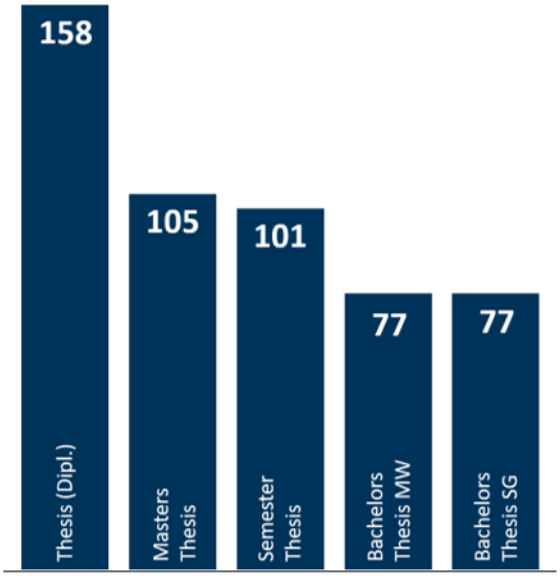
In the process, the students learn how a 3D scanner can be used to capture a body and how the scan can be processed in CAD. A customized product is then designed for the scanned object. Finally, the object is 3D printed. The students learn how to design according to standards and how to create technical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

Achievements

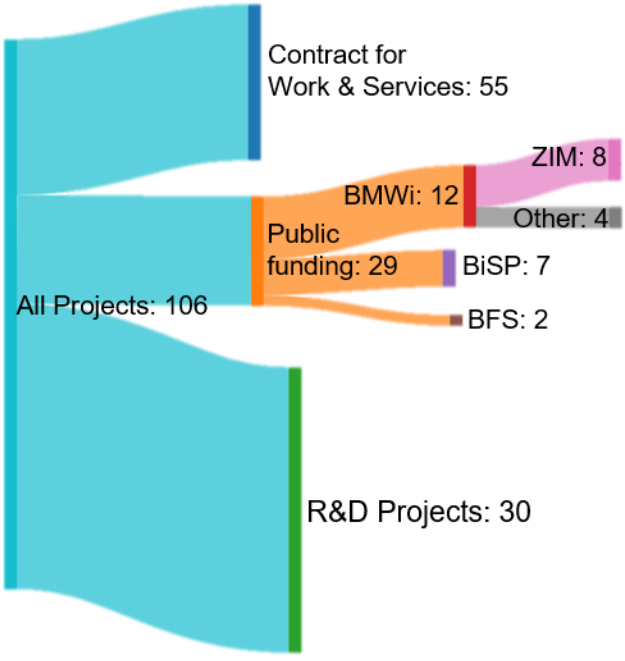
Dissertations



Student research projects



Projects



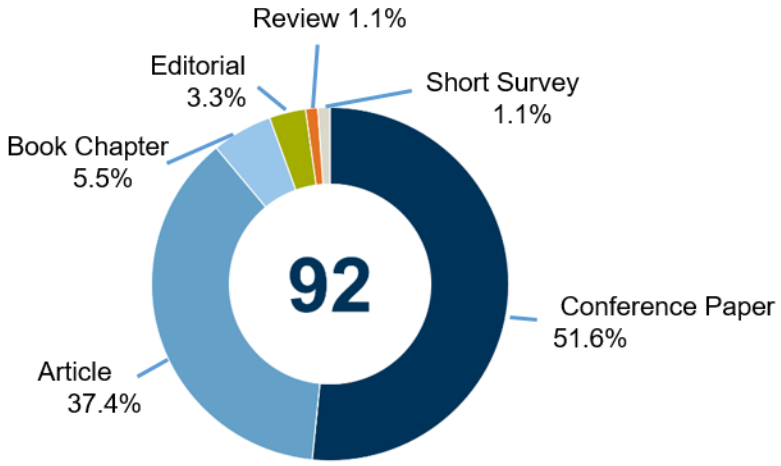
Scientific talks & presentations:

234

Raised funding:

4,189,233.72 €

Scopus listed publications

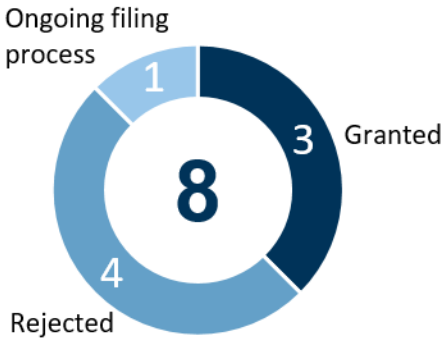


Spin-offs

Exist-Program supported by BMWi

evoha Electrolyte TRIPSTIX SURFBOARDS MOTICON

Patent applications



All numbers as of July 22, 2022

Tanja
Lerchl

Interviews
Research Associates

Christian Fritzsche

Started in 2022 with a focus on biomechanical modelling 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 just reduced to engineering-related topics, but rather an interdisciplinary interaction.

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

From my own experience, I know how much foot pain can limit one's general 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 have felt immediately welcome. The joint activities outside working hours have also strengthened the sense of belonging.

What do you take away from 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 on an engineering level and thus ideally combine my two disciplines of sports science and mechanical engineering. I really enjoy working in an interdisciplinary team 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 for general and 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 digitization are certainly the keywords of our time, which we also encounter and shape 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 fine SPGM team. Different characters and competencies are represented, which is very rewarding both professionally and personally. You can find a good contact person for 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 of a musical nature. And of course - despite sometimes stressful everyday life - our almost exclusively sporty team events are never neglected.

What do you take away from 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 take with me a diverse spectrum of methods, a lot of knowledge about many different sports products and a lot of joy in this work.

Valentin Wohlgut

Since 2020 Valentin is member of the SpGM-Team and focuses of 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 the design of 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 for general and your personal every-day life?

Optimizing the outsole of Trail Running shoes is about two key elements that are absolutely rele-vant for both amateurs and professional athletes: The risk of injury should be minimized. At the same time, performance is to 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 do you take away from your time at the SpGM?

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

Gheorghe Lisca

Is 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 the human movement from a holistic perspective. Here, I am building a solid foundation for researching the emergence of the movement within the human body, and its mechanical properties while in interaction with the environment. More specifically, I can solidly validate the results of the Artificial Intelligence algorithms which I leverage in order to understand deeper the human movement.

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

On one side, for neuroscientists, it is still an enigma how the human brain triggers and controls the movement of the body. On the other side, Artificial Intelligence algorithms become increasingly better at generating anthropomorphic movements on biomechanical models in neuromechanical simulations. In this context, these algorithms become 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 into 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 do you take away from your time at the SpGM?

A lot! ... inspiration, new know-how, support, fun, collectible 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 employments. 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 made my first steps into 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?

I work at acatech - Deutsche Akademie der Technikwissenschaften as manager for 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 forseeable 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 the 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 make the environment more and more accessible to me and give me the opportunity to discover it more. In the field of skiing, the technological innovations have contributed enormously to the professionalisation of the whole competitive sport.

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

Actually, the BikAble is a very big affair of the heart for me. 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 while sitting down.

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.

Technical University of Munich
School of Engineering and Design
Professorship of Sport Equipment and Sport Materials

Boltzmannstr 15
85748 Garching